**Jefferson County School District No. R-1**

**Support Services**

# TECHNICAL GUIDELINES

# DIVISION 26 – ELECTRICAL

**AUGUST 2022**

## Table of Contents

# DIVISION 26 – ELECTRICAL

## 26 00 01 General – August 2021

- Only the Construction Project Manager is authorized to accept delivery of equipment or spare parts specified to be delivered to the owner.
    1. The specifications shall define time of delivery as a milestone early in the project and relative to some identifiable event.
- Warranties
    1. Reference “General Conditions” for warranty periods and conditions except for special conditions and warranties, which shall be identified and listed within the appropriate individual Sections.
- Design Documents involving the modification or replacement of existing systems or equipment shall include a specific list of work items and shall give clear direction on phases of work if applicable.
    1. Statements of a global nature to rehabilitate, i.e.; "as required" or “as necessary" are not acceptable.
- Design Documents for modification or demolition of existing systems shall include drawings of equipment and materials to be removed.
    1. Statements of a global nature such as “Remove all wire in this area” are not acceptable.
    2. For equipment being removed, obtain direction from District Project Manager on what is to be returned to Jeffco and what can be otherwise disposed of.
- Completely coordinate between all design disciplines.
- Xcel Rebate Program
    1. Consultant to collect and submit the following data:
        a. Manufacturer, Model #, and Quantity are needed for every rebate. If multiple models are used, each must be included, quantities must be very clear. Provide summary sheet tagging all equipment under consideration for rebate.
            (1) Cooling Efficiency Rebates require Cut sheets that detail Tons/Unit as well as efficiency information – EER, FLV, IPLV, NPLV, SEER. Must qualify per efficiency ratings. After 9/1/2015, RTU’s, PTAC, and air cooled chillers will be discounted at point of purchase.
            (2) Drive Rebates require Drive HP, Motor HP, Motor RPM, Open (OLV) or Closed Drive and cut sheets. Rebates are for new and replacement VFDs.
            (3) Motor Rebates require the following for the new and the replaced motors. Motor Type (Open or Closed), RPM, Nominal Efficiency at full load, HP, the end use (fan, pump, etc.), manufacturer and model # of new and old motors.

(4) Heating Efficiency (for Xcel Gas Customers only) MBH of Boiler, Average fluid temp, R-value of piping insulation, linear feet of piping for every pipe size.

(5) Lighting rebates will be handled by CLEAResult, requirements can vary. Jeffco will contact CLEAResult at the beginning of each project to ensure that the needed information is gathered.

b. Include invoices for labor and materials in addition to manufacturer cut sheets. (Has to be an invoice rather than PO or other forms.)

c. Consultant to check on status of rebates with contractor when the pay-app for 50% completion is submitted. Rebates received at time of purchase shall be given to Jeffco at this point (if not already).

END SECTION 26 00 01

## 26 05 19 Building Wiring, Electrical Power Conductors and Low-Voltage Cable – August 2015

- Work in this section is open to any product meeting the requirements of this Technical Guideline.
- Section Includes
  1. Building wire
  2. Cable
  3. Wiring connections and terminations
- Coordination
  1. Section 07 80 00 Fire and Smoke Protection
  2. Section 26 05 53 Identification for Electrical Systems
  3. Section 26 08 00 Commissioning of Electrical Systems
  4. Division 23 – Low Voltage Systems
  5. See Data, Communications, and Alarm Diagram
- In the absence of other information, the following standards apply:
  1. NEMA WC 3 - Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
  2. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- General Quality Control
  1. Individual single pole breakers with handle ties shall be prohibited.

2. Dedicated neutral for single phase to neutral loads only.

- Submittals
  1. Product Data:
     a. Required
  2. Closeout:
     a. Submittals listed above
        (1) Updated to record status.
     b. Operation and Maintenance Data
- Service entrance conductors:
  1. Wire-rack conduit with State and NEC methods
- Building Wire
  1. Thermoplastic-Insulated Building Wire: NEMA WC 5.
  2. Rubber-Insulated Building Wire: NEMA WC3.
  3. Feeders and Branch Circuits 4 AWG to 250 kcmil: Copper, stranded conductor, 600 volt insulation, 75° C, THW, THHN/THWN, XHHW.
  4. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600 volt insulation, THW, THHN/THWN, XHHW. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid conductor.
  5. Feeders and Branch Circuits 250 kcmil and Larger: Copper stranded conductor, 600 volt insulation, 75° C, THHN, XHHW, THW, THWN.
  6. Control Circuits: Copper, #14 AWG, 19/25 stranding, THHN, 90° C, 600 volt. Multi-conductor control cables are allowed where more than three conductors are used between common terminations. Minimum of two spare control conductors in each cable.
  7. Wiring: #12 AWG solid, minimum, with full size ground conductors unless specifically noted otherwise for certain limited applications.
  8. 600 volt cross-linked polyethylene or thermoplastic insulated copper, 98% conductivity, single conductor.
  9. Aluminum conductors are prohibited in any application other than feeders furnished and installed by the power utility.
- Remote Control and signal cable

1. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 75° C, individual conductors twisted together, shielded and covered with interlocked aluminum armor.
2. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 75° C, individual conductors twisted together shielded, and covered with a non-metallic jacket; UL listed and labeled as CL2, CL3, CL2R, CL3R, or PLTC.
3. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 75° C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums and labeled as CL2P or CL3P.

- Armored Cable, MC Cable, ENT/NM, Modular Wire:
  1. Prohibited
- General Installation
  1. VD% less than 3% total service to end use
  2. Use no wire smaller than 12 AWG for power and lighting circuits and not smaller than 14 AWG for control wiring.
  3. Use 10 AWG conductors for 20 ampere, 120 volt branch circuit home runs longer than 75 feet and for 20 ampere, 277 volt branch circuit home runs longer than 150 feet.
  4. Make conductor lengths equal for parallel circuits.
- Wiring installation in raceways
  1. Completely and thoroughly swab raceway system before installing conductors.
  2. Pull all conductors into a raceway at the same time. Use UL-listed wire pulling lubricant rated for - 20ºF for pulling 4 AWG and larger wires.
  3. Install wire only in complete raceways after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- Support cables above accessible ceilings at four to six foot maximum intervals.
  1. Do not rest on ceiling tiles.
  2. Use hangar rods to support cables from structure.
  3. See Data, Communications, and Alarm Diagram for support details.
- Wiring connections and terminations
  1. Splice only in accessible junction or outlet boxes.

2. Use insulated spring wire connectors with plastic caps for 10 AWG and smaller.
3. Use U.L. listed connectors (Ilsco Clear Tap Products, or equal) for wire splices and taps, Ilsco Clear Tap or Burndy Hi Press #8-500 KCMIL
4. Tape or heat shrink uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.
5. Terminate spare conductors with electrical tape.
6. Use only corrosion resistant connectors listed for terminations in wet locations.

- Field Quality Control
  1. Control and signal cables passing through fire rated construction: In sleeves; conform to Technical Guideline 07 80 00 Fire and Smoke Protection.
  2. Provide sleeves for fire alarm, paging, data, telecommunications, and CATV.
- Wire and Cable Installation Schedule
  1. Concealed Interior Locations: Building wire in raceways.
  2. Exposed Interior Locations: Building wire in raceways.
  3. Above Accessible Ceilings: Building wire in raceways.
  4. Exterior Locations: Building wire in raceways.
  5. Underground Locations: Building wire in raceways.
- Color Coding Schedule
  1. Required for all wire sizes - full/length;
     a. Factory applied
  2. 208Y/120Volt Systems:
     a. Phase A: Black
     b. Phase B: Red
     c. Phase C: Blue
     d. Neutral: White
        (1) Colored stripe to indicate which phase it is connected to.
     e. Ground: Green
  3. 480Y/277 Volt Systems:
     a. Phase A: Brown
     b. Phase B: Orange

c. Phase C: Yellow

d. Neutral: Gray

(1) Colored stripe to indicate which phase it is connected to.

e. Ground: Green

4. Low Voltage Systems:

a. Lighting Controls: Yellow

- Tracer Wire:

1. Reference Division 33 for type and size of tracer wire for underground utilities.
2. Install warning caution tape above underground utility lines.
3. Install at all underground utility lines, to run with each utility listed in this Division 26, including electrical, low and medium voltage and other utilities

END SECTION 26 05 19

## 26 05 26 Grounding and Bonding for Electrical Systems – October 2011

- Work in this section is open to any product meeting the requirements of this Technical Guideline.
- Summary

1. Ground the main electrical service system according to the NEC.
2. Provide Concrete Encased Electrode (UFER).
3. See Data, Communications, and Alarm Diagram for details.

- Section Includes

1. Power system grounding.
2. Communication system grounding.
3. Electrical equipment and raceway grounding and bonding.

- Submittals

1. Shop Drawing:

a. Required

b. Indicate locations of system grounding electrode connections and routing of grounding electrode conductors

2. Closeout:

a. Submittals listed above

(1) Updated to record status.

- Materials Summary

1. Ground Rods:

a. Copper-encased steel

b. 3/4 inch diameter

c. Minimum length 10 feet

- Execution Summary

1. Ground each separately-derived system neutral as required i.e., steel structure;

a. Use or provide Burndy QGFL34B1 termination.

2. The electrode should be terminated to XO before bonding to the transformer case.

3. Provide communications system grounding conductor according to the Data, Communications, and Alarm Diagram.

4. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connections, potable cold water supply, fire sprinkler main, and natural gas lines.

5. All neutrals and grounds to comply with NEC via continuous conductor.

- Installation

1. Provide a separate, insulated equipment grounding conductor in all feeder and branch circuits. Feeders require steel ground bushing, all ends.

a. Terminate each end on a grounding lug, bus or bushing.

b. Ground to all boxes unless otherwise specified

2. Use conduit grounding bushings on feeder circuits, flex conduits to transformers, services, and panels.

a. Motors:

(1) Both ends all splice and pull boxes

(2) Provide steel bonding bushings on feeders all ends, including motors, motor controls, disconnect for TVSS and VFD drives.

3. To establish the grounding electrical system, connect grounding electrode conductors to each of the following:

a. Metal potable cold water and fire sprinkler main pipe using a suitable ground clamp on the service side of the building shutoff valve per NEC.

(1) Provide and label a bonding jumper around the water meter.

b. Steel structure where effectively grounded.

c. Concrete-encased electrode per NEC 250.52 (3).

4. Supplementary Grounding Electrode:

a. Use driven ground rods in main electrical room.

b. Install ground rod in suitable recessed well; fill with gravel after connection is made.

c. Use effectively grounded steel structure of the building.

5. Use minimum 4 AWG copper conductor for communications service grounding conductor.

a. Insulated from building

b. Terminate to approved grounding bus.

c. See Data, Communications, and Alarm Diagram.

6. All conduit and raceways shall contain an insulated ground wire sized per NEC 250.122

7. Provide grounding and bonding at utility company's metering equipment and in accordance with utility company's requirements.

END SECTION 26 05 26

## 26 05 29 Hangers and Supports for Electrical Systems – August 2015

- Work in this section is open to any product meeting the requirements of this Technical Guideline.
- Section Includes

1. Conduit and equipment supports.
2. Fastening hardware.

- Coordination

1. Division 03 - Concrete pads for electrical equipment
2. See Data, Communications, and Alarm Diagram.

- Submittals

1. Product Data:
    a. Required
2. Shop Drawing:
    a. Required
3. Closeout:
    a. Submittals listed above
        (1) Updated to record status.

- Support Channel:
    1. Galvanized or painted steel.
- Conduit Supports
    1. Clamps, straps, supports:
        a. Steel or malleable iron
    2. Galvanized straps, lay-in adjustable hangers, clevis hangers or bolted split stamped galvanized hangers
    3. Perforated pipe strap is prohibited.
    4. Wire of any type is prohibited.
    5. Arrange to prevent distortion or misalignment from wire pulling.
    6. Spacing:
        a. Per NEC
        b. In no case more than 2' from panels, boxes, conduit bodies
        c. 8 feet-0 inches o.c.
- Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance.
    1. Hardware:
        a. Corrosion resistant.
- Secure transformers and switchgear to floor or slab. Install approved vibration isolators on transformer mounting hardware.
    1. Under distribution switchboards, install free-standing electrical equipment on 4 inch concrete pads.
- Install surface-mounted cabinets, panelboards, and transformers with minimum of four anchors.

1. Align tops of all adjacent cabinets.

- Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- Fasteners
    1. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors or preset inserts.
    2. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.
    3. Use expansion anchors or preset inserts in solid masonry walls
    4. Use self-drilling anchors or expansion anchor on concrete surfaces
    5. Use sheet metal screws in sheet metal studs.
    6. Use hexagon head bolts with spring lock washers under all nuts.
    7. Powder-actuated anchors are prohibited without specific written permission.
- Quality Control
    1. Fasten supports directly to structure.
        a. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or ceiling system suspension wires or wire of any type.
    2. Drilling or other modification of structural steel members is prohibited without specific written permission from the structural engineer.

END SECTION 26 05 29

## 26 05 33 Raceways and Boxes for Electrical Systems – August 2016

- Coordination
    1. Section 08 31 00 Access Doors and Panels.
    2. Section 26 05 53 Identification for Electrical Systems.
    3. Section 26 27 16 Electrical Cabinets and Enclosures.
    4. Section 26 27 26 Wiring Devices: Service fittings and fire-rated poke-through fittings for floor boxes.
    5. Trenching: Division 31
    6. Roof penetrations are prohibited unless coordinated and detailed in strict compliance with Division 07.
    7. Coordinate exposed and surface mounted runs with Architect prior to rough-in.

8. See Data, Communications, and Alarm Diagram.

- In the absence of other information, the following standards apply:
  1. ANSI/EMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
  2. NEMA 250 Enclosures for Electrical Equipment (1000 volts maximum).
  3. ANSI C80.1 Rigid Steel Conduit, Zinc Coated
  4. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated
  5. ANSI/NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies
  6. NEMA RN 1 PVC Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
  7. NEMA TC 2 and TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
- Applications
  1. Acceptable under-slab-on-grade installation (within buildings):
     a. Main and branch lines
     b. Homeruns from branch circuits
  2. Underground installations more than 5 feet from foundation wall:
     a. Rigid Metal Conduit
     b. Intermediate Metal Conduit
     c. Plastic coated Rigid steel conduit
     d. Schedule 40 PVC conduit, with 90 degree plastic coated rigid steel conduit were it protrudes out of the earth.
  3. Underground installations within 5 feet of foundation wall or in or under concrete slab:
     a. Rigid Metal Conduit
        (1) Transition between PVC and metal conduit below grade or within slab. Must use PVC coated GRC 90's to transition above grade
     b. Intermediate Metal Conduit
     c. Plastic coated rigid steel conduit
     e. Schedule 40 PVC conduit, with 90 degree plastic coated rigid steel conduit were it protrudes out of the earth.
  4. Exposed outdoor locations
     a. Rigid Metal Conduit (GRC) 0-4'

b. Intermediate Metal Conduit 0-4’

c. Electrical Metallic Tubing 4’- +

5. Wet interior locations

a. Rigid Metal Conduit 0-4’

b. Intermediate Metal Conduit 0-4’

c. Electrical Metallic Tubing 4’- +

6. Concealed dry interior locations

a. Rigid Metal Conduit

b. Intermediate Metal Conduit

c. Electrical Metallic Tubing

7. Exposed dry interior locations

a. Rigid Metal Conduit (GRC) 0-4’

b. Intermediate Metal Conduit 0-4’

c. Electrical Metallic Tubing 4’- + (AFF and AFG) Applies to all.

- Restrictions

1. Attachment of conduit and tubing to any exterior part of the building envelope is prohibited without the approval of Jefferson County School District, R-1 and compliance with Division 07 of these Technical Guidelines.

2. Horizontal conduit runs within above grade concrete slabs are prohibited.

- Submittals

1. Product Data: Required for surface raceways, multi-outlet assemblies, auxiliary gutters, and accessories.

2. Shop Drawing: Required

3. Closeout: Submittals listed above, updated to record status.

- Wall and ceiling outlet boxes

1. Open to any product meeting the requirements of this Technical Guideline..

2. Sheet Metal Outlet Boxes:

a. ANSI/NEMA OS 1;

b. Galvanized steel, with 1/2 inch male fixture studs where required.

c. Standard size for all systems: 4 inches x 4 inches x 2 1/8 inch minimum depth

3. Cast Boxes:
    a. Aluminum, deep type, gasketed cover, threaded hubs.

- Pull and Junction Boxes

1. Restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 .
    a. Appleton Electric
    b. Bowers
    c. Carlton
    d. Lew Electric
    e. National Electrical Products
    f. Raco
    g. Steel City
2. Sheet Metal Boxes less than 24 inches: ANSI/NEMA OS 1; galvanized steel.
3. Sheet Metal Boxes Larger than 24 inches in any dimension: Hinged enclosure in accordance with Section 26 27 16.
4. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain tight. Cast aluminum box and cover with ground flange, neoprene gasket and stainless steel cover screws.
    a. Shall not be used at vehicle traffic areas
5. Fiberglass Handholes for Underground Installations:
    a. Die-molded with pre-cut 6 x 6 inch cable entrance at center bottom of each side
    b. Fiberglass weatherproof cover with non-skid finish
    c. Traffic Rated
    d. 20k rated weight minimum.
    e. Shall not be used at vehicle traffic areas such as parking lots and drives.
6. Locate and install boxes above accessible ceilings or in unfinished areas to allow access.
    a. Where installation is inaccessible, coordinate locations and size of required access doors.
    b. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

7. Locate and install boxes to maintain headroom and to present a neat appearance.
8. Support pull and junction boxes independent of conduit.

- Floor Boxes
  1. Restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.
     a. Appleton Electric
     b. Bowers
     c. Hubbell
     d. Lew Electric
     e. Raceway Components Inc.
     f. Rotco Inc.
     g. Steel City
     h. Walker
  2. The use of floor boxes is discouraged. Consider other options first.
     a. Coordinate with District Project Manager
- Outlet Boxes
  1. Open to any product meeting the requirements of this Technical Guideline.
  2. Do not install boxes back-to-back in walls.
     a. Provide minimum 6 inch separation;
        (1) 24 inch separation in acoustic or fire-rated walls.
  3. Locate boxes in masonry walls to require cutting of masonry unit corner only.
  4. Provide knockout closures for unused openings.
  5. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.
  6. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes.
  7. Provide barriers to separate wiring of different voltage systems.
  8. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness.
     a. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

9. Provide cast outlet boxes in exterior locations exposed to the weather and wet interior locations.
10. Exposed boxes in kitchens and shops:
    a. Provide bell type boxes with threaded openings.

- Underground Pull Boxes in vehicle traffic areas.
  1. Restricted to specific products of specific manufacturers that have been previously approved by Jefferson County School District, R-1 :
     a. Amcor 3 x 3 precast PB 3030-30; #0300720:
        (1) Pre-cast concrete open-bottom
        (2) Steel traffic rated lid stamped “ELECTRICAL”.
        (3) Bonded to equipment ground
        (4) Traffic Rated to 20K minimum.
     b. Approved equivalent.
- Underground Ducts and Raceways
  1. Open to any product meeting the requirements of this Technical Guideline.
- Exterior Pedestals
  1. Concrete pad mounted electrical pedestals for exterior use
     a. At temporary classroom buildings
     b. Milbank, or equivalent
     c. Weathertight
- Rigid Metal Conduit and Fittings
  1. Work in this section is open to any product meeting the requirements of this Technical Guideline.
  2. Rigid Steel Conduit:
     a. ANSI C80.1 galvanized
  3. PVC Externally Coated Conduit:
     a. NEMA RN 1 Rigid steel conduit with external 40 mil PVC coating and internal galvanized surface
  4. Fittings and Conduit Bodies:
     a. ANSI/NEMA FFB 1

b. Threaded type, material to match conduit

- Intermediate Metal Conduit and Fittings
  1. Open to any product meeting the requirements of this Technical Guideline..
  2. Conduit:
     a. Galvanized steel
  3. Fittings and Conduit Bodies: ANSI/NEMA FB 1; Threaded type, material to match conduit
- Electrical Metallic Tubing and Fittings
  1. Open to any product meeting the requirements of this Technical Guideline.
  2. EMT:
     a. ANSI C80.3 Galvanized tubing
  3. Fittings:
     a. ANSI/NEMA FB 1
     b. High quality, insulated throat, steel set screw
     c. Die cast fittings are prohibited
  4. Steel Compression Fittings:
     a. High quality compression is required on surface work in kitchens, greenhouses, and other areas where waterproof fittings are required by NEC
  5. Conduit Bodies: Aluminum, steel or malleable iron
     a. PVC is prohibited
- Flexible Metal Conduit and Fittings (Armored Cable)
  1. Open to any product meeting the requirements of this Technical Guideline.
  2. Use only at fixture whips and part of a listed assembly.
  3. All other locations prohibited.
  4. Conduit:
     a. Steel
  5. Fittings and Conduit Bodies:
     a. ANSI/NEMA FB 1
     b. Material to match conduit
  6. Length:

a. 6 feet maximum except where fished or approved by NEC and Jefferson County School District, R-1.

- Liquid Tight Flexible Metal Conduit and Fittings
  1. Open to any product meeting the requirements of this Technical Guideline..
  2. Conduit:
     a. Flexible metal conduit with PVC jacket
  3. Fittings and Conduit Bodies: ANSI/NEMA FFB 1; waterproof material to match conduit.
  4. 6 feet maximum lengths or as required by NEC.
- Non-Metallic Conduit and Fittings
  1. Open to any product meeting the requirements of this Technical Guideline.
  2. Shall not be used above grade.
  3. Conduit:
     a. NEMA TC 2; Schedule 40 PVC
  4. Fittings and Conduit Bodies: NEMA TC 3
  5. Prohibited for exposed or concealed applications in stud and masonry walls or ceiling plenum.
  6. Wipe plastic conduit clean and dry before joining
  7. Apply full even coat of cement to entire area that will be inserted into the fitting
  8. Cure joint 20 minutes minimum
  9. Transition between PVC and metal conduit below grade or within slab. Must use PVC coated GRC 90's to transition above grade.
  10. PVC expansion couplings shall be used at transition between grade and building surface, and as required by NEC.
- Plastic surface raceways prohibited.
- Surface Metal Raceways
  1. Restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1:
     a. Carlton
     b. Hubbell
     c. IsoDuct

d. Panduit

e. Square D

f. Walker

g. Wiremold

2. System of sheet metal channel with fitted cover suitable for use as surface metal raceway
3. Couplings, elbows and connectors designed for use with the raceway system
4. Boxes and Extension Rings designed for use with the raceway systems
   a. Extension boxes and/or rings not allowed on new work
5. Use flat head screws to fasten channel to surfaces
   a. Option: Use suitable clips and straps
6. Use insulating bushings and inserts at connections to outlets and corner fittings
7. Maintain grounding continuity between raceway components
8. Preferred location: below the work surface or deck tops

- Multi-Outlet Assembly
  1. Restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1 :
     a. Carlton
     b. IsoDuct
     c. Panduit
     d. Pass & Seymour
     e. Walker
     f. Wiremold
  2. Multi-outlet Assembly: channel with fitted cover and pre-wired receptacles, suitable for use as a multi-outlet assembly.
  3. Convenience receptacles mounted in cover at designated intervals.
  4. Couplings, elbows, outlet and device boxes and connectors designed for use with multi-outlet system.
  5. Use flat head screws to fasten channel to surfaces
     a. Option: Use suitable clips and straps

6. Use insulating bushings and inserts at connections to outlets and corner fittings
7. Maintain grounding continuity between raceway components
8. Preferred location: Below the work surface or deck tops

- Auxiliary Gutters
  1. Open to any product meeting the requirements of this Technical Guideline..
  2. General purpose type wireway, with knockout
  3. Connector:
     a. Hinged cover
        (1) Screw applied cover.
  4. Lay-in type fittings with removable top, bottom, and side; captive screws.
  5. Rust inhibiting primer coat with gray enamel finish.
  6. Bolt auxiliary gutter to steel channels fastened to the wall or in self-supporting structure.
  7. Install level
  8. Gasket each joint in oil-tight gutter.
  9. Mount rain tight gutter in horizontal position only.
- Accessories
  1. Open to any product meeting the requirements of this Technical Guideline.
  2. Conduit Rack:
     a. Steel channel with conduit straps or clamps;
     b. Oversize by 25%
- Conduit Size
  1. Size conduit for installed conductor type or for type THW conductors, whichever is larger.
  2. ½ inch minimum except flexible fixture whips which may be 3/8 inch
  3. Home runs to switchboards and panels: 3/4 inch minimum
- General Installation Requirements
  1. Conceal conduit to the greatest extent possible
  2. Run conduit parallel and perpendicular to adjacent walls, ceilings, piping, exposed and concealed.

3. Install horizontal runs of conduit to maintain a minimum clearance of 6 inches above ceiling grid assembly where possible.
4. Maintain 6 inch minimum clearance between conduit and piping.
5. Maintain 12 inch minimum clearance between conduit and heat sources such as flues, pipes, and heating appliances.
6. Group conduit in parallel runs where practical. Conduit Rack is preferred.
7. Remove temporary conduit supports before pulling conductors
8. Exposed/concealed interior locations
    a. Raceway, cables, boxes installed under metal-corrugated sheet roof decking shall be installed and supported to maintain a minimum of 3- inches clearance from the lowest surface of the roof decking to the top of the raceway, cable, or box.

- Special Installation Techniques
    1. Bring conduit to the shoulder of fittings and couplings.
    2. Fasten securely
    3. In damp or wet locations, use conduit hubs or sealing locknuts for fastening conduit to cast boxes and to fasten conduit to sheet metal boxes.
    4. Use conduit bodies to make sharp changes in direction, as around beams
    5. Use hydraulic one shot conduit bender or factory elbows for bends in conduit larger than 2 inch size
    6. Avoid moisture traps. Where unavoidable, provide junction box with drain fitting at conduit low point
    7. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture
    8. Use nylon pull string ("jetline") with a pull strength of 200 pounds or greater in empty conduits except sleeves and nipples.
    9. Use PVC coated rigid steel factory elbows
        a. For bends in plastic conduit runs longer than 100 feet
        b. In plastic conduit runs which have more than 2 bends, regardless of length
- Interface with other work
    1. Install expansion joints where conduit crosses building expansion joints.
    2. Where conduit penetrates fire rated construction, provide pipe sleeves 2 sizes larger than conduit. Conform to Technical Guideline 07 80 00 Fire and Smoke Protection.

- Interior underground and Concrete Encased Conduit
    1. Interior slab-on-grade: Install conduit 6 inches minimum below slab-on-grade to top of conduit unless otherwise authorized by Jefferson County School District, R-1.
        a. Properly prepare trench bedding
        b. Follow main corridors to the greatest extent possible
    2. Minimum slope: 4%
    3. Minimum size: 3/4 inch
    4. Use suitable separators and chairs installed no more than 4 feet 0 inches o.c. and securely anchor conduit to prevent movement during placement of concrete
    5. Provide minimum 3 inch concrete cover at top, bottom, and sides of conduit.
    6. Seal ends to be completely water tight.
    7. Install warning ribbon in trench 12 inches above raceway or cable.
- Raceway for telephone, television, paging, and local area network.
    1. Conduit runs less than 100 feet from point-to-point shall not contain more than two 90º standard factory bends, or three 90º , 24 inch radius bends.
    2. Conduit runs exceeding 100 feet from point-to-point or exceeding two 90º - 24" radius bends shall contain accessible pull boxes.

END SECTION 26 05 33

## 26 05 53 Identification for Electrical Systems – August 2015

- Work in this section is open to any product meeting the requirements of this Technical Guideline.
- Framed graphic map of one line diagram of the electrical system, mounted in the main electrical room. These shall be extracted from the close out documents. Include room numbers for all electrical panel locations and arc flash calculations on one line.
    1. Also included when any changes are made to MDC or SDC and updates are necessary.
    2. One-line diagrams shall be installed in a protective cover and frame at each location.
- Nameplates, wire markers, or labels are required at each and every component of the electrical system.
- Coordination
    1. Section 09 90 00 – Painting and Coating

2. See Data, Communications, and Alarm Diagram.

- Submittals
  1. Product Data:
     a. Required
  2. Shop Drawing:
     a. Required
     b. Include complete schedule of nameplates and labels.
  3. Samples:
     a. Required
  4. Closeout:
     a. Submittals listed above
        (1) Updated to record status.
        (2) Samples excluded
- Fonts for all identification
  1. Sans Serif typeface such as Helvetica
- Color Code – Printed Self-Adhesive Labels:
  1. Black characters on white or clear background for "Normal",
  2. White characters on red background for "Emergency" and fire alarm devices
  3. White characters on green background for "Ground".
- Nameplates:
  1. Mechanically mounted - riveted.
  2. White letters on black background.
  3. Provide engraved nylon trim plates for gym lighting corridor and boxes three (3) gang and larger.
  4. Provide on all large equipment
  5. Distribution and control equipment
     a. Engraved three-layer laminated plastic
     b. UV Resistant
     c. Identify equipment and loads served.

d. 1/8 inch lettering for individual switches and loads served

e. 1/4 inch lettering for distribution and control equipment.

6. Panelboards and Switchboards:

   a. 1/4 inch lettering to identify equipment designation

   b. 1/8 inch lettering to identify voltage rating and source.

7. Individual Circuit Breakers and Switches in Panelboards and Switchboards:

   a. 1/8 inch lettering to identify circuit and load served, including location.

8. Individual Circuit Breakers, Enclosed Disconnect Switches, and Motor Starters:

   a. 1/8 inch lettering to identify load served and circuit designation.

9. Transformers:

   a. 1/4 inch lettering to identify equipment designation.

   b. 1/8 inch lettering to identify primary and secondary voltages, primary source, and secondary load and location.

10. Main Grounds:

    a. 1/4 inch lettering "Do Not Disconnect". 1/4 inch lettering to identify type of ground.

11. Data/Communications: No requirements at this time.

- Printed, Laminated Labels:

  1. Self-adhesive, thermal transfer tape

  2. Minimum 3/8 inch high characters

  3. Colors as noted in color code above

  4. Use only for identification of individual wall switches and receptacles, control device stations.

  5. Locate tape on the front side of the cover plate and with indelible ink on the back of the cover plate and with indelible ink on the device/junction box.

  6. Electrical Disconnects above ceilings and other semi-concealed spaces.

- Wire and Cable Markers:

  1. Permanently printed split sleeve tube type adhesive backed circumferential:

  2. Brady, or approved equivalent.

- Degrease and clean surfaces to receive nameplates and tape labels.

- Install nameplates and tape labels parallel to equipment lines.
    1. Secure nameplates to equipment fronts using screws, rivets.
    2. Secure nameplate to inside face of recessed panelboard doors in finished locations.
- Label “Grounding Electrode Conductor” and “Main Bonding Jumper” with engraved tags.
- Wire Identification
    1. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection.
    2. Identify with branch circuit or feeder number as indicated on equipment manufacturer’s shop drawings for control wiring.
- Junction Box and Pull Box Identification
    1. Use indelible black marker to inscribe circuit or bus, switch numbers and source panel on the outside of each junction and pullbox cover.
- Systems Identification
    1. Arc flash labeling on all equipment including disconnects. Per NFPA 70E
    2. Telephone:
        a. Identify telephone raceways with the label “TELEPHONE” on pull and junction boxes and conduit at the termination points.
        b. Identify Telephone Termination Backboard with the legend “TELEPHONE” on pull and junction boxes and conduit at the termination points.
    3. Television:
        a. Identify television raceways with the label “TELEVISION” on pull and junction boxes and conduit at the termination points.
    4. Label outlets and switches in front with printed labels, back of plate use indelible ink.

END SECTION 26 05 53

## 26 08 00 Commissioning of Electrical Systems –August 2015

- Work in this section is open to any product meeting the requirements of this Technical Guideline.
- Testing is required for all Division 26 equipment, wiring, devices, etc. to assure that electrical equipment is operational within industry and manufacturer's tolerances and conforms to the contract documents.
- In the absence of other information, standards of the following organizations apply:

1. National Electrical Testing Association, Inc. - NETA.
2. Association of Edison Illuminating Companies - AEIC.

- Submittals
  1. Documentation of Testing Agency accreditation:
     a. Required
  2. Written Test Reports:
     a. Required
        (1) Preliminary
        (2) Certified Final Test Reports
  3. 3 Electronic copies to the District of all testing and procedures.
  4. Closeout:
     a. Submittals listed above
        (1) Updated to record status.
- Testing Equipment
  1. All instruments used to evaluate electrical performance shall meet NETA's Specifications for Test Instruments.
     a. The Contractor shall have a calibration program which maintains each applicable test instrument within its rated accuracy.
  2. Instruments shall be calibrated in accordance with the following frequency schedule:
     a. Field instruments - 6 months maximum.
     b. Laboratory instruments - 12 months.
     c. Leased specialty equipment - 12 months.
  3. Dated calibration labels shall be visible on all test equipment.
  4. Maintain an up-to-date instrument calibration instruction for each test instrument.
  5. Maintain up-to-date documentation showing date and results of instrument calibration and testing.
- Acceptable Testers
  1. Any independent testing laboratory meeting federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907. Membership in the National Electrical Testing Association constitutes proof of meeting such criteria.
  2. Electrical subcontractor unless otherwise noted.

- Testing Schedule

1. Cables - Low Voltage (600 Volts and less – Electrical Systems Only)
    a. Visual and Mechanical Inspection
        (1) Inspect cables for physical damage and proper connection in accordance with the engineer's single line diagram.
        (2) Torque test each feeder cable connection to the manufacturer's recommended value.
        (3) Branch circuits excluded.
    b. Electrical Tests
        (1) Prior to final wire termination perform an insulation resistance test on each feeder cable (branch circuit wires are excluded) with respect to ground and adjacent cables.
        (2) Perform continuity test to insure proper cable connection.
        (3) Test Values:
            (a) Insulation resistance tests shall be performed at 1000 volts D.C. for 30 seconds.
            (b) Minimum resistance value: 250,000 ohms.
2. Circuit breakers - low voltage
    a. Visual and Mechanical Inspection
        (1) Check each circuit breaker for proper mounting, conductor size and feeder designation.
        (2) Operate each circuit breaker to insure smooth operation.
        (3) Inspect each case for cracks or other defects.
        (4) Check tightness of each connection with torque wrench in accordance with manufacturer's recommendations.
3. Grounding Systems
    a. By independent testing laboratory only
    b. Visual and Mechanical Inspection
        (1) Inspect ground system for compliance with plans and specifications.
    c. Electrical Tests:
        (1) Test before any work has started and at completion. Contractor guarantees that grounding is compliant if no test has been completed prior to work.

(2) Perform fall of potential test per IEEE Standard No. 81, Section 9.04, on the main grounding electrode or system.

(3) Perform the two point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the MDCs and SDPs.

(4) Test Values:

(a) The main ground electrode system resistance to ground should be no greater than 5 ohms.

4. Ground Fault Systems (NEC 230-95)

a. By independent testing laboratory only

b. Visual and Mechanical Inspection:

(1) Inspect for physical damage and compliance with plans and specifications.

(2) Inspect neutral main bonding connection to assure:

(a) Zero sequence system is grounded upstream of sensor.

(b) Ground strap systems are grounded through sensing device.

(c) Ground connection is made ahead of neutral disconnect link.

(3) Inspect control power transformer to insure adequate capacity for system.

(4) Manually operate monitor panels (if present) for:

(a) Trip test.

(b) No trip test.

(c) Non-automatic reset.

(5) Record the proper operation and test sequence.

(a) Provide written results to District Project Manager

(6) Inspect zero sequence systems for symmetrical alignment of core balance transformers about all current carrying conductors.

(7) Verify ground fault device circuit nameplate identification by device operation.

(8) Set pickup and time delay values in accordance with the engineer's design on construction documents.

(9) Set main switch GFI to job-specific values.

(10) Do not leave at factory minimum setting.

b. GFI Settings shall be verified by independent testing.

(1) Print GFCI relay settings on electrical one-line drawing.

5. Electrical Test: By independent testing laboratory only.

(1) Infrared test of all electrical switchgear, lugs, power and light panels under full load.

(2) Infrared test at 11month walk, of all electrical switchgear, lugs, power and light panels under full load.

(3) Remove the neutral-to-ground connecting link to measure the neutral insulation resistance and insure that no shunt ground paths exist. Replace the link.

(4) Determine the relay pickup current.

(5) Test system operation at 125% rated voltage.

(6) Test Parameters:

(a) System neutral insulation shall be a minimum of one megohm or greater.

(b) Relay pickup current: Within 10% of device dial or fixed setting and in no case greater than twelve hundred amperes.

(c) Relay timing: In accordance with manufacturer's published time current characteristic curves but in no case longer than one second.

(7) Provide written results to District Project Manager.

(8) Submit written results with Close-out Documents.

- See Division 27 for testing requirements of communication and alarm systems.

END SECTION 26 08 00

## 26 09 33 Lighting Controls – August 2022

Lighting Controls

1. General Guidelines
   a. Comply with latest state adopted IECC standard.
   b. Provide control systems which are local to spaces and non-centralized.
   c. The lighting control system shall “sweep off” all controlled interior lights that are not controlled with an occupancy sensor at pre-determined programmable intervals during unoccupied times.
      (1) Occupancy sensors in occupied spaces shall be programmed to stay on for ten minutes after last detecting motion or sound.
      (2) Occupancy sensors in spaces normally unoccupied shall be programmed to stay on for five minutes.

d. Occupancy sensors shall be installed per manufacturer recommendations. If wired, provide dual technology occupancy sensors (passive infrared and ultrasonic) with auto-on-off capability. If wireless, provide passive infrared only. Occupancy sensor(s) shall turn off all lights in the room after a pre-set but programmable interval after room has been vacated (as defined in Section 26 09 33). Lighting control equipment shall be locked, located, or otherwise made secure against vandalism.
e. Upon reactivation of luminaires, light level shall return to last setting/level.
f. Keyed switches or lockable covers required in auditoria, main corridors, and gymnasiums, which also require the cover to be vandal proof.
g. Upon failure of normal power, emergency lighting fixtures shall automatically operate from the emergency power source. Emergency lights shall turn-on in case of power failure. Upon return of normal power all emergency fixtures shall return to their prior state.
h. For Elementary and Middle Schools, provide centralized control panel with a manual switch located in the main office and in the Facility Manager's office to manually activate the corridor and common area lighting. If occupancy sensors are not required, luminaires shall be controlled manually on. Luminaires shall be controlled to turn automatically off at a 10:45PM. Unless otherwise noted and approved by District Project Manager. For High Schools Lighting Designer/Electrical Engineer to make recommendations on corridor and commons control method as well as location of switches.
i. The lighting control system for common areas and corridors shall cause the luminaires to "blink" at pre-determined but programmable intervals prior to sweeping the lights off at 10:45 PM.
j. Interior photosensors for daylighting control shall be located and wired per manufacturer recommendations. The Designer is required to coordinate with the manufacturer to determine the best location for the sensors and the most appropriate wiring approach, which could be open or close loop.
k. Demolish unused branch circuiting and conduit back to the panel. Label unused breakers as "SPARE" in Contract Drawings.

2. Specific Control Requirements – Illuminances are provided for each space type in Jeffco Schools –Average Illumination Levels Table in section 265000. The lighting control system shall include but not be limited to the following areas:
    a. Classroom Lighting Controls (also Laboratories and CTE)
        (1) All classrooms shall utilize a local room controller to support control configuration functions and devices as listed within this section. Room controller(s) shall support the desired presets in addition to being equipped with manual dimming of all room luminaires
            a. The room controller shall be UL924 listed where used in conjunction with an emergency power source for emergency lighting.
        (2) Each classroom shall be equipped with a controller with four preset buttons. Three presets will be labelled as "HIGH", "MEDIUM", and "LOW" and will

be programmed during the installation of the lighting system to the levels included in Jeffco Schools –Average Illumination Levels Table in section 265000. The fourth preset button shall be labelled "OFF". Lighting Designer/Electrical Engineer shall verify that illuminance presets provide the levels listed in Jeffco Schools –Average Illumination Levels Table in section 265000.

(3) Provide single zone lighting controls for each classroom.

(4) Provide minimum of two (2) dual technology occupancy sensors with manual-on, auto-off capability. Additional sensors may be required depending on the size of the room. Controllers must also be capable of manual-off for use during lock-downs. Occupancy sensor(s) shall turn off all lights in the room 20 minutes after room has been vacated.

(5) If required, provide photo sensor(s) with necessary interconnections to the classroom lighting dimming controls. Amperage changes in light fixtures shall be proportional to external light changes. In addition to manual dimming, the fixtures shall automatically dim at a rate slow enough to not be bothersome to occupants. Locate one photo sensor near the entrance to the room and a second near the teaching wall for the lights to be controlled. Photo sensors shall not be positioned where the device will be affected by direct sun light, room luminaires or obstructions. Local control station shall override daylight harvesting functions.

(6) Circadian rhythm lighting shall, be equipped with four presets defining color temperature and illuminance as well as a full range dimmer to allow manual adjustment of color temperatures and melanopic content. The keypad shall be fully capable of tuning between preset CCT as well as controlling the light level in the space. The presets shall be labeled as "CHARGE" at 6500K, "CLASS" at 4500K, "CREATE" at 3500K, and "CALM" at 2700K.

(7) The use of touchscreens is prohibited unless approved by the District Project Manager.

(8) The use of wireless controls is prohibited in new buildings. The use of wireless controls in existing buildings is prohibited unless approved by the District Project Manager. Wireless controllers are required to utilize only off-the-shelf batteries. Use of wireless controls shall be coordinated with Jeffco Schools I.T. Department.

b. Offices, Workrooms, and Conference Rooms

(1) Each space shall be equipped with a manual dimmer.

(2) Dual Technology Occupancy sensors shall be configured as "vacancy" sensors or as manual on/auto off. Luminaires shall remain lit for 5 minutes after last detecting motion.

c. Locker Rooms.

(1) Provide ceiling-mounted occupancy sensor(s) as required for full coverage. Occupancy sensors shall turn off all lights in the room via a pre-set but programmable interval after the room is vacated. At minimum, occupancy sensor to be placed to detect motion upon entering the space.

d. Gymnasium
   (1) Wall-mounted dimmer switches shall provide for manual light reduction when daylighting is adequate, or for darkening of the room for activities. Locate dimmer switch easily accessible to the teacher.
   (2) Provide dual technology occupancy sensors (infrared and passive sonic) with auto-on-off capability. Occupancy sensor(s) shall turn off all lights in the room after a pre-set but programmable interval after room has been vacated.
   (3) If required, provide photo sensor(s) with necessary interconnections to the classroom lighting dimming controls. Amperage changes in light fixtures shall be proportional to external light changes. In addition to manual dimming, the fixtures shall automatically dim at a rate that is slow enough to not disrupt occupants. Locate photo sensors in an optimal place for the lights to be controlled. Photo sensors shall not be positioned where the device will be affected by direct sun light, room luminaires or obstructions. Local control station shall override daylight harvesting functions.
   (4) If multi-level switching is present keep circuiting in place and add dimming capability.
   (5) Middle and High School gyms shall be capable of providing 50% illuminance. This may be achieved through dimming or selective switching. The most practical approach shall be determined by the Lighting Designer/Electrical Engineer.
   (6) If a curtain divider is present, provide separate switching for both sides.

e. Auditoria
   (1) Provide preset controller and dimmer for control of general lighting.
   (2) Provide means of control of house lights from backstage and from control booth. Lighting controls accessible in the space shall be equipped with a lockable cover.
   (3) If this or any other area or room is intended for general assembly and utilized in a manner that requires dimming or turning off the lighting, the house lighting shall be interfaced with the Fire Alarm System, which in case of a fire emergency will force the lighting fully on regardless of the manual or automatic control settings.

f. Cafeteria
   (1) Provide ceiling mounted occupancy sensor(s) with switch(es) with four presets and manual dimming. Quantity and placement of occupancy sensors shall allow detection of persons located throughout the room.
   (2) The light level for dining shall be at the student level defined in Jeffco Schools –Average Illumination Levels Table in section 26 50 00.

g. Staff Restrooms
   (1) Occupancy sensor switches adjacent to the door, and wall mounted occupancy sensors for on/off controls. The sensor shall be configured in a "vacancy" or Manual On / Automatic Off configuration.
   (2) If the exhaust fan is dedicated to the restroom or a pair of ganged restrooms, luminaire and exhaust fan operation shall be interlocked.

h. Student's Restrooms
   (1) Occupancy sensor switches adjacent to the door, and ceiling mounted occupancy sensors for on/off controls. The sensor shall turn off the lights after the room has been vacated.
   (2) If the exhaust fan is dedicated to the restroom or a pair of ganged restrooms, lights and exhaust fans shall be interlocked.

i. Main Office
   (1) Provide non-locking local switching for manual operation. In addition, use light sensor(s) to reduce electric lighting levels in areas where natural lighting contribution is significant.
   (2) Individual offices to be equipped with wall mounted occupancy sensor switches in the "vacancy" or Manual On / Automatic Off configuration.
   (3) Central building lighting controls for common areas shall be located here and in the Facility Manager's office.

j. Conference rooms
   (1) Provide non-locking local switching for manual operation. In addition, use light sensor(s) to reduce electric lighting levels in areas where natural lighting contribution is significant.
   (2) Individual Conference rooms to be equipped with wall mounted dimmer switch and ceiling or corner mounted occupancy sensors switches if wall mounted occupancy sensor is inappropriate for the room size.

k. Custodial and storage rooms
   (1) Provide occupancy sensor with automatic on-off capability in addition to manual switches. The sensor shall turn off the lights in the room via a pre-set but programmable interval after the room has been vacated.

l. Mechanical, Electrical, MDF/IDF rooms, Attics, and other unoccupied spaces
   (1) Manual switch.

m. Emergency Lighting
   (1) Emergency lighting controls shall be equipped with bypass circuitry that will bypass all manually operated switches, lighting control systems, dimmers and occupancy sensors during power failure situations, design shall comply with applicable codes and regulations. Each area of luminaries or groups of luminaries shall be equipped with and controlled by a UL924 listed emergency lighting control units to allow the detection of localized power failures.
   (2) If site is equipped with an emergency generator, all emergency lighting and exit signs shall be circuited to the emergency generator. Otherwise, emergency lighting and exit signs shall be equipped with battery backup.
   (3) Emergency lights that will also be used for general lighting shall be switched, dimmed and controlled together with the general lighting for the same area, but shall turn on (at full brightness for dimmable fixtures) upon loss of general power.
   (4) LED exit sign luminaries shall operate continuously. Continuously operating luminaries other than LED exit luminaries are not permitted.

(5) All emergency lights shall be powered by the emergency power source, and may be controlled by a lighting control panel.
(6) Provide connection details for each style of control for the emergency lighting on the drawings. Also indicate on the drawings the style of control that is required for the luminary.

n. Corridors
(1) If lighting level target defined in Jeffco Schools – Standard for Average Illumination Levels table cannot be met with selected luminaire and layout, dimming shall be provided and space shall be programmed (or trimmed) to provide the 15 fc at all times when operating.

END SECTION 26 09 33

## 26 22 00 Low Voltage Transformers –August 2015

- Work in this section is restricted to specific products of specific manufacturers that have been previously approved by Jefferson County School District, R-1.
  1. General Electric
  2. Howard Industries
  3. International Transformer Corporation
  4. ITE
  5. Square D
  6. Cutler Hammer/Eaton
- In the absence of other information, the following standards apply:
  1. ANSI/NEMA ST 20 – Dry Type Transformers for General Applications.
- Submittals
  1. Product Data:
     a. Required
  2. Manufacturer's specification and product data cut sheets for all system components and devices, including:
     a. Outline and support point dimensions of enclosures and accessories
     b. Unit weight
     c. Voltage, KVA, impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load,
     d. Sound level, tap configurations, insulation system type and rated temperature rise.

3. Manufacturer Instructions:
    a. Required
4. Closeout:
    a. Submittals listed above
        (1) Updated to record status.

- Coordination
    1. See Data, Communications and Alarm Diagram
- Dry type High Efficiency dual winding Transformers
    1. ANSI/NEMA ST 20
        a. Factory-assembled
        b. Air cooled dry type transformers
    2. Insulation system and average winding temperature rise for rated KVA as follows:
        a. Rating  K-Rated Transformer Rise (°C)
    3. Case temperature shall not exceed 35°C rise above ambient at its warmest point.
    4. Winding Taps for Transformers Less than 15 KVA:
        a. Two 5 percent below rated voltage
        b. Full capacity taps on primary winding.
    5. Winding Taps for Transformers 15 KVA and Larger:
        a. Six 2.5% taps,
            (1) 2 above and 4 below rated high voltage;
            (2) ANSI/NEMA ST 20.
        b. Sound Levels:
            (1) Minimum 3 dBA less than NEMA ST20 standard sound level when factory tested according to IEEE Standard (57.12.91), “Test Code for Dry Distribution and Power Transformers”:

| KVA Rating | Sound Level |
|---|---|
| 0-9 | 40 db |
| 10-50 | 45 db |
| 51-150 | 50 db |

| | |
|---|---|
| 151-300 | 55 db |
| 301-500 | 60 db |
| 750 | 64 db |

6. Basis Impulse Level:
    a. 10 KV for transformers less than 300 KVA
    b. 30 KV for transformers 300 KVA and larger.
7. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
8. Coil Conductors:
    a. Continuous copper primary and secondary windings with terminations brazed or welded.
9. Enclosure:
    a. ANSI/NEMA ST 20
    b. Type 1.
10. Provide lifting eyes or brackets

- 3 Phase Transformers
    1. Delta Primary
    2. Y Secondary
- Mounting
    1. Transformers:
        a. 30 KVA and smaller
            (1) Floor mounting preferred
            (2) Wall or trapeze mounting permitted
        b. 45 KVA and larger
            (1) Floor mounting required
    2. Transformers are prohibited within plenums and above ceilings.
    3. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
        a. Provide seismic restraints.
    4. Install transformer to provide proper ventilation per NEC 450.9.

- Installation
    1. Connect to transformer case with liquid tight or seal tight conduit
        a. 2 feet minimum;
        b. 4 feet maximum length with grounding bushing
        c. Steel bonding bushings at both ends
    2. Make conduit connections to side panel of enclosure.
    3. Ground bushings required for all installations.
- Field Quality control
    1. Check for damage and tight connections prior to energizing transformer
    2. Measure primary and secondary voltages and make appropriate tap adjustments.

END SECTION 26 22 00

## 26 24 00 Switchboards and Panelboards – August 2015

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.
    1. Cutler Hammer/Eaton/Westinghouse
    2. General Electric
    3. Square D
    4. Siemens
- A single manufacturer per project or facility is required for all items specified in this section
- Coordination
    1. Fully rated system
    2. Series rated system prohibited
    3. See Data, Communications and Alarm Diagram.
- Section Includes
    1. Main Service switchboards
    2. Distribution switchboards
    3. Disconnect switches
    4. Lighting and appliance branch circuit panelboards

5. Molded Case Circuit Breakers
6. Switch enclosures

- References
  1. In the absence of other information, the following standards apply:
     a. ANSI C12 - Code for Electricity Metering.
     b. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.
     c. ANSI C57.13 - Requirements for Instrument Transformers.
     d. NEMA KS 1 - Enclosed Switches.
     e. NEMA PB 2 - Dead Front Distribution Switchboards.
     f. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operating and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
     g. NEMA AB 1 - Molded Case Circuit Breakers.
     h. NEMA PB 1 - Panelboards.
     i. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
     j. NEMA KS 1 - Enclosed Switches.

- Submittals
  1. Product Data:
     a. Required
  2. Shop Drawing:
     a. Required
     b. Include:
        (1) Detailed front and side views of enclosures with overall dimensions
        (2) Conduit entrance locations and requirements
        (3) Nameplate legends (including short circuit bracing of bus structures);
            (a) Size and number of bus bars for each phase, neutral and ground
        (4) Switchboard instrument details;
            (a) Instructions for handling and installation of switchboard
     c. Electrical characteristics including:
        (1) voltage

(2) frame size

(3) trip ratings

(4) time-current curves of all equipment and components

d. Ratings and descriptions for all main, submain and distribution circuits.

e. Include outline drawings with dimensions and equipment ratings for:

(1) voltage

(2) capacity

(3) horsepower

(4) Short circuit.

3. Manufacturer Instructions:

a. Required

4. Design Data, Test Reports, Certificates, Manufacturers Field Reports

a. Outline and support point dimensions

b. Voltage, phase, wires (busses), main bus ampacity, main circuit breaker ampacity (where applicable) and integrated short circuit ampere ratings

c. Include branch circuit breaker arrangement and sizes in a panelboard schedule

d. Installation Instructions

5. Closeout:

a. Submittals listed above

(1) Updated to record status

b. Operation and Maintenance Data including spare parts list and the recommended maintenance procedures and intervals

c. Extra Materials:

(1) Furnish three keys for each differently keyed panelboard.

- Switchboard construction and ratings
  1. Factory-assembled, dead front, metal enclosed and self-supporting switchboard assembly conforming to NEMA PB2 and complete from incoming line terminals to load-side terminations
  2. IR (infra-red) thermal imaging inspection window in main switchgear enclosure. Window as approved or installed by switchgear manufacturer.
  3. Line Terminations:

a. Accessible from the front of the switchboard

b. Suitable for the conductor material (copper) used

4. Main Section Devices:
   a. Individually mounted and compartmented
5. Distribution Section Devices:
   a. Panel mounted
6. Auxiliary Section Devices:
   a. Individually mounted and compartmented
7. Bus Material:
   a. Copper only
   b. Sized in accordance with NEMA PB 2
8. Bus Connections:
   a. Bolted
   b. Accessible for maintenance
9. Horizontal bus feeding sub-sections shall be fully rated.
10. Bus bars shall be non-tapered throughout with bus spacing based on air insulation.
    a. Insulation:
       (1) Poly-fiber material.
    b. Cable splicing bus sections are prohibited
    c. Bus all switchboard sections for the full height of the structure.
11. Provide a minimum 1 x 1/4-inch copper ground bus through the length of the switchboard.
12. Enclosure:
    a. NEMA PB 2 Type 1, General Purpose.
    b. Sections shall align at front and rear.
13. Switchboard Height:
    a. NEMA PB2, 90 inches
       (1) Excluding floor sills, lifting members and pull boxes
14. Finish:
    a. Manufacturer's standard light gray enamel over external surfaces.

b. Coat internal surfaces with minimum one coat corrosion-resisting paint or plate with cadmium or zinc.

15. Pull Section:

a. Same construction as switchboard, 30 inch width, depth and height to match switchboard

16. Future Considerations:

a. Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents.

b. Continuous current rating

c. 25% expansion capacity of switchboards

- Switching and overcurrent protective devices
  1. Breaker or Switch Fuse criteria:

     a. Per electrical engineer

  2. Provide 25% spare spaces for future loads.

  3. Fusible Switch Assemblies Through 600 Amperes:

     a. NEMA KS 1 quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle.

     b. Provide interlock to prevent opening front cover with switch in ON position.

     c. Handle lockable in OFF position.

     d. Fuse Clips: Designed to accommodate Class R fuses.

  4. Fusible Switch Assemblies, 800 Amperes and Larger:

     a. Bolted pressure contact switches.

     b. Fuse Clips:

        (1) Designed to accommodate Class L fuses.

     c. Provide with electric trip and integral ground fault and blown fuse sensing and trips where required.

- Ground Fault
  1. Ground Fault Sensor:

     a. Zero sequence type.

  2. Ground Fault Relay:

     a. Adjustable ground fault sensitivity from 200 to 1200 amperes

(1) Time delay adjustable..

(2) Final setting by electrical engineer, not left at factory setting

b. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

- Lighting and appliance branch circuit Panelboards

1. Series rated breakers prohibited.
2. Fully rated.

1. NEMA PB1;

   a. Circuit breaker type.

2. Enclosure:

   a. NEMA PB 1

   b. Type 1.

3. Minimum Cabinet Size:

   a. 6 inches deep

   b. 20 inches wide for 480 volt and less panelboards.

4. Flush or surface cabinet front with door in hinged cover construction:

   a. Trim shall be:

      (1) Screw-on type

      (2) Door-in-door type with continuous piano hinges

5. Finish:

   a. Manufacturer's standard gray enamel.

6. Construct adjacent panels to the same size;

   a. The largest section shall therefore determine the physical size of the remaining panels.

7. Copper bus rated as scheduled on Panel Board Schedules.

8. Copper ground bus.

9. Extend vertical bussing the full height of the panelboards.

10. Minimum of 50% spare spaces with 25% spare capacity.

11. Height: 6 feet.

12. Filler plates for unused spaces in panelboards.

- Molded Case Circuit Breakers:
    1. NEMA AB 1 bolt-on type thermal magnetic trip circuit breakers with common trip handle for all poles.
    2. Circuit breakers UL listed as:
        a. Type SWD for lighting circuits.
        b. Type HID for high intensity discharge lighting circuits
    3. UL Class A ground fault interrupter circuit breakers
        a. Stab or push-in style breakers are prohibited
- Provide typed circuit directory for each branch circuit panelboard.
- Disconnect Switches
    1. NEMA Type 1: Indoors in dry locations.
    2. NEMA Type 3R: For outdoors as required by the NEC or where "weatherproof" (wp) is required
    3. Bonding bushings mandatory at both ends of all feeders
- Fusible Disconnect Switch Assemblies:
    1. NEMA KS 1;
        a. Heavy Duty (HD)
        b. Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position.
    2. Handle lockable in OFF position.
    3. Fuse clips designed to accommodate Class R fuses.
- Nonfusible Disconnect Switch Assemblies:
    1. NEMA KS 1
        a. Heavy Duty (HD)
        b. Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position.
    2. Handle lockable in OFF position.
    3. Fractional Horsepower Motors:
        a. Horsepower rated thermal overload switches or manual motor starters.

4. Provide ground bus.
5. Provide neutral bus where called for
6. Switches used as service entrance equipment shall be U.L. SE labeled.

- Switchgear and Switchboard Assemblies General
  1. Visual and Mechanical Inspection:
     a. Inspect for physical damage
     a. Compare equipment nameplate information with latest single line diagram and report discrepancies.
     b. Inspect for proper alignment, anchorage and grounding.
     c. Torque all bolted bus joints to manufacturer's written instructions.
        (1) Mark near bus joint with indelible ink:
            (a) Date and torque value.
     d. Verify that gear is firmly attached to floor or wall.
     e. Inspect all doors, panels and sections for damaged paint, dents, scratches and proper fit.
  2. Electrical Tests:
     a. Insulation Resistance Test:
        (1) Measure the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute.
        (2) Use the manufacturers' recommended test voltages and the minimum acceptable resistance values.
     b. Test Values
        (1) Bolt torque levels shall be in accordance with values specified by manufacturer.

- Transformers – dry type
  1. Visual and Mechanical Inspection:
     a. Inspect for physical damage
     b. Compare equipment nameplate information with the engineer's latest single line diagram.
     c. Check tightness of accessible bolted electrical joints
     d. Specific inspections and mechanical tests as recommended by manufacturer.

2. Electrical Tests:
    a. Insulation resistance tests shall be performed winding-to-winding and winding-to-ground.
        (1) Appropriate guard circuit shall be utilized under all bushings.
    b. Winding resistance tests shall be made for each winding at the nominal tap position.
    c. Test values
        (1) Insulation resistance test voltage, temperature corrected

- Execution Summary
    1. Install switchboards on 4 inch high concrete housekeeping pad.
    2. Bolt switchboard to floor or wall.
    3. Stub five empty 1 inch conduits to accessible location above ceiling out of each recessed panelboard.
    4. Circuit Directory:
        a. Revise directory to reflect circuiting changes required to balance phase loads.
        b. Note spare circuits in pencil.
        c. Provide new, updated, typed panel schedule for any panel with two or more changes.
    5. Ground bushing feeder conduit only;
        a. Required – both sides of all transitions.
    6. Neatly train and tie wrap conductors.
    7. Remove all debris.

END SECTION 26 24 00

## 26 27 16 Electrical Cabinets and Enclosures –October 2011

- Work in this section is open to any product meeting the requirements of this Technical Guideline.
- In the absence of other information, the following standards apply:
    1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum.)
    2. ANSI/NEMA ICS 1 - Industrial Control and Systems.

3. ANSI/NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
4. ANSI/NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems.

- Coordination
  1. See Data, Communications, and Alarm Diagram
- Submittals
  1. Product Data:
     a. Required
  2. Shop Drawing:
     a. Cabinets:
        (1) Include dimensioned plan and elevation, front and side views and any other pertinent elevation views
        (2) Knock-out or punching information.
     b. Equipment Panels:
        (1) Include wiring schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS 1.
  3. Closeout:
     a. Submittals listed above
        (1) Updated to record status.
- Hinged cover enclosures
  1. Construction:
     a. NEMA 250
     b. Type 1, steel.
  2. Components:
     a. 14 gauge steel, white enamel finish.
  3. Finish:
     a. Manufacturer's standard enamel finish.
  4. Covers:
     a. Continuous hinge
     b. Held closed by flush latch operable by key.

5. Panel for Mounting Terminal Blocks or Electrical devices

- Cabinets
  1. Cabinet Boxes:
     a. Galvanized steel with removable endwalls
     b. 24 inches wide
     c. 6 inches deep.
  2. Cabinet Fronts:
     a. Steel
     b. Surface type with concealed hinge and flush lock keyed separately for each system
     c. Finish in gray baked enamel.
- Terminal blocks and accessories
  1. Terminal Blocks:
     a. ANSI/NEMA ICS 4
     b. UL listed.
  2. Power Terminals:
     a. Unit construction type
     b. Closed-back type
     c. With tubular pressure screw connectors
     d. Rated 600 volts.
  3. Signal and Control Terminals:
     a. Modular construction type
     b. Channel mounted
     c. Tubular pressure screw connectors
     d. Rated 300 volts.
- Provide 3/4 inch thick fire rated plywood backboard for mounting cabinet terminal blocks.
  1. Do not paint.
- Fabrication

1. Shop-assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.
2. Provide knockouts on enclosures.
3. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosures.

- Execution Summary
  1. Install cabinets, enclosures, and trim plumb.
  2. Anchor securely to wall and structural supports at each corner, minimum.
  3. Provide accessory feet for free-standing equipment enclosures.

END SECTION 26 27 16

## 26 27 26 Wiring Devices – August 2022

- Work in this section is restricted to specific products of specific manufacturers that have been previously approved by Jefferson County School District, R-1.
  1. Approved Manufacturers.
     a. Arrow Hart
     b. Bryant
     c. Eagle
     d. Hubbell
     e. Leviton
     f. Lutron
     g. Pass & Seymour
  2. Floor mounted service fittings:
     a. Raceway Components
  3. Cord Drops:
     a. Daniel Woodhead with strain relief at both ends.
- In the absence of other information, the following standards apply:
  1. NEMA WD 1 - General-Purpose Wiring Devices.
  2. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
  3. NEMA WD 5 - Specific-Purpose Wiring Devices.

- Submittals
    1. Product Data:
        a. Required.
            (1) Include configurations, finishes, and dimensions.
    2. Samples:
        a. Submit samples of each device. Devices shall be reviewed and approved prior to procurement and installation.
    3. Manufacturer Instructions:
        a. Required
    4. Closeout:
        a. Submittals listed above
            (1) Updated to record status.
- Coordination
    1. Coordinate wiring connections, cords and caps with:
        a. Section 01 64 00 – Owner supplied products.
        b. Section 10 14 00 - Signage.
        c. Section 11 30 00 - Residential Equipment
        d. Section 11 40 00 - Food Service Equipment.
        e. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.
        f. Section 23 05 13 - Common Motor Requirements for HVAC Equipment
        g. Section 27 31 00 – Voice Communications Switching and Routing Equipment.
        h. Section 27 41 16 – Integrated Audio Video Systems and Equipment
    2. Prior to beginning work obtain the HVAC Equipment Schedule from Division 23 to determine the related electrical data required to wire each equipment item.
    3. Refer to Coordination Schedule in Division 01 for additional information on Mechanical/Electrical coordination.
    4. See Data, Communications, and Alarm Diagram.
- Wall Switches
    1. For Lighting Circuits and Single Phase Motor Loads Under 1/2 HP:
        b. NEMA WD1

(1) AC quiet type, nylon, specification grade, UL listed with toggle handle, rated 20 amperes at 120-277 volts AC.

c. Mounting straps:

(1) Metal and offer self-grounding or be equipped with a green hex-head ground screw.

d. Handle:

(1) Nylon.

2. Pilot Light Type:

a. Lighted handle

3. Switches:

a. Screw connections only

b. Quick push-in wire connectors are prohibited.

4. District approved Grounding Type or District approved equal:

a. Basis of design:

(1) Single pole, 20A Leviton 5362

(2) Three-way, 20A Hubbell No. 1223-I

(3) Single pole, 20A keyed Hubbell No. 1221-L

(4) Three-way, 20A, keyed Hubbell No. 1223-L

5. Classrooms:
   a. Dual level switching and occupancy sensors
   b. Occupancy sensors in classrooms shall be ceiling mounted to provide full coverage of the intended area.
   c. Provide submittals for occupancy sensors for approval by District Project Manager.

- Receptacles

1. Duplex, single and special receptacles:
   a. UL listed with a metal mounting strap with self-grounding and a hex-head green grounding screw
   b. 20 amp
   c. Specification Grade – Heavy Duty Industrial Grade
   d. Nylon
   e. Flat faced
2. Convenience and Straight-blade Receptacles:
   a. NEMA WD 1
   b. Leviton 5362 (I) Ivory or (W) White

(1) District approved equivalent

3. Locking-Blade Receptacles:
   a. NEMA WD 5.
4. Convenience Receptacle Configuration:
   a. NEMA WD 1;
   b. Type 5-20 R
   c. Nylon face.
5. All receptacles connected to emergency circuits shall have a red face.
6. Receptacles in compliance with IECC – C405.11 AUTOMATIC RECEPTACLE CONTROL preferred method:
   a. Receptacles shall be controlled by a time of day function provided by one of the following devices: Time Clock, Lighting Controller, Pelican Wireless Control System, Building BAS
   b. The control portion of the receptacle branch circuits shall be routed through an electronically or mechanically held, 20-Amp multipole contactor dedicated for each zone of receptacle control with HOA switch and 2-hour override dial timer switch.
   c. The contactors shall be mounted in NEMA-1 enclosures located in the electrical room.
   d. Other control methods/arrangements in compliance with IECC and contractor locations may be considered with prior approval of District Project Manager.
   e. All receptacles connected to Automatic Receptacle Control shall have a gray face with applied label: "Time Controlled Receptacle".
      (1) Reference Section 26 05 53 for label requirements.
7. Specific-use Receptacle Configuration:
   a. NEMA WD 1 or WD 5;
   b. Black plastic face.
8. GFCI Receptacles:
   a. Duplex convenience receptacle with integral ground fault current interrupter.
   b. All receptacles within 6 feet of a water source shall be GFCI.
9. Isolated Ground Receptacles:
   a. Duplex receptacle with metal strap for self-grounding and green hex-head source for isolated ground.
   b. Orange face.
10. Tamper proof outlets typical throughout Elementary and Pre-school buildings or areas. Also include in all labs and clinics in all buildings.

- Floor mounted service fittings
  1. Poke-through Fittings:
     a. UL Listed as a fire-rated poke-through device or cast in place
        (1) Coordinate fire stops and smoke barriers in through-floor components.
        (2) Terminate in 4 inch square by 2-1/2 inch deep junction box.
        (3) Device shall have two convenience receptacles and two individual low-tension openings.
- Wall dimmers:
  1. At selected areas only as coordinated and approved by District Project Manager
  2. In general, use of dimmers is discouraged.
  3. LED Wall Dimmers:
     a. NEMA WD 2
     b. Linear slide type.

c. LED dimmer, 0-10 volts, Arrow/Hart SF-10P-V or equivalent.

4. LED Wall Dimmer Rating:
   a. 600-Watts minimum
   b. Larger size to accommodate load

- Wall Plates
  1. Cover Plates:
     a. Nylon
  2. Weatherproof Cover Plate:
     a. Gasketed cast metal with hinged gasketed device covers
  3. Metallic Cover
- Cords and Caps
  1. Pendant type outlets:
     a. Non-metallic box and strain relief required at both ends.
        (1) Daniel Woodhead, or approved equivalent
  2. Straight-blade Attachment Plug:
     a. NEMA WD 1
  3. Locking-blade Attachment Plug:
     a. NEMA WD 5
  4. Attachment Plug Configuration:
     a. Match receptacle configuration at outlet provided for equipment.
  5. Cord Construction:
     a. Oil-resistant thermoset insulated Type SJ, SJO, SO, SJOOW multi-conductor flexible cord with identified equipment grounding conductor, suitable for extra hard usage in damp locations.
  6. Cord Size:
     a. Suitable for connected load of equipment and rating of branch circuit overcurrent protection.
     b. Not less than 12 AWG.
  7. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
  8. Make conduit connections to equipment using flexible conduit.
     a. Use liquid-tight flexible conduit in damp or wet locations. (motors, kitchen, technical education shops)
     b. Cord drops:
        (1) Use non-metallic boxes with strain relief.
  9. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
  10. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
  11. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring.
  12. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches. Connect with conduit and wiring.
- Execution Summary
  1. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions.
  2. Install wall switches OFF position down.

3. De-rate ganged dimmers per manufacturer.
4. Install convenience receptacles with grounding pole on top left where installed horizontally.
   a. Grounding pole position shall be consistent throughout.
   b. Provide GFCI protection where required by NEC.
5. Wire receptacles using pigtails for easy future service.
6. Install cover plates on switches and receptacles in all areas.
   a. Use jumbo size plates for devices in masonry walls.
7. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

END SECTION 26 27 26

## 26 28 13 Current Limiting Fuses –August 2015

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.

  1. Little Fuse Company

  2. Bussman Corporation

- All fuses on the project shall be of the same manufacturer.

  - Intermixing of fuse type and manufacturers within the same series-connected circuit is prohibited

  - Fuse types (e.g. KRP-C & FRS) of the same manufacturer within the same series-connected circuit is permitted and encouraged.

- In the absence of other information, the following standards apply:

  - ANSI C97.1 - Low Voltage Cartridge Fuses 600 Volts or Less

  - ANSI/UL 198C - High Interrupting Capacity Limiting  Class L Fuses

  - ANSI/UL 198E - Class R Fuses

  - ANSI/UL 198G - Fuses for Supplementary Overcurrent Protection

  - ANSI/UL 512 - Fuseholders

- Submittals

  1. Product Data:

     a. Required

  2. Closeout:

     a. Submittals listed above

(1) Updated to record status.

- Extra Materials:
  - Fuses:
    a. Furnish to Owner 10% or two extra sets of three (whichever is greater) of each fuse type and rating installed on the project.
    b. Place inside the spare fuse cabinet.
  - Fuse Puller:
    a. Furnish 2
- Class R Fuses
  - Dual element time delay 250 and 600 volt AC
  - 1/10-600 amperes
  - Current limiting, with short circuit rating of 200,000 amperes symmetrical.
  - Comply with U.L. standard 198E.
    a. Class RK1: LPN-R or LPS-R.
    b. Class RK5: FRN-R or FRS-R.
- Fuse Blocks:
  - Install fuses in class R fuse blocks.
- Spare fuse cabinet
  - Mount a spare fuse cabinet in the main electrical room.
  - NEMA 1 sized as required with hinged cover.
  - Minimum of 3 full width shelves.
  - Paint to match switchboard
  - Label "SPARE FUSE CABINET" in white core black phenolic on the front.
- Install fuses with labels to face towards the front of the switchboard.

END SECTION 26 28 13

## 26 31 00 Photovoltaic Collectors – August 2020

- Use is prohibited on building roofs and restricted to certain ground-mounted applications. Approval of District Project Manager and District Energy Manager is required.

END SECTION 26 31 00

## 26 32 00 Packaged Generator Assemblies – August 2015

- Work in this section is restricted to specific products of specific manufacturers that have been previously approved by Jefferson County School District, R-1.
  - Caterpillar, Inc.
  - Kohler Power Systems
  - Cummins Company
- In the absence of other information, the following standards apply:
  - N.E.C. (NFPA 70) including but not limited to, Emergency and Standby Power Generation Systems
  - NFPA 30 - Flammable and Combustible Liquids Code
  - NFPA 31 - Standard for the Installation of Oil burning Equipment
  - NFPA 37 - Standard for the Installation and use of Stationary Combustion Engines and Gas Turbines
  - NFPA 110 - Standard for Emergency and Standby Power Systems.
  - Underwriters Laboratories
  - National Electric Manufacturers Association
  - National Electric Code
- Coordination:
  1. SNP (serial network protocol) card to report EM generator status/ alarms to critical District personnel. Coordinate through the District Project Manager.
  2. Preferred Fuel Type: Diesel.
     a. Consultant responsible for obtaining approvals from State of Colorado for any variances requested by the District for use of alternative fuel sources, such as natural gas.
     b. All other/alternate fuel sources shall be approved by Jeffco Project Manager
  3. Concrete housekeeping pad
  4. Rodent proof generator
  5. See Division 22 for piping and connection requirements.

6. See Data, Communications, and Alarm Diagram.

- Submittals
  - Submit for approval, in electronic format appropriate to submittal:
    a. Selective coordination to protect generator set.
    b. Complete shop drawings
    c. Catalog cuts marked to show:
      (1) Specific manufacturer's model numbers
      (2) Factory output ratings
      (3) Fuel type and consumption rate
      (4) Ventilation and combustion air requirements
      (5) Dimensions
      (6) Weight
      (7) Any special installation instructions for the engine-generator set
      (8) All major items of auxiliary equipment including:
        (a) Generator set including plans and elevations or risers clearly indicating entrance or connection points for all the inter-connections necessary.
        (b) Automatic transfer switch
        (c) Remote annunciator with on-site installation requirements
          1. Locate in FM Office
        (d) Diagrams including schematics and a single, integrated interconnection wiring diagram for all equipment to be provided.
          1. Separate wiring diagrams for various parts of the system which require interconnection will not be accepted.
        (e) Legends for all devices on all drawings.
        (f) Color samples for paint finish;
        (g) Control panel and remote annunciator.
        (h) Battery and charger.
        (i) Fuel tank
        (j) Exhaust system
- Closeout

a. Submittals listed above,

(1) Updated to as-built record status

(2) In appropriate electronic format (AutoCAD, PDF, etc.)

b. Operation and Maintenance instruction manuals on the complete system and itemized components.

c. Detailed operation and maintenance procedures to the Owner's operating personnel or representatives after successful completion of the specified testing. Include code required periodic exercise procedures.

d. 3 electronic copies of each test and procedure used.

e. Keys (6)

f. One hour on-site training

- Guarantee specified equipment against defective material and workmanship under the terms of the manufacturer's and dealer's standard published warranty.
  - Minimum period of one year from the date of the acceptance of the system.
  - Installing contractor shall be responsible for labor and travel time and mileage for necessary repairs at the jobsite.
- Supplier must have serviceable parts readily available.
- Generator Set
  1. Products submitted must be manufactured as a complete unit, and be supplied by that manufacturer’s franchised, authorized dealer only.
  2. Under no circumstances will assemblers of engine generator sets be acceptable.
  3. Authorized dealers must have complete, local replacement parts stock, and shop and field service capability for all equipment to be supplied, with a facility within 90 miles of the job location.
  4. Factory built complete unit shipped to the job site and unloaded by an authorized dealer/distributor.
  5. U.L. 2200 listed.
- Engine
  - Diesel fuel preferred.
    a. Natural gas only at the request of the District.
  - Water cooled, four stroke cycle compression ignition, i.e. diesel type, meeting specified generator output when operating on Number 2 domestic burner oil at the site altitude.

- Two-stroke cycle engines will not be considered
- Engines requiring premium fuels will not be considered.
- Maximum operating speed: 1800 RPM.
- Fuel, full flow lubricating oil, and dry type air filters, lube oil cooler, fuel transfer pump, fuel filter, fuel priming pump, and unit mounted instruments including a fuel pressure gauge, water temperature gauge, and lubricating oil pressure gauge.
- Engine governor: Standard mechanical type to maintain frequency regulation of not more than 2% from no load to full rated load with recovery within 2 seconds and 0.5% steady state.
- Provide a Vernier type speed adjust.
- Safety shut offs for high water temperature, low oil pressure, over speed and engine overcrank.
- Guards over all exposed moving parts as required by OSHA.

- Installation
  - Mount the unit on a structural sub-base with suitable vibration isolators for noise and vibration attenuation.
    a. Securely fasten to housekeeping pad
    b. Rodent-resistant construction with Generator manufacturer's approved installation intended for this purpose.

- Generator:
  1. Manufacturer rated for continuous standby service with size rating per engineer and derated for the elevation and wide temperature range.
  2. 4 pole reconnectable brushless synchronous generator with brushless excitor.
  3. Three-phase single bearing synchronous type, directly connected to the engine through a flexible disc drive.
     a. Gear reductions of any kind will not be allowed.
  4. Built to NEMA standards, except that maximum temperature rise at its specified output shall be limited to 130 (standby) degrees C. rise by resistance over a 40 degrees C. ambient.
  5. Minimum Class F insulation:
     a. Materials shall not support fungus growth.
  6. Incorporate reactive droop compensation and include a resettable thermal protector for exciter/regulator protection against extended low power factor operation.

7. Rotor:
    a. Include amortisseur windings.
8. Generator mounted volts per hertz type exciter/regulator provided to match the characteristics of the generator the turbo-charged engine.
9. Voltage regulation:
    a. Plus or minus 1% from no load to full rated load.
10. Readily accessible voltage drop, voltage level and voltage gain controls.
11. Voltage level adjustment:
    a. Minimum of plus or minus 5%.
12. Solid state regulator module:
    a. Shock mounted and epoxy encapsulated for protection against vibration and atmospheric deterioration.

- Cooling System:
    1. Engine mounted radiator with a blower-type (pusher) fan to maintain safe engine temperature at operating ambient temperature of 120 degrees F. at the installed elevation.
    2. Equip radiator with a duct adapter flange and a lockable cap.
    3. Air restriction for the radiator system shall not exceed .5 inches water.
    4. The cooling system solution of 50% Ethylene Glycol and de-ionized water.
- Fuel System:
    1. Diesel Fuel: Double wall fuel storage tank with capacity for 24 hours of operation at full load built into structural steel sub-base of the unit.
    2. Designed and constructed to withstand the vibration of continuous operation of the engine.
    3. Equip tank with:
        a. A raised, sealed and lockable filler cap,
        b. Mechanical visual level gauge
        c. Low level switch for status panel
        d. Interstitial leak monitor for status panel
        e. A vent line extended above normal snow level.
    4. Provide flexible fuel connections at the engine.

- Exhaust System:
    1. Properly sized, critical silencing level muffler and piping including a seamless, bellows type flexible connector.
    2. Horizontally mounted muffler supported independently of the engine, so that none of its weight is supported by the engine turbocharger.
    3. Threaded or flanged fittings with the proper gaskets.
        a. Clamp-type fittings are prohibited.
    4. If the outlet of the muffler is at less than 6 feet from the finished grade at the installed location:
        a. Turn pipe up to 90 degrees
        b. Terminate with a flapper type rain cap.
    5. If the outlet is above 6 feet from the ground:
        a. Cut the horizontal pipe off at a 45 degree angle to the horizontal
        b. Weld a one inch mesh bird screen over the end.
- Starting motor:
    1. DC electric starting system with positive engagement motor.
    2. Motor voltage as recommended by the engine manufacturer.
- Automatic Control:
    1. Fully automatic generator set start-stop controls in the generator control panel.
    2. Provide shut-down for:
        a. Low oil pressure
        b. High water temperature
        c. Overspeed
        d. Overcrank
        e. 3PDT auxiliary relay for activating accessory items.
- Jacket Water Heater:
    1. Unit mounted thermal circulation type water heater incorporating a thermostatic switch to maintain engine jacket water to 80 degrees F.
    2. 120 volts, single phase, 60 Hertz.
    3. Vee type engines require one heater per each bank of cylinders.

- Batteries:
    1. Lead-acid storage battery set for maintenance free, heavy duty diesel starting.
    2. Battery voltage compatible with the starting system.
    3. Battery set rated not less than 700 cold cranking amps at 0 degrees F.
- Battery Racks:
    1. Metal treated to be resistant to deterioration by battery electrolyte.
    2. Construct so that non-conductive insulation material directly supports the cells.
- Battery Charger:
    1. Dual rated, DC regulated, line compensated battery charger to automatically recharge the batteries.
    2. Float at 2.17 volts per cell and equalize at 2.33 volts per cell.
    3. Include:
        a. Overload protection
        b. Silicone diode full wave rectifiers
        c. Voltage surge suppressor
        d. DC ammeter
        e. DC voltmeter
        f. Fused AC input.
    4. AC input voltage:
        a. 120 volts, single phase.
    5. Amperage output:
        a. 10 amperes minimum.
    6. Wall mounting type in NEMA 1 enclosure, by the generator supplier, mounted in the housing and connected to the battery on the DC side.
- Main Line Circuit Breakers:
    1. Main-line, molded case circuit breaker mounted upon and sized to the output of the generator installed as a load circuit interruption and protection device.
    2. Operate both manually for normal protection device.
    3. Operate both manually for normal switching functions and automatically during overload and short circuit conditions.

4. Equipped with bus bars on the line side for bolted connection of the generator leads, and output lugs for on the line side of the circuit breaker.
5. Size at 115% of generator full load current.
6. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection.
7. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.

- Generator Control Panel:

1. A generator mounted NEMA 1 type, vibration isolated 14 gauge steel control panel containing, but not be limited to the following equipment:
   a. Frequency meter, 3 1/2 inch, dial type, 45-65 Hz.
   b. Voltmeter, 3 1/2 inch, 2% accuracy.
   c. Ammeter, 3 1/2 inch, 2% accuracy.
   d. Ammeter (4 position)-Voltmeter (7 position) phase selector switch.
   e. Automatic starting control as specified.
   f. Voltage level adjustment rheostat.
   g. Dry contacts for remote alarms wired to terminal strips.
   h. Individual fault indicator lights for low oil pressure, high water temperature, overspeed, low fuel, and overcrank and a push to test indicator light.
   i. A 3 PDT aux relay connected to a terminal strip.
   j. A 4 position function switch marked "auto", "manual", "off-reset" and "stop".
   k. Running time meter, oil pressure and water temperature gauges.
   l. Hinged, solid protective cover with provision for locking.

- Annunciator Panel:

1. Panel for remote mounting to give audible and visual warning of all the above listed alarm conditions in the generator system. The panel shall conform to the requirements for the National Electrical Code, Section 700, and the National Fire Protection Association, Section 110 - Level 2.
2. The panel shall be remote mounted in the FM's Office and shall include all alarms required by this guideline.
   a. Required at:
      (1) Running

(2) Out of Auto

(3) Failed to Start

(4) High or Low Water Temperature

(5) Battery Charger

(6) Load Transfer

(7) Overcrank

(8) Low Fuel

- Enclosure:
  1. Enclose the complete unit with all accessories in an insulated, sound attenuated, weatherproof enclosure suitable for outdoor use.
  2. Provide necessary heavy gauge metal screens to prevent small rodent access.
  3. Provide access doors with full length piano type hinges to allow access to all components for normal maintenance and inspection.
  4. Doors: Locking handles with matching keys.
  5. Rainproof louvers sized for the generator manufacturers recommended air flow through the housing.
  6. Mount the silencing muffler on top of the enclosure as specified with a rain collar roof penetration.
  7. Rodent-proof all enclosures as per Generator manufacturer's original equipment and written requirements.
- Automatic Load Transfer Switch(es) (ATS):
  1. Provide number of ATS units required by NEC and State code.
     a. Life safety systems
     b. Owner provided power system, as directed by Owner
  2. Number of poles and current ratings as required for a normal and emergency source voltage.
  3. Listed per U.L. Standard 1008 as recognized components for emergency systems, and rated for 125% of total system load.
  4. Automatic pickup voltage adjustable from 85% to 100% of nominal (set at 90%)
  5. Dropout voltage adjustable from 75% to 98% of the pickup value (set at 85%).
  6. Electrically operated, mechanically held, and be suitable for continuous duty in an unventilated enclosure at 100% rated load.

7. Inherently double throw so both sets of contacts move simultaneously when the switch is transferring.
8. Mechanically interlocked to ensure that only one side can be closed at a time.
9. Main contacts:
    a. Silver alloy wiping action type
    b. Protected by arcing contacts in sizes above 400 amperes.
10. Switch and relay contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panels from the enclosure and without disconnection of drive linkages or power conductors.
11. Sensing and control relays:
    a. Continuous duty industrial control type
    b. Minimum contact rating of 10 amperes.
12. Automatic Transfer Switches utilizing components of molded case circuit breakers, circuit interrupters, disconnect switches, or parts thereof which were not intended for repetitive switching are not acceptable.
13. An overload or short-circuit shall not cause the transfer switch to go into a neutral position.
14. Harnessing between the transfer switch and the control panel shall have built in disconnect feature for routine maintenance.
15. Supply in a NEMA 1 enclosure for wall mounting.
16. Manufacturers:
    a. As manufactured by the generator set manufacturer or furnished with generator by generator set manufacturer.

- Accessories:
    1. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals.
        a. Field adjustable from 0.5 to 6 seconds
        b. Factory set at 3 seconds.
    2. A time delay on retransfer to normal source.
        a. Automatically bypassed if the emergency source fails and normal source is available.
        b. Field adjustable from 0 to 10 minutes
        c. Factory set at 10 minutes.

3. An unloaded running time delay for emergency generator cool-down.
    a. Field adjustable from 0 to 5 minutes
    b. Factory set at 5 minutes.
4. Automatic exercise timer with programmable logic and with or without load pickup selection.
    a. Programmable and set to exercise at certain times as designated by District Project Manager.
5. Independent single phase voltage and frequency sensing of the emergency source.
    a. Adjustable from 85% to 100% of nominal.
    b. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.
6. A contact that closes when normal source fails for initiating engine starting, rated 10 amperes.
    a. Gold plated for low voltage service.
7. Panel lamps to show switch position.
8. One set of normally open and one set of normally closed auxiliary contacts on each side of the switch.
9. A test switch to momentarily simulate normal source failure.

- Installation by manufacturer/supplier
    1. Unload the equipment and insure that it is properly set in place with all vibration isolators properly installed.
    2. Provide technical assistance to the electrical contractor as required for interconnection of the system.
- Testing
    1. Provide results of 100% load bank test at the factory prior to shipping.
    2. Upon completion of the installation:
        a. Test the generator system to confirm:
            (1) It is free of any defects
            (2) The phase rotation matches the incoming utility
            (3) It will start automatically within code required time
            (4) Will automatically transfer and retransfer the loads.

3. The system shall be subjected to full rated load test through the use of dry type load banks designed for this purpose.
4. The load bank shall be capable of definite and precise incremental loading
    a. The load settings shall not be dependent upon the generator control instrumentation to read amperage and voltage of each phase.
    b. Rather, the test instrumentation will serve as a check of the generator set meters.
5. Load bank testing shall be required at the factory and the results are to be received on site before installation may begin.
6. All load tests (at the factory and on site) to be a minimum of 2 hours and recorded on a log showing load, ambient temperature, oil pressure, etc. on 10 minute intervals.
7. After testing and startup is completed, completely fill the fuel tank and add oil to the engine as necessary.

- Connections:
    1. Due to vibration, install stranded wire from generator to:
        a. Remote annunciator
        b. Block Heater
        c. Battery Charger
    2. Provide independent branch circuitry (IBC) for block heater.
    3. Provide IBC for charger, both served from life safety panel.
- Labeling Requirements:
    1. Provide Nameplate Label as per Section 26 05 53.
        a. Include power source
- Start-up and Instruction
    1. On completion of the installation, start-up the generator set by manufacturer's factory trained service representative as a part of and immediately prior to the specified testing.

END SECTION 26 32 00

## 26 35 00 Power Filters and Conditioners –October 2011

- Work in this section is restricted to specific products of specific manufacturers that have been previously approved by Jefferson County School District, R-1.
    1. Current Technologies

2. Liebert

- Coordination
  1. Section 26 05 26 – Grounding and Bonding for Electrical Systems
  2. Section 26 05 53 - Identification for Electrical Systems
  3. Section 26 24 00 – Switchboards and Panelboards
- References
  1. In the absence of other information, the following standards apply:
  2. ANSI/IEEE compliance; Comply with ANSI/IEEE C62.1, C62.41 and C62.45.
  3. NEC as applicable to construction and Article 280 for installation.
- Submittals
  1. Product Data:
     a. Required
  2. Shop Drawing:
     a. Required
  3. Design Data, Test Reports, Certificates, Manufacturer Instructions, Manufacturer Field Reports:
     a. TVSS specifications
     b. Latest edition of the UL 1449 surge suppression rating Category C3 for the Filter.
  4. Closeout:
     a. Submittals listed above
        (1) Updated to record status.
     b. Maintenance manuals
- Warranty
  1. TVSS shall be warranted for 5 years
  2. Label equipment on inside of door with length of warranty from date of acceptance.
- Maintenance Service
  1. Local service support shall be provided for TVSS such that upon failure, a replacement shall be available within twenty-four hours.
- TVSS

1. Mechanical and electrical requirements suitable for application in category C3 environments as described in ANSI/IEEE C62.41.
2. TVSS must not affect the performance of the frequency corrected slave clock system.

- Manufacturer Qualifications:
  1. Regularly engaged in the manufacture of TVSS product for category C3 (ANSI/IEEE C62.41)
  2. Whose products have been in satisfactory service for not less than ten years.
- TVSS Installation:
  1. The conductors are to be as straight and short as practically possible; not to exceed 10 feet in length.
- Install an appropriately sized manual safety/disconnect switch or circuit breaker before and in line with TVSS.
  1. Capable of electrically isolating the TVSS from the electrical service for repair without interrupting service to the building.
- TVSS units must be downstream of main distribution center (MDC) disconnect.
- TVSS shall be self-diagnostic, with panel lamp to show status of TVSS

END SECTION 26 35 00

## 26 50 00 Lighting – August 2022

- General Guidelines
  1. All new lighting in Jeffco shall be LED.
  2. Comply with State adopted IECC.
  3. Lighting design shall comply with guidelines and follow recommendations and procedures of the Illuminating Engineering Society of North America (IESNA) in its "Lighting Handbook" and "Recommended Practice on Lighting for Educational Facilities 10th Edition, ANSI/IESNA RP-3-00," as well as other documents referenced herein.
  4. Ultra Violet (UV) Lighting is prohibited in any areas designed for student or school staff occupancy.
  5. Comply with latest ASHRAE/IESNA 90.1 standard.
     a. Lighting Power Density (LPD) requirements
        (1) Include actual LPD versus current standard (defined in space-by-space section) on room schedule.

6. Lighting Designer/Electrical Engineer to provide the following:

   a. Room by room schedule of luminaires existing in building including: Quantity removed, manufacturer, luminaire type, number of lamps, Wattage, etc. as well as the same details on the luminaires proposed to replace these. Include "Total Building kW Removed" at the bottom of the schedule. Schedules may appear on the Contract Documents or in additional submittals. Xcel Energy or their representative may request these schedules in Microsoft excel in order to process rebates. A material and labor cost breakdown is required by Xcel Energy in order to process rebates.

   b. Photometric plans with a maximum of a 3' spacing grid, shall be provided in the Contract Documents drawing set showing every occupied space receiving new lighting. Provide a schedule showing every room (occupied and non-occupied) and the average designed illuminance. Average illuminance shall be calculated by taking the sum of all illuminance points on the photometric plan and dividing by the total number of points. For classrooms, auditoria, cafeterias, gymnasiums, and conference rooms, this average shall be calculated four feet from all walls. The maximum illuminance permitted in the space shall not exceed twice of the average targeted value for that space defined below in the "Jeffco Schools – Standard for Average Illumination Levels" table.

   c. In projects where the Basis of Design luminaires are not selected for installation, the lumen output must be within 200 lumens of the Basis of Design luminaire to not require resubmittal of photometric plans validating that the selected fixtures are within acceptable range of the average illuminance targets defined in the Jeffco Schools – Standard for Average Illumination Levels Table.

   d. Lumen depreciation factor of 0.88 shall be used for all photometric calculations.

7. Lighting Designer/Electrical Engineer to coordinate all documentation requirements for Xcel rebates.

8. Provide uniform light distribution in all learning and working spaces. Interior lighting systems shall provide illumination without discomfort caused by glare. Consider reflectance of room surfaces and coordinate with architectural finishes.

9. Avoid harsh or extremely bright lighting. Minimize veiling reflections in task details.

10. Utilize daylight harvesting as required by code. Daylight harvesting shall be integrated with electric lighting, photo sensors, and dimmer controls.

    a. To the greatest extent possible, daylighting design and daylight harvesting is to be utilized in gymnasiums, cafeterias, cafetoriums, and common areas that are receiving natural light.

11. The District may elect to procure the services of a Commissioning Agent to confirm the lighting system is designed and implemented accurately. Based on the extent and

complexity of the scope of work, the District Project Manager may direct the design engineer, contractor, or sub-contractor to provide these services as part of their scope. The commissioning services will be required, and corrections made, prior to the District's final acceptance of the project.

12. Provide LEDs in lighted display cases.
13. The lighting controls in Theatrical applications shall be interfaced with the Fire Alarm System to cause house lighting to be forced on during alarm conditions, regardless of manual or automatic control settings.

- Luminaires
  1. All luminaires shall be supplied with individual drivers.
  2. If special or custom luminaires are considered they will require approval of the District Project Manager.
  3. Utilize high color-rendering source.
     a. The minimum CRI for all spaces shall be 80.
     b. The minimum CRI for Visual Art Rooms in Middle and High Schools shall be 90. (Theatre lighting is specified elsewhere.)
  4. Luminaires shall be capable of dimming to 5% output, except in auditoria where they shall dim to 0%.
  5. Wall mounted light fixtures shall be located in compliance with ADA requirements.
- Lighting replacement projects
  1. Space redesign with consideration of photometric and uniformity is required. One-for-one replacements are not acceptable without photometric plans provided to validate existing layout.
  2. If retrofitting the lighting in a room, retrofit all luminaires.
  3. One control point is needed per room unless otherwise directed by District Project Manager.
  4. Each classroom, office, conference room, cafeteria, and gym shall be equipped with dimming and multi-level controls.
  5. Type B LED conversions are prohibited.
- Illumination Criteria
  As referenced in the table below, some educational spaces shall have multi-level control. Multi-level control provides presets of different levels of illuminance: "HIGH", "MEDIUM", and "LOW" in addition to an "OFF" setting. All numbers in the table below indicate average Foot-Candle (fc) levels in each space. The maximum acceptable

illuminance level at any point in the classroom shall not exceed twice the allowed average for each space in the table below.

| **Jeffco Schools - Standard for Average Illumination Levels** | | | | **Other** | **User Controls in Space** (automated where blank) |
|---|---|---|---|---|---|
| All numbers are in foot candles (fc) | Scene Setting | | | Single Setting* | |
| | HIGH | MEDIUM | LOW | | |
| Auditorium - Classroom & House | 30 | 19* | 4 | | Dimmer/Multi level |
| Cafeteria | 30 | 7* | 4 | | Dimmer/Multi level |
| Classrooms (General) | 35 | 21* | 4 | | Dimmer/Multi level |
| Classrooms (Visual Arts) | 35 | 21* | 4 | | Dimmer/Multi level |
| Classrooms (Computer) | 35 | 21* | 4 | | Dimmer/Multi level |
| Classroom (Music) | 35 | 21* | 4 | | Dimmer/Multi level |
| Classroom (Science Lab) | 35 | 21* | 4 | | Dimmer/Multi level |
| Classroom (CTE) | | | | 50 | Manual Switch |
| Conference Room | | | | 30 | Dimmer/Multi level |
| Corridor | | | | 15 | |
| Stairs and Stairways | | | | 15 | |
| Vestibules and Lobbies | | | | 15 | |
| Gym (ES) | | | | 30 | Dimmer/Multi level |
| Gym (MS/HS) | 70* | 35 | 15 | | Dimmer/Multi level |
| Kitchen | | | | 50 | |
| Kitchen (Food Prep) | | | | 50 | |
| Library | | | | 30 | |
| Locker Rooms | | | | 15 | |
| Mechanical/Electrical/MDF/IDF Room | | | | 30 | Manual Switch |
| Office/Teacher Workroom | | | | 30 | |
| Open Office Area | | | | 30 | Dimmer/Multi level |
| Restroom | | | | 15 | |
| Restroom (Staff) | | | | 20 | |
| Storage | | | | 15 | |

Average illuminance shall be calculated considering only illuminance levels taken in the room area beginning four feet from all walls for auditoria, cafeterias, classrooms, gymnasiums, and conference rooms. Average illuminance shall be calculated considering all room area (no spacing from walls) for corridors, offices, CTE classrooms, and kitchens.

*Illumination Level to control to if daylight harvesting is utilized in the space.

- Specific Lighting Criteria

1. Classrooms (General, Science, Visual Art, and Computer)

   a. Classrooms shall consist of rows of continuous suspended indirect or indirect/direct LED luminaires.

      (1) If ceiling height will not permit suspended lights, utilize recessed fixtures that minimize glare with approval of Jeffco PM.

   b. Provide white board illuminance at least 20 fc in the vertical plane.

   c. Align any suspended rows and supporting cables with the ceiling grid. Vary the length and spacing of the continuous rows of luminaires to suit the size and shape of the classrooms and their specific functional needs.

   d. If required by the state adopted IECC Code, incorporate daylight harvesting into classroom lighting.

   e. For larger science, technical and art classrooms consider using longer rows. Since these rooms sometimes have perimeter work counters, and the illuminance should be greater over the counters, consider adjusting the spacing to adequately illuminate the counters or providing under cabinet luminaires.

   f. Uniformity of illuminance on the work surfaces are important – especially on the core desk space. Beginning four feet from classroom walls, a maximum: average ratio of 2.0:1.0 shall not be exceeded.

   g. During the design development phase provide point to point photometric lighting calculations to graphically demonstrate the light levels on all room surfaces.

   h. Lighting power density (LPD) in the classroom shall not exceed 0.85 watts per square foot (w/sf) connected load.

2. Classrooms - Circadian Lighting

   a. “Circadian” or “Tunable” LEDs shall be utilized in selected Special Education spaces. Coordinate locations with the District Project Manager.

      (1) These lights are not required in other spaces.

      (2) Manual dimming and adjustment of color temperature shall be available to users in the space.

(3) Luminaire styles shall be similar to those described in General Classrooms.

(a) Luminaires shall be capable of dimming to 0%.

(4) Luminaires shall produce white lighting only and have CCT tuning capability for adjustment range of 2700K to 6500K.

(5) The lighting system shall produce melanopic light intensity at a minimum 150 lux at 75% at desks, on the vertical plane at least 4-feet above the floor.

3. Library

a. Lighting Designer/Electrical Engineer may recommend multiple zones of control to the District Project Manager.

4. Gymnasium Lighting

a. Illuminate gyms with daylighting for daytime use, using skylights, tubular daylighting devices, high semi-transparent panels, or clerestories.

b. Provide electric lighting for nighttime use and daytime supplementary lighting using suspended high-bay LED luminaires with protective wiregaurds, accompanied by daylight sensors to selectively dim the lamps in response to the daylight illuminance.

c. Using average lumen output of the daylight device for the brightest 2,400 hours of the year (based on TMY2 weather data), design daylighting to provide a minimum 30 fc in Elementary Schools, 75 fc in Middle and High Schools average on the floor with a max: average ratio of 2:1

5. Locker Rooms

a. Lighting shall be provided using LED luminaire with gasketed acrylic lens, vandal-resistant, with IP (“Ingress Prevention”) Rating of IP 64.

b. Lighting layout shall be coordinated with placement of lockers so as to provide illumination to areas in front of lockers and to not cast shadows.

6. Kitchens

a. Provide lensed lay-in style LED troffers with wipe down lens. IP (“Ingress Prevention”) Rating of IP 64.

7. Office / Conference Rooms / Teachers Workrooms

a. Similar to classrooms, recessed LED direct/indirect style troffer luminaires or rows of continuous suspended indirect or indirect/direct LED luminaires parallel to the window wall.

8. Corridors/Stairways/Vestibules/Lobbies

a. Provide wall illumination levels to a minimum 40% of floor values.

b. Layout and selection shall be made to prevent casting shadows on stair treads.

c. Stairways, Vestibules, and Lobbies shall be controlled with the Corridor Lighting

9. Student Restrooms:

a. Layout shall be such that shadows are not cast by stall walls. Average illumination levels shall be maintained within stalls and at countertops.

10. Career and Technical Education (CTE) Classrooms

a. Same as classrooms, or industrial surface-mounted, or suspended open LED luminaire if appropriate to the architectural design. Specify appropriate fixtures to eliminate dust collection in high dust concentration areas; such areas may include wood and metal shops.

11. Mechanical, Electrical, MDF/IDF Rooms

a. Strip style LED luminaire with wiregaurd.

b. Consider wall mounted luminaires in combination with suspended.

12. Elevator Pits

a. LED luminaire with guard, and with IP ("Ingress Prevention") Rating of IP 64.

13. Exit Signs

a. LED type.

b. Metal support brackets

14. Casework

a. LED tape lights may be utilized in Science Classrooms (as task lighting) and in Display Cases. These lights shall be controlled separately from other luminaires in the space.

- Luminaires

1. Luminaires shall be 3500K. If 3500K is not available for a specific luminaire, other color temperatures may be approved by District Project Manager.

2. Selection of luminaires shall be made on the basis of lighting characteristics (including uniform distribution and glare), appearance, cost, maintainability, energy efficiency, and resistance to vandalism.

3. Each luminaire shall be fully specified and correlated with the Fixture Schedule.

4. On the Schedule, provide full data for basis of design of each luminaire on lamps (if applicable), luminaire type, input wattage, and mounting type.

5. Provide not fewer than three manufacturers' products for each application. If less than three manufacturers are available, selection requires approval by District Project Manager.

- Lighting Power

1. Lighting branch circuits shall be 20 amp, unless otherwise required by the system.
2. Provide a distributed balanced load on all phases for panels and branch circuits.
3. Lighting panel boards shall be 480/277-volt, 3-phase, and 4-wire, with thermal-magnetic bolt-on type branch circuit breakers if service exists in building. Otherwise, at small sites or smaller buildings at large sites may use 208/120-volt, 3-phase, and 4-wire panels.

- Emergency Lighting

1. Emergency lighting fixtures shall be located nearest to the exit in a space.
    i. Locate signs out of the reach of students to avoid damage and vandalism
2. All emergency system luminaries shall be labeled as being part of the emergency lighting system with labeling similar.

END SECTION 26 50 00

## 26 55 61 Theatrical Lighting – August 2021

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.
- Section includes:
    1. Requirements for elementary, middle and high school theatrical lighting systems.
    2. Flexible and controllable performance lighting to provide adequate illumination for performances such as plays, musicals, orchestra, choir and assemblies.
    3. Lighting for front stage, overhead, back stage and "house".
- Acceptable manufacturers:
    1. Dimming and Control Systems:
        a. Electronic Theatre Controls
        b. Strand Lighting
    2. Work light Control:
        a. Electronic Theatre Controls
        b. Strand Lighting
        c. Douglas Lighting Controls
    3. Fixtures:
        a. Altman: Follow Spots, Work lights and Cyc lights

b. Electronic Theatre Controls
c. Lycian: follow spots only
d. Strand/Phillips Lighting
e. CantoUSA follow spots only

4. Suppliers not included in the approved manufacturers list must submit the following information ten days prior to the bid date to be considered as an alternate supplier for the specified system.
   a. Annotated manufacturer cut sheets
   b. Complete one-line drawing of the proposed system
   c. List of three projects of similar size and scope located in the local area.

- Point by point review of the specification denoting product compliance or non-compliance for each specification line item.
- Technical Requirements
  1. Where particular manufacturer's P/Ns are listed, the technical performance characteristics of listed product shall serve as the minimum acceptable performance standard when determining equal or alternate products.
  2. Power Control Panels
     a. Provide, fully install, power, program, and test specified power control panels/equipment.
     b. Provide panels with UL924 listing where indicated
     c. Supply panel type to be compatible with project voltage
     d. MLO phase dimmer panels
        (1) Chassis sized to application but available in standard sizes of 12, 24, 48, and 96 circuit enclosures.
        (2) Minimum short circuit current rating 22,500A, available with up to 100,000A when required.
        (3) Shall be high density modular panel, actively cooled
        (4) Supply with electronics control module that offers an on board UI with LCD screen and keypad for manual setting of panel performance parameters.
        (5) Shall accept DMX-512A and sACN data signals.
        (6) Shall be modular in nature and offer at minimum the following power control modules:
            (i) Dual 20A SCR based forward phase dimmer module rated for 100% duty cycle @ 20A
            (ii) Dual 20A air gap relay module rated for 100% duty cycle at 20A
            (iii) Dual 10A phase adjustable electronic dimming module rated for full duty cycle at 10A
            (iv) Dual 20A unswitched power modules (over-current only) rated for 100% duty cycle at 20A

     e. MLO or MCB Relay Panels

        (1) Chassis sized to application but available in standard sizes of 12 and 24 circuit enclosures.

(2) Minimum short circuit current rating 10,000A, available with up to 65,000A with the use of a MCB when required.
(3) Breakers associated with relay shall be sized at 20A, 100% duty cycle.
(4) Shall be available with single pole and two pole relays
(5) Supply with electronics control module that offers an on board UI with LCD screen and keypad for manual setting of panel performance parameters.
(6) Shall accept DMX-512A and sACN data signals.

d. Feed Thru Relay Panels
(1) Chassis sized to application but available in standard sizes of 12, 24, and 48 circuit enclosures.
(2) Minimum short circuit current rating for each relay - 14,000A.
(3) Shall be available with single pole and two pole relays
(4) Relays shall be mechanically latched in both Open and Close position and feature an on board means of indicating relay contact status. Relay shall contain an on board 100% manual operation lever allowing manual operation of the relay with no electronics control power present.
(5) Supply with electronics control module that offers an on board UI with LCD screen and keypad for manual setting of panel performance parameters.
(6) Shall accept DMX-512A and sACN data signals.

e. MLO or MCB Intelligent Breaker Panels
(1) Chassis sized to application but available in standard sizes of 12, 24, and 48 circuit enclosures.
(2) Minimum short circuit current rating 10,000A, available with up to 65,000A with the use of a MCB when required.
(3) Shall be available with single pole and two pole 20A breakers. Breakers shall be manually operable in the event panel electronics fail.
(4) Supply with electronics control module that offers an on board UI with LCD screen and keypad for manual setting of panel performance parameters.
(5) Shall accept DMX-512A and sACN data signals.

f. Distributed and/or Discrete Power Control Devices
(1) Shall be rated for plenum installation
(2) Shall be controlled by DMX-512A
(3) Shall consist of but not be limited to
(i) 4 pole and 8 pole UL924 listed feed thru relay panels with 0-10V dimming interface for each relay
(ii) 1 pole and 2 pole – ½" KO mount – 20A relay with 0-10V dimming interface for each relay
(iii) 600W – ½" KO mount – phase dim modules available as phase adaptive (self-adjust forward and reverse phase dependent upon load type) and forward phase only for MLV type loads.

3. Architectural Control System

a. Shall be processor centric control system capable of merging theatrical (DMX-512A) data from theatrical control console with data from UI devices (keypads, touchscreens).

b. Processor shall host system configuration (program) including preset/scene values and UI device configuration. This configuration shall be uploadable and downloadable with digital media via USB connection.
c. Processor shall host a minimum of 512 zones of control with up to 1012 zones of control when required.
d. Processor or processor enclosure shall power and host data bus network connecting UI devices (keypads, touchscreens, etc..). Data buss shall be open topology installation for ease of connecting field mounted UI devices.
e. Processor shall host various UI and automated control devices such as keypads (button stations), touchscreens, slider stations, occupancy and vacancy sensors, and photocells.
f. Processor shall receive and transmit DMX-512A and offer sACN connectivity.
g. Processor shall have 4 dry contact inputs to interface with building systems such as HVAC, fire alarm, and security.
h. Processor shall include astronomical time clock and support electronic lockout of UI devices during events.

4. Data Distribution Network

i. Shall be a system of DMX Gateways and/or DMX Optosplitters as specified
j. Shall distribute DMX data from control equipment to Digital (LED) lighting fixtures and/or power control devices.
k. Shall be compatible with DMX-512A and sACN protocols.

5. Performance lighting

l. DMX controlled LED theatrical fixtures shall be rated for a minimum L70 LED array lifespan of 54,000 hours, be supplied with a full 10 year LED array warranty, a full 5 year warranty for the entire fixture, and be UL or ETL certified.
m. Shall be supplied with installed power connector, minimum 5’ - 5 pin XLR DMX cable, listed accessories such as media frame, pattern holder, mallable iron C-clamp, 30” safety cable, etc…
n. Supply multi-attribute LED lighting fixtures with specified lighting engine featuring specified lighting engine. Provide fixtures that offer a single blended color output at fixture aperture.
o. Fixtures shall be physically and electrically installed, connected, programmed and tested. Fixtures shall be rough focused for an even stage wash unless otherwise directed.

6. House Light Fixtures

p. Shall be compatible with the specified lighting control power equipment and data distribution.
q. Supply as Phase Dim to OFF Fixtures – or – DMX dim to OFF fixtures.
r. Supply in appropriate voltage for power source and lighting control power equipment
s. Supply for even illumination of audience seating area

t. Implement Emergency Lighting Fixtures and Emergency Lighting Control Equipment as required.
   (1) Provide emergency lighting control equipment compatible with current NEC Article 700.2 section
   (2) Specifically 700.24, 700.25, and 700.26 as required.

- Submittals

1. Product Data:
   a. Required

      (i) Annotated manufacturers cut sheets for approval by engineer / architect prior to installation
2. Shop Drawings:
   a. Required

      (1) Complete drawings of all racks, enclosures, control stations and wiring devices for the system, including:

         (i) Power feeds
         (ii) Load and low voltage terminations
         (iii) Wire types
         (iv) Physical space requirements
         (v) Station locations
         (vi) Power requirements
         (vii) Light plot
         (viii) Panel Schedule
         (ix) All other installation information

      (2) Complete system one line diagram

         (i) Power requirements

         (ii) Emergency generator connections
         (iii) Line voltage connections to the dimmer rack(s) / relay panels
         (iv) Processor connections detail
         (v) Wire entry points
         (vi) Control station details
         (vii) Control relays
         (viii) DMX addresses
         (ix) Channel assignments for architectural controls
         (x) Work light load schedule and control station engraving
         (xi) Emergency power transfer devices
      (3) Complete bill of materials, including:
         (i) Manufacturers part numbers
         (ii) Manufacturers component drawings
         (iii) Point to point details
3. Closeout:

a. Submittals listed above:
   (1) Updated to record status, including any wiring, load schedule, or programming changes.
      (i) One electronic copy of:
         1. Complete systems drawings in AutoCAD
            a. One Line Riser diagram in AuroCAD
         2. Manufacturer's annotated cut sheets
         3. System maintenance manuals
         4. Warranty
         5. Factory contact information
         6. Local service center information
      (ii) Written documentation of performance testing
b. Owners' manuals for all system equipment and distribution components
c. Warranties:
   (1) List of Warranted components, coverage, length of warranties, and contact information.
d. Operation and Maintenance Data
   (1) Three copies of all software required to communicate with and program the system.
   (2) Demonstration and Training
   (3) Training of Owner's maintenance personnel and teaching staff shall be provided by a factory authorized service representative
   (4) Training to include information on adjusting, operating and maintenance of stage lighting equipment
   (5) Provide two sessions:
      (i) One at project completion
      (ii) One approximately 45 days after students occupy the building
         1. Each session to be minimum of 4 continuous hours

e. Documentation of third-party inspection documentation, including findings and identified corrections.

f. Documentation of factory-authorized service representative inspection documentation.

- Quality Assurance

1. Installer qualifications:
   a. Licensed electrical contractor in the State of Colorado
      (1) Working in conjunction with a theatrical specialist engaged in the sale, design, operation and installation of theatrical dimming systems.
   b. Previous experience installing systems in similar type projects.
2. Theatrical Specialist qualifications:
   a. A theatrical professional presently engaged in the sale, design, installation and operation of theatrical dimming systems, typically a theatrical dealer or theatrical systems manufacturer representative.

3. Dimming Equipment Manufacturer qualifications:
   a. Minimum ten years of continuous experience in the manufacture of the specific theatrical system equipment supplied.
4. Electrical Components, Devices, and Accessories:
   a. Listed and labeled in accordance with NFPA 70, Article 100
   b. Listing and label provided by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
5. A local manufacturer's authorized equipment and service center that can support equipment installed is required within the Denver metro area.
   a. Training
   b. Parts
   c. Emergency repair support within 24 hours maximum response time
6. Emergency Transfer:
   a. Comply with UL 1008
7. All systems must allow for emergency systems override
8. Microprocessor-based modular system
   a. Consisting of dimmer, relay and control modules operated from remote-control stations and a control module
   b. Comply with UL 508
   c. Comply with USITT DMX 512 and USITT ACN for data transmission
9. Installer's Warranty: 1 year from Owner Acceptance
10. Parts Warranty: Manufacturer's standard warranties for the following:
    a. Stage Lighting Fixtures – L70 = 54,000 hours, 10 year LED array warranty, 5 year warranty for the entire fixture
    b. House Lighting Fixtures – L70 +50,000 hours, 5 year full fixture warranty
    c. Processors – 2-year warranty
    d. Controllers – 2-year warranty
    e. Other major components – 2-year warranty
11. Structural engineer review and services required where components are suspended from, or otherwise mounted to, the building structure.

- Elementary School Performance lighting system – Provide a complete LED based performance lighting system meeting the following criteria.

1. LED fixtures:
   a. RRGBL – (5 color minimum) LED soft edged PAR washlight as needed for an even wash of the stage from the downstage and upstage lighting positions
   b. RRGBL – (5 color minimum) LED Ellipsoidal framing projector for even front lighting of the downstage area. Mount fixtures 45 degrees up from, and parallel to, the downstage edge of the stage area. Enclose in protective metal cage if in gymnasium.

2. Power Control
   a. Relay control for power on / off of all performance lighting. Provide Mini Relay Panel or Feed Thru Relay Panel as required for Stage Lighting Circuits and House Lighting Circuits
3. LED fixture control station
   a. Locate at side wall 48 inches AFF
   b. Provide a 7" Touchscreen station to control the LED fixtures.
      (1) Program touchscreen with no less than 8 typical stage scenes on page #1.
      (2) Provide a LED Fixture Power ON/OFF button on page #2
      (3) Subsequent touchscreen pages shall be password protected and allow owner to adjust the lighting at each lighting position to various colors using a color wheel and re-record the page #1 scenes. Provide individual fixture programming and control from this device IF indicated.
      (4) Final page of touchscreen shall not be password protect and will offer information for installing specialist, specialist contact #, manufacturer contact #, project # and 24/7 service #.
   c. Program system to turn power OFF to Light by time clock at 12:01AM each day.
   d. Install station in recessed locking enclosure if password protected device is not available
4. DMX receptacle
   a. Locate on the sidewall of the stage area at 18 inches AFF.
5. Performance Lighting Controller
   a. Provide a DMX512A Performance Lighting Controller with imbedded flat screen monitor and capable of controlling each stage lighting fixture and each zone of house lighting fixtures independently. Equal to or better than ETC ColorSource 20 or Strand Spectra.
   b. Provide with minimum 10' DMX Control Cable
6. Provide DMX data distribution system for Stage Lighting Fixtures
7. Provide an LED based system capable of 50 foot-candles, dimmable to at least 5%. The system shall be controlled through the performance lighting console, architectural controls, snapshot stations and touch screen. Fixtures will be controlled though 0 – 10 or phase controlled dimming. Individual fixture control systems will not be accepted.
8. House and performance area fixtures will illuminate in the event of:
   (1) Utility power outage
   (2) Loss of power to the dimmer / relay rack
   (3) Activation of the fire alarm system.
   (4) Activation of the security system

- Middle School Performance lighting system – Provide a complete LED based performance lighting system meeting the following criteria.

1. LED fixtures:
   a. RRGBL – (5 color minimum) LED soft edged PAR washlight as needed for an even wash of the stage from the downstage and upstage lighting positions
   b. RRGBL – (5 color minimum) LED Ellipsoidal framing projector for even front lighting of the downstage area. Mount fixtures 45 degrees up from, and parallel to, the downstage edge of the stage area. Enclose in protective metal cage if in gymnasium.
2. Power Control
   a. Relay control for power on / off of all performance lighting. Provide Mini Relay Panel or Feed Thru Relay Panel as required for Stage Lighting Circuits and House Lighting Circuits
3. LED fixture control station
   a. Locate at side wall 48 inches AFF
   b. Provide a 7" Touchscreen station to control the LED fixtures.
      (1) Program touchscreen with no less than 8 typical stage scenes on page #1.
      (2) Provide a LED Fixture Power ON/OFF button on page #2
      (3) Subsequent touchscreen pages shall be password protected and allow owner to adjust the lighting at each lighting position to various colors using a color wheel and re-record the page #1 scenes. Provide individual fixture programming and control from this device IF indicated.
      (4) Final page of touchscreen shall not be password protect and will offer information for installing specialist, specialist contact #, manufacturer contact #, project # and 24/7 service #.
   c. Program system to turn power OFF to Light by time clock at 12:01AM each day.
   d. Install station in recessed locking enclosure if password protected device is not available
4. House lighting control keypads and automation control
   a. Provide houselight keypads as indicated on drawings to allow use of houselights in a non-stage event.
   b. Provide sensor control of houselights as indicated on drawings
5. DMX receptacle
   a. Locate on the side wall of the stage area at 18 inches AFF or at a location in seating area as indicated on drawings
   b. Provide one each, 10' and 100' DMX control cables
6. Performance Lighting Controller
   a. Provide a DMX512A Performance Lighting Controller with imbedded flat screen monitor and capable of controlling each stage lighting fixture and each zone of house lighting fixtures independently. Equal to or better than ETC ColorSource 40.
7. Provide DMX data distribution system for Stage Lighting Fixtures
8. Provide an LED based house light system capable of 50 foot-candles, dimmable to at least 5%. The system shall be controlled through the performance lighting console, architectural controls, snapshot stations and touch screen. Fixtures will be controlled though 0 – 10, or phase controlled dimming. Individual fixture control systems will not be accepted.

a. Gymnasium / Cafetorium house lighting associated with the stage
    (i) Provide dimmable or switchable bank LED fixtures for seating area

9. House and performance area fixtures will illuminate in the event of:
    a. Utility power outage
    b. Loss of power to the dimmer / relay rack
    c. Activation of the fire alarm system.
    d. Activation of the security system.

- High School - Auditorium

1. Performance system:
    a. Relay cabinet - 48 circuits controlled by 20 amp relays with distributed receptacles to support theatrical performance lighting fixtures.
        (1) System to support DMX and ACN network control consoles
    b. Stage lighting console – Minimum (2) DMX universe. Specifically designed to control theatrical dimming systems and LED fixtures. The console must have a fixture library designed for the operation of intelligent fixtures and LED fixtures. The console shall have a minimum of 4 encoder wheels and 24 submasters and capable of independent control of a minimum 100 LED fixtures. Provide (2) 20" or larger, LED or touch screen monitors compatible with the console. Provide wireless access point and software as required for remote access of the console within the auditorium.
    c. DMX distribution system – Provide a minimum 1 isolated DMX output receptacle per stage strip, front of house position, and wall outlet.
    d. Ethernet distribution system – Located at booth, stage, front of house position.
    e. Control input stations – To include, network, DMX 1 and DMX 2 in, located in the booth and stage
    f. Entry stations – House lights will be accessible from main entries. Preset stations with (4) buttons will be programmed as "house full", "cleaning" (example – down lights at 80%, step lights on), "performance" (example - step lights on) and off.
    g. House light architectural controls – Provide a multi zone house light control system accessible via the architectural control system, entry stations and touch screen and stage lighting console.
    h. Backstage control - Provide a 7" or larger touch screen station for access of the stage and house lighting at stage level. The touch screen will be programmed to control architectural lighting and provide presets of stage lighting for multiple facility users.
    i. Provide a work light, relay control system for control of backstage utility lighting

2. Theatrical plug strips with receptacles controlled by the relay cabinet, typical.
    a. Front of House position – prewired plug strip(s) mounted to an accessible catwalk which runs the full width of the stage
        (1) Capable of supporting 18 LED fixtures, with DMX out
    b. Catwalk mounted will plug strips are to be installed on the stage side of catwalk

(1) The catwalk should be located no closer than 45 degrees nor farther than 30 degrees up from the front of the stage

c. First Electric – prewired plug strip(s) mounted to a 1.5" schedule 40 black pipe which runs the full width of the stage, located behind the proscenium, main valance, and main drape.
   (1) Capable of supporting 18 LED fixtures, with DMX out receptacle
d. Second Electric - prewired plug strip(s) mounted to a 1.5" schedule 40 black pipe which runs the full width of the stage
   (1) Capable of supporting 18 LED fixtures, with DMX out receptacle
e. Third Electric - prewired plug strip(s) mounted to a 1.5" schedule 40 black pipe which runs the full width of the stage, located 5' downstage of the rear cyclorama drapery.
   (1) Capable of supporting 18 LED fixtures, with DMX out receptacle

f. Plug boxes – prewired plug 2 circuit boxes to be located stage left, stage right and upstage, 2 per location with DMX out receptacle

3. LED performance fixtures shall be powered from theatrical plug strips as noted above and shall be designed as follows:

   a. Theatrical plugs strips shall include 1.5" schedule 40 pipe, with internal sleeves for all pipe joints, 6' longer than the proscenium opening
   b. Masked by inherently flame-resistant stage drapery so fixtures are not visible from the third row of audience seating
   c. Side walls of the stage area should not be visible from the third row center audience seats.
   d. Plan and section views of the theater are required to verify sight lines

4. Typical LED performance fixture package
   a. (18) LED ellipsoidal framing projectors RGBW
   b. PAR lights to provide a full wash of the stage
      (1) Either zoomable or with (3) diffusion lenses (Medium Round, Wide Round, Xtra Wide Round)
   c. (12) RGBA or RGBW Pars with lens kits or variable optics
   d. (8) RGBA or RGBW Cyc lights
   e. (6) LED white work lights

5. All pre-wired plug strips shall be hung with load rated hardware (proof coil chain, turnbuckles, screw pin shackles, forged shouldered eyebolts, etc.)
   a. All hardware shall be rated for a minimum 500 pound per support point and stamped by the manufacturer for rated load

   b. Attached to building structure

   c. All hanging plug strips shall be supported every 5 – 10 feet. (10 ft. maximum), see manufacturer's specifications.

6. House Lights

a. Provide an LED based house light system capable of 50 foot-candles, dimmable to OFF. The system shall be controlled through the performance lighting console, architectural controls, snapshot stations and touch screen. Fixtures will be controlled through DMX or phase controlled dimming. Individual fixture control systems will not be accepted.

b. House and stage fixtures will illuminate in the event of:
   (1) Utility power outage
   (2) Loss of power to the dimmer / relay rack
   (3) Activation of the fire alarm system.

7. Locate entry stations to activate the stage and auditorium non-dim lighting in metal locking enclosures at every entry to the auditorium area
8. Provide OSHA approved above stage fixture access with the system. ie-non motorized lift or ladder. The lift platform or top ladder rung should be approximately 4’ shorter than the stage lighting hanging pipe.
9. Individually circuited duplex receptacles shall be provided in the following locations to provide power for the following;
   a. Lighting console in booth
   b. Front catwalk
   c. Two for follow spots
   d. Four on stage side walls for tools and lifts
   e. Four for the orchestra area
10. Provide relay based lighting control for catwalk work lights, pit work lights, offstage work lights, pit night light, offstage blue running lights, grid lights, and dressing room receptacles. Provide automatic shut off and low voltage override for each zone. Provide engraved switching for each zone on a low voltage switch to be located backstage entry.
11. Provide a locally dimmed track light system above the lighting control console in the booth.
12. Provide a communication system for:
   a. Follow spots
   b. Stage control position
   c. Orchestra area
   d. Lighting console
   e. Dressing Rooms
   f. Audio console
13. Provide the following deliverables to District Project Manager:
   a. Complete lens sets for any PAR or flood fixture
   b. 100% spare lamps for follow spots
   c. 10 – 15’ Grounded pin extension cords
   d. 2-15 duplex receptacle x 50’ orchestra stinger
   e. 2 ellipsoidal iris
   f. 10 pattern holders
   g. 10 patterns to include

(1) 5 breakups
(2) 5 realistic stars

h. (2) 25’ spare DMX cables
i. (4) spare fixture power cables
j. 2 manually operated theatrical follow spots
   (1) With stands capable of a minimum 100 foot-candles at 2’ circle from the booth location
   (2) Drawing no more than 10 amps at 120 VAC.

14. All dimming receptacles shall be 20 amp grounded stage pin. All relay controlled receptacles shall be 20 amp U ground.

- Identification

1. Permanently identify components, control stations, power and control wiring
   a. Reference 26 05 03, Identification for additional information
   b. Label each lighting outlet, distribution device, and dimmer module with unique designation.
      (1) Plug strips shall be labeled with 2” vinyl labels
      (2) Outlet boxes shall be labeled with 1” vinyl labels
   c. Circuits shall be ordered sequentially from Down Stage Left to Up Stage Right
      (1) Architectural lights shall be controlled through the performance lighting system and be accessible though the console, control stations and snapshot stations.
   d. DMX communication and network between booth, stage, front light position and dimmer rack will be permanently labeled and identified in High School systems.

- Field Quality Control

1. Manufacturers’ Field Service:
   a. Engage a factory-authorized service representative to inspect, test and adjust field assembled components and equipment installation, including connections and to assist in field-testing.
      (1) Operational Tests:
         (i) Connect each outlet to a fixture and a dimmer output circuit, to test each dimmer module, dimmer control, output circuit and output receptacle.
         (ii) Include operation, testing and control of:
            1. Houselights, work lights and stage lights
   b. Engage a third-party to inspect equipment supports, rigging, and connections to building structural components to confirm proper and secure installations.
   c. Network outlets from each control location and station
      (1) Include optional plug-in control console locations
   d. Provide written documentation of performance testing.
   e. Provide an initial light plot and patch of the lighting system. The supplier shall focus the system to provide an even wash of the stage with limited light spill on the proscenium and drapes.
   f. Provide a minimum (2) owner training sessions.

END SECTION 26 55 61

## 26 56 68 Exterior Athletic Lighting – August 2021

- Work in this section is restricted to specific manufacturers that have been previously approved by Jefferson County School District, R-1.
- Section includes:
    1. Requirements for exterior athletic lighting at competition fields:
        a. Football
        b. Soccer
        c. Lacrosse
- Provide complete system including:
    1. Reinforced concrete drilled piers or spread footing as per Geotechnical Engineer
        a. Designed by Structural Engineer
    2. Precast concrete base
    3. Integrated lightning ground system
    4. Galvanized steel pole with finish
    5. Electrical Components Enclosure
    6. Internal Wire Harness
    7. Pole top Luminaire Assembly
    8. LED Light Fixtures
- Pole height and quantities based on adequate illumination coverage
- Average Horizontal Illuminance:
    1. Football: 32 fc at 3’-0” above grade
    2. Soccer and Lacrosse: 32 fc at 3’-0” above grade
- Post-construction certification/commissioning:
    1. Independent testing agency to confirm average fc.

END SECTION 26 56 68