

6. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.
7. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimp Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.
8. Lugs:
 - a. Single Cable (Compression Type Lugs): Copper, one or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.
 - b. Single Cable (Mechanical Type Lugs): Copper, one or 2 hole style (to suit conditions); Blackburn/T&B Corp.'s Color-Keyed Locktite Series, Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Locktite Series.
9. Acceptable Manufacturers:
 - a. Burndy
 - b. T & B
 - c. Erico

2.4 MOLDED FUSION WELDS

- A. Provide fusion welds designed for size and type of cable, rods, or assembly. Solder prohibited for connections.
 1. Acceptable Manufacturers:
 - a. Erico Cadweld
 - b. Metalweld
 - c. Thermoweld

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Service Entrance
 1. Solidly ground the electrical service at the service entrance. Provide a grounding electrode conductor from the service entrance ground bus to all of the following grounding electrodes:
 - a. Metal water pipe, ahead of the meter.
 - b. Building steel
 - c. Made grounding electrode grid.

- d. Concrete encased electrode (steel rebar in foundation)
 - 2. For a grounded electric service, solidly connect the grounded (neutral) conductor to the service entrance ground bus. Do NOT make any grounding connections to any grounded conductors on the load side of the service disconnecting means.
 - 3. Provide a bare, copper, #4/0 bonding jumper across the water meter.
- B. Raceway Systems:
- 1. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250.122.
 - 2. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.
 - 3. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250.122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.
 - 4. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250.122 for all conduit expansion joints.
 - 5. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250.122.
 - 6. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250.122.
 - 7. Provide isolated ground conductors of systems as called for on the plans.
- C. Ground Grid:
- 1. Provide 3 ground rods, 8 feet long, driven on 10 foot centers, with top of rod 12 inches below finished grade, and located as called for on plans.
 - 2. Connect with size #4/0 AWG copper conductors as called for.
 - 3. Connecting conductors shall be located within 6 inches of the top of the ground rod.
 - 4. Provide two size #4/0 AWG grounding conductors from the ground grid to the service entrance ground bus.
 - 5. Provide one size #4/0 AWG grounding conductor from the ground grid or service entrance ground bus to the service side of nearest metallic cold water and/or sprinkler main.
 - 6. Provide one size #4/0 AWG grounding conductor from the ground grid or service entrance ground bus to building steel.
 - 7. Provide molded fusion welds for all below grade connections. Molds shall be new, unused, and shall be replaced when worn or broken.
 - 8. Required ground grid resistance to earth shall be 25 ohms maximum.
- D. Primary Electrical Equipment:
- 1. Transformers:
 - a. Provide two bare #4/0 AWG conductors, one from each of two ground buses, to ground.
 - b. Provide one size #4/0 AWG conductor from each air terminal chamber to ground bus.

- c. Provide a grounding conductor from the neutral bushing or bushings to system ground, sized as called for, or in accordance with NEC Table 250.102(C)(1), whichever is of greater capacity.
 - d. System ground conductors, usually run with phase conductors, shall be connected to the ground bus.
- 2. Metal Enclosed Switchgear:
 - a. Two size #4/0 AWG grounding conductors from the ground bus to ground or one size #4/0 AWG ground circuit from ground bus to ground for each two compartments in continuous line-up equipment, whichever is the greater number.
 - b. System ground conductors, usually run with phase conductors, shall be connected to the ground bus.
 - c. Where metal enclosures are pierced or penetrated to accommodate ground conductors, seal opening around ground conductor to metal enclosure with "Duxseal" to maintain enclosure integrity.
- E. Secondary Electrical Systems:
 - 1. Solidly ground all transformer neutral conductors and enclosures to building steel, or a cold water pipe 1" or larger in size as called for in Table 250.122 of the National Electrical Code.
 - 2. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, or transformer. Do not splice equipment grounding conductors.
 - 3. Provide an equipment grounding conductors from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.
 - 4. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.
- F. Emergency Generators with Three Pole Transfer Switches:
 - 1. Do NOT ground the generator neutral conductor at the generator.
 - 2. Circuit the generator neutral to the secondary electrical distribution system neutral.
 - 3. Connect the generator neutral system neutral so as not to negate any ground fault protective equipment applied to distribution system.
 - 4. Connect the generator frames to system ground with conductor as sized in accordance with NEC Table 250.122.
- G. Emergency Generators with Four Pole Transfer Switches, Separately Derived System:
 - 1. Provide a separate ground system for the generator as called for.
 - 2. Ground the neutral of the generator to ground through a service entrance type ground link at the generator switchgear, according to NEC.
 - 3. Provide a #4/0 ground conductor connection to cold water pipe, and a size #4/0 connection to the building normal switchgear ground field.
 - 4. Connect generator equipment frame to ground field at two points, for each generator.
 - 5. Provide a test report of the generator ground field resistance prior to interconnecting to other system grounds.]

H. Medium Voltage Conductors:

1. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.
2. The grounding conductor contained in raceway systems shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.
3. The grounding shield tape or concentric wire shields on cables shall be circuited to system ground; ground at each splice and termination.

I. Power Company Requirements:

1. Grounding conductor from service entrance equipment to meter enclosure per. utility standards.
2. One 5/8" diameter by 8' long ground rod and size #4/0 AWG grounding conductor at each riser pole.
3. Additional requirements per. latest power company published standards.

3.2 TESTS

A. Grounding:

1. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:
 - a. For grounding of 5 KV equipment, enclosures, and cable shields: 10 Ohms
 - b. For grounding secondary service neutral: 25 Ohms
 - c. For grounding non-current carrying metal parts associated with secondary distribution system: 25 Ohms
2. Providing grounding tests to verify the above values. Add additional ground rods or connections in order to meet these values.

END OF SECTION 260526

SECTION 260533 – RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

- A. This section includes minimum requirements for the following:

1. Galvanized Rigid Steel Conduit (GRS)
2. Electrical Metallic Tubing (EMT)
3. Flexible Metal Conduit (FMC)
4. Liquidtight Metal Flexible Conduit (LFMC)
5. Fittings
6. Surface Raceway
7. Cable Hangers

1.3 QUALITY ASSURANCE

- A. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- B. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)
 - a. 300 – General Requirements for Wiring Methods and Materials
 - b. 314 – Outlet, Device, Pull and Junction Boxes, Conduit Bodies; Fittings; and Handhole Enclosures
 - c. 344 – Rigid Metal Conduit: Type RMC
 - d. 348 – Flexible Metal Conduit: Type FMC
 - e. 350 – Liquidtight Flexible Metal Conduit: Type LFMC
 - f. 358 – Electrical Metallic Tubing: Type EMT
 - g. 376 – Metal Wireways
 - h. 378 – Nonmetallic Wireways
 - i. 386 – Surface Metal Raceways
 - j. 388 – Surface Nonmetallic Raceways

2. The following National Electrical Manufacturers Association (NEMA) Standards:
 - a. NEMA, RN1 – PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - b. NEMA, TC 3 – PVC fittings for use with Rigid PVC Conduit and tubing.
 - c. NEMA, TC 6 & TC 8 – PVC Plastic Utilities for Underground Installation.
 - d. NEMA, TC 9 & TC 10 – Fittings for PVC Plastic Utilities Duct for Underground Installation.
3. The following American National Standards Institute (ANSI) standards:
 - a. ANSI-C80.1 – Electric Rigid Steel Conduit
 - b. ANSI-C80.3 – Specification for Electrical Metallic Tubing, Steel
4. The following U.L. Standards:
 - a. UL 1 – Flexible Metal Electrical Conduit
 - b. UL 3 – Flexible Nonmetallic Tubing for Electric Wiring
 - c. UL 5 – Surface Metal Raceways and Fittings
 - d. UL 6 – Electrical Conduit Rigid Metal Conduit, Steel
 - e. UL 360 – Liquidtight Flexible Metal Conduit
 - f. UL 514B – Conduit, Tubing and Cable Fittings
 - g. UL 651 – Schedule 40, 80, Type EB and A Rigid PVC
 - h. UL 797 – Electrical Metallic Tubing, Steel
 - i. UL 870 – Wireways, Auxilliary Gutters and Associated

1.4 SUBMITTALS

- A. Provide product data for the following:
 1. Conduit
 2. Surface Raceway
 3. Cable Hangers

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRS)
 1. Shall be hot-dipped galvanized steel, including threads.
 2. Acceptable manufacturers:
 - a. Allied Tube
 - b. Atkore
 - c. LTV Steel
 - d. Steel Duct
 - e. Triangle
 - f. Wheatland

B. Electrical Metallic Tubing (EMT)

1. Electrical Metallic Tubing shall be electro-galvanized steel.
2. Acceptable manufacturers:
 - a. Allied Tube
 - b. Atkore
 - c. LTV Steel
 - d. Steel Duct
 - e. Triangle
 - f. Wheatland

C. Flexible Metal Conduit (FMC)

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges.
2. Acceptable manufacturers:
 - a. American Flexible Conduit Co.
 - b. Anaconda
 - c. Atkore
 - d. O-Z/Gedney
 - e. Southwire
 - f. Thomas and Betts

D. Liquidtight Flexible Metal Conduit (LFMC)

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC).
2. Acceptable Manufacturers:
 - a. Allied
 - b. American Flexible Conduit
 - c. Atkore
 - d. Carlon
 - e. Southwire
 - f. Thomas and Betts

2.2 FITTINGS

A. Non-Hazardous Location Fittings:

1. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.
2. Fittings for PVC coated rigid galvanized steel conduit shall be threaded, hot dipped galvanized, and coated inside and outside with a urethane coating.
3. Fittings for electrical metallic tubing shall have plastic insulated throat type. Connection be single set screw indenter for conduits up to 2" and double set screw indenter for conduits 2" and larger.
4. Fittings for flexible metal conduit shall be center stopped, plastic insulated throat type, U.L. E-11852 listed.

5. Fittings for liquid tight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.
6. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.
7. Die-cast or pressure cast fittings are not permitted.
8. Provide conduit bodies types, shapes and sizes as required to suit application and NEC requirements. Conduit bodies for installation in conduit systems shall allow in-line pull outlets, make 90° bends, "T" take-offs, etc. Provide matching gasketed covers secured with corrosion-resistant screws.
9. Acceptable Manufacturers:
 - a. O.Z. Gedney
 - b. Steel City
 - c. Thomas & Betts
 - d. Crouse-Hinds
 - e. Carlon

B. Expansion Fittings

1. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit.
2. Minimum 4" movement in either direction.
3. Weatherproof for outdoor applications.
4. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of $\frac{3}{4}$ " in all directions from the normal.
5. Design Make: O.Z./Gedney, Type "AX" (exposed), "DX" (Concrete Pour)
6. Acceptable manufacturers:
 - a. O.Z./Gedney
 - b. Crouse-Hinds
 - c. Appleton

2.3 SURFACE METALLIC RACEWAY

A. One-Piece raceway suitable for (8) #12 AWG conductors or (2) 0.2" O.D. cables

1. Color shall be factory finished white.
2. One-piece steel construction.
3. Surface box w/ matching knockouts as required at end(s).
4. Design Make: Wiremold 700 Series

B. Two-Piece raceway suitable for up to (9) #12 AWG conductors or (11) 0.2" O.D. Cables

1. Color shall be factory finished white.
2. Two-piece steel construction with single compartment.
3. Nominal 1-3/4" x 7/8" with snap on cover.
4. Surface box w/ matching knockouts as required at end(s).
5. Design Make: Wiremold 2400 Series

C. Two Channel (Dual Channel) with devices suitable for up to (48) #12 AWG conductors or (50) 0.2" O.D. Cables.

1. Color shall be factory finished white.

2. Two-piece steel construction with removable front cover and divider for power and communications, length as indicated on the drawings.
 3. Nominal 4-3/4" x 1-3/4" with snap on matching cover.
 4. Provide wiring devices and data/audio/video outlets in the raceway as shown on plans.
 5. Design Make: Wiremold 4000 Series
- D. Provide miscellaneous boxes, mounting bezels, covers, entrance fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.
- E. Cat.6A and optical fiber installations:
1. Cable entrance fittings shall include 1" min. minimum knockouts.
 2. Provide 2" minimum radius fittings.
- F. Acceptable Manufacturers:
1. Hubbell
 2. Panduit
 3. Wiremold
 4. Mono-Systems

2.4 SURFACE NON-METALLIC RACEWAY

- A. Two piece construction, manufactured of rigid PVC compound with matte texture with "off-white" finish. Provide the manufacturers standard fittings as required for the installation. All system components shall meet UL 94 requirements for nonflammable, self-extinguishing characteristics.
1. One-Piece Raceway:
 - a. Hubbell Mini Trak (Design Make)
 - b. Mono-Systems
 - c. Panduit
 - d. Approved Equal
 2. Two-Piece Raceways:
 - a. Provide duplex receptacles or Communication devices as specified in wiring devices and indicated on the drawings.
 - b. Provide divider in raceways utilized for power and communications.
 - c. Acceptable manufacturers:
 - d. Hubbell Base Trak and Wall Trak
 - e. Mono-Systems
 - f. Panduit
 - g. Approved Equal

2.5 CABLE HANGERS

- A. Provide prefabricated, zinc coated, carbon steel hangers UL listed to support category 5, 6, 6A, optical fiber cable, and innerduct installations.
- B. Hangers shall have open top with spring loaded cable retainer clip.

- C. 4" high with rolled vertical and horizontal edges and a 3" deep and 2" wide support flange.
- D. Flat bottom profile to reduce cable crushing in center.
- E. Stackable with same model hangers below.
- F. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- G. Design Make: Mono-Systems H-433-S or Approved Equal

PART 3 - EXECUTION

3.1 GENERAL

- A. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.
- B. Minimum 1/2" trade size for branch circuit and fire alarm wiring.
- C. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.
- D. Where cable quantities are identified on drawings provide telecom conduit sleeves and raceways according to the below schedule (Note this table is an estimate and the actual quantity is dependent on the installed cable diameter):

Cat. 6 Cable Qty.	Conduit Trade Size
4 Cables	3/4" Conduit
6 Cables	1" Conduit
10 Cables	1 1/4" Conduit
20 Cables	2" Conduit
70 Cables	4" Conduit
Cat. 6A Cable Qty.	Conduit Trade Size
2 Cables	3/4" Conduit
4 Cables	1" Conduit
6 Cables	1 1/4" Conduit
10 Cables	1 1/2" Conduit
20 Cables	2 1/2" Conduit
70 Cables	4" Conduit

*Refer to specification section 271000 for maximum outside diameter of UTP cabling.

- E. Support raceways from building structure and wall construction. Do not support raceways from ceiling systems ductwork, piping, or equipment hangers. Do not support raceways from pre-existing conduit runs, banks, racks, hangers, etc.
- F. Support outlet, pull, and junction boxes independently from building structure and wall construction. Do not support from raceways.
- G. Install raceways parallel or perpendicular to building walls, floors and ceilings.

- H. Install raceways concealed except in the following areas:
 - 1. Mechanical Rooms
 - 2. Electric Rooms
 - 3. Manufacturing areas
 - 4. Garage or maintenance areas
 - 5. Unfinished basements or crawl spaces
- I. Provide a code compliant ground path between all outlets and the established electrical system ground.
- J. Cut raceways square, ream ends to remove burrs, and bush where necessary.
- K. Coordinate all raceway runs with other trades.
- L. Do not install raceways adjacent to hot surfaces or in wet areas.
- M. Provide expansion fittings with external grounding straps at building expansion joints.
- N. Do not install conduit horizontally in concrete block or dry wall partitions.
- O. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.
- P. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
- Q. Core drill, sleeve, and fire stop all penetrations through existing floors.
- R. Support all raceways with malleable iron pipe clamps or other approved method. In exterior or wet locations, provide minimum ¼" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.
- S. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.
- T. Do not install voice and data cabling in any surface metal raceway smaller than Wiremold V2400, except single voice outlets where cable runs straight down and no bends occur in raceway.

3.2 CONDUIT

- A. EMT conduit is approved for installations in indoor dry locations only.
- B. Install with a minimum of bends and offsets. Bends shall not kink or destroy the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.
- C. Provide at least one junction or pull box for each 270 degrees of bends.
- D. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

- E. Provide UL approved rain-tight and concrete-tight couplings and connectors.
- F. Secure within three feet of each outlet box, junction box, cabinet or fitting.
- G. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.
- H. Install raceways in concrete floor slabs as follows:
 - 1. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings.
 - 2. Provide expansion fittings where conduits cross building expansion joints.
 - 3. Install conduit below the reinforcing mesh.
 - 4. Locate conduits to provide a minimum of 1" of concrete around conduit.
 - 5. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.
- I. Wherever a cluster of four (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.
- J. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
½", ¾"	Concealed	7	10
1", 1-¼"	Concealed	8	10
1-½" & larger	Concealed	10	10
½", ¾"	Exposed	5	7
1", 1-¼"	Exposed	7	8
1-½" & larger	Exposed	10	10

- K. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.

3.3 RACEWAY SYSTEM INSTALLATION:

- A. Wiring above 600 volts in interior or exterior, above grade locations:
 - 1. Rigid Galvanized Steel
- B. Wiring below 600 volts in exterior, above grade locations:
 - 1. Rigid Galvanized Steel where exposed and for the complete roof penetration
 - 2. Final connections to rotating or vibrating equipment: Liquid Tight Flexible Metal Conduit (4-foot maximum length)
- C. Wiring below 600 volts, interior above grade locations:
 - 1. Electrical Metallic Tubing where concealed within walls, above ceilings and in unfinished or unoccupied areas.
 - 2. Where unable to conceal in finished occupied areas: Surface Metal Raceway.
 - 3. Electrical or Mechanical rooms where raceway is installed below 10' AFF or exposed to potential damage: Electrical Metallic Tubing

4. Final connections to rotating or vibrating equipment: Liquid Tight Flexible Metal Conduit (4-foot maximum length)
 5. Final connections to luminaires: Flexible Metal Conduit (6-foot maximum length from EMT conduit & junction box to individual luminaire)
- D. Wiring below 600 volts, interior, inside corrosive environment (i.e. bus garage wash bays, swimming pool areas and pool mechanical room) locations:
1. Electrical Metallic Tubing
 2. Liquid Tight Flexible Metal Conduit (6-foot maximum length)

3.4 SURFACE RACEWAYS

- A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.
- B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.
- C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.
- D. Submit factory drawings detailing the installation. Include a complete part list.

END OF SECTION 260533

SECTION 260620 - WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE

- A. This section includes minimum requirements for the following:
 - 1. Receptacles
 - 2. Switches
 - 3. Coverplates

1.3 QUALITY ASSURANCE

- A. All wiring devices shall be installed neatly, and parallel with building lines. Recessed devices shall be flush with the face of the wall. Provide extension rings on outlet boxes as required. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.4 SUBMITTALS

- A. Provide product data for all wiring devices and cover plates.
- B. Indicate selected part numbers.
- C. Indicated selected color selections.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Wiring devices shall be heavy duty specification grade as a minimum. Standard commercial grade is not acceptable.
- B. Wiring device color shall be white.
- C. Suitable for installation in a 2-1/2" deep outlet box.

D. All receptacles and switches shall be from the same manufacturer.

E. Acceptable Manufacturers:

1. Eaton
2. Hubbell
3. Legrand Pass & Seymour
4. Leviton

2.2 CONVENIENCE DUPLEX RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. Side and back wiring.
- C. 0.32" thick brass three prong power contacts and #8 brass screws
- D. Brass center rivet
- E. All brass grounding system
- F. Nylon face with glass reinforced nylon back
- G. Dielectric Voltage withstands 2,000V minimum
- H. Terminals Identified in accordance with UL 498
- I. Tamper-Resistant
- J. UL 94V-2 Flame rating
- K. Design Make: Hubbell 5362TR Series

2.3 USB CHARGING RECEPTACLES

- A. Décor Style
- B. Commercial Grade USB Charger Outlet: (2) Type-C port configurations, high power 5 Amp, 5 Volt USB output, Tamper-Resistant duplex receptacle, USB ports rated 10,000 cycles.
- C. Duplex 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- D. LED indicator lamp to show USB power is available.
- E. Tamper Resistant
- F. Meets UL94 and complies with USB BC1.2
- G. Design Make: Hubbell USB20C Series

2.4 GFI RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. LED trip/test indication
- C. Tamper Resistant
- D. Side and back wiring.
- E. Nylon face and back.
- F. 2006 UL 943 revisions including "no power to the face when miswired" and "end of life indication" when unit is no longer capable of providing GFCI protection
- G. Designed to trip at maximum 6mA leakage current to ground.
- H. Suitable for feed through protection.
- I. Design Make: Hubbell GFR5362TR Series (Specification Grade)

2.5 SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Side or back wired.
- C. Quiet operation.
- D. Single pole, three way, and four way as called for on the plans.
- E. Design Make:
 - 1. Single pole: Hubbell Catalog No. 1221
 - 2. Three way: Hubbell Catalog No. 1223
 - 3. Four way: Hubbell Catalog No. 1224

2.6 KEY SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Locking type. Provide (1) key per switch, all keyed alike.
- C. Side or back wired.
- D. Quiet operation.
- E. Single pole, three way, and four way as called for on the plans.
- F. Design Make:
 - 1. Single pole: Hubbell Catalog No. 1221L

2. Three way: Hubbell Catalog No. 1223L
3. Four way: Hubbell Catalog No. 1224L

2.7 MOMENTARY SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Momentary contact.
- C. 2 circuit, 3 position, "center off".
- D. Side wired.
- E. Quiet operation.
- F. Design Make: Hubbell catalog no. 1557

2.8 COVERPLATES

- A. Provide high impact nylon with type 302 stainless steel with satin finish coverplates for general purpose flush devices.
- B. Provide utility cover plates for surface mounted devices in mechanical rooms.
- C. Provide gasketed weatherproof cover plates with a hinged cover on a cast aluminum outlet box for all devices in wet areas designated "WP".

2.9 WEATHERPROOF COVERS

- A. Impact resistant polycarbonate, NEMA 3R construction.
- B. Clear cover to view the connection of the device.
- C. UL listed as a weatherproof enclosure with the receptacle in use.
- D. Hinged, latching cover with an opening at the bottom for a cord to exit the device.
- E. Padlockable
- F. Suitable for installation of a GFI protected duplex receptacle.
- G. Design Make: Hubbell Catalog No. WP26MP
- H. Acceptable Manufacturers:
 1. Hubbell
 2. Leviton
 3. Arrow Hart
 4. Pass & Seymour
 5. Bryant

PART 3 - EXECUTION

3.1 GENERAL

- A. Install devices generally where called for.
- B. Coordinate exact locations of all devices with equipment, millwork, counters, fin radiation, windows, etc. and adjust locations as required as part of this contract.
- C. Provide steel box for all devices.
- D. Install receptacles and switches vertical, with the grounding pin down, and the toggle up in the on position.
- E. Install all switches on the strike side of the door, with the edge of the outlet box approximately 3" from the door frame.
- F. Do not install devices "back to back" in the same stud cavity without prior approval of the Owner. Offset devices as required to maintain code required fire rated assemblies or provide fire-stopping assembly around adjacent devices.
- G. Provide plaster rings on all outlet boxes to permit flush installation of devices.
- H. In all wet or damp areas, provide a surface mounted cast aluminum outlet box with threaded connections, gasketed cover, and non-ferrous screws.
- I. Prior to installation and as part of the contract, relocate any device a distance of 5 feet in any direction at the request of the Owner.
- J. Size outlet boxes in accordance with the NEC, based on the number and size of wires in the box.
- K. Provide a coverplate on all devices.

3.2 EQUIPMENT MOUNTING HEIGHTS:

- A. Refer to Specification Section 260100 – Basic Materials and Methods for mounting heights.

3.3 LABELING

- A. Provide tape labels indicating panelboard and circuit on the outside of all device coverplates.

3.4 TESTING

- A. Test all receptacles for proper voltage, polarity, and grounding.
- B. Test all GFI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.

- C. Rewire receptacles as required until receptacles test properly.

END OF SECTION 260620

SECTION 262400 - SWITCHBOARDS AND PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:

- 1. Circuit Breakers
- 2. Branch Circuit Panelboards
- 3. Enclosed Circuit Breakers

1.3 QUALITY ASSURANCE

- A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- B. Materials and installation practices specified herein shall comply with the applicable requirements of:

- 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 240 - Overcurrent Protection
 - b. 368 - Busways
 - c. 404 - Switches
 - d. 408 - Switchboards and Panelboards
- 2. The following National Electrical Manufacturers Association (NEMA) Standards:
 - a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches
 - b. NEMA BU 1 - Busways
 - c. NEMA PB 1 - Panelboards
 - d. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
 - e. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - f. NEMA 250 - Enclosures for Electrical Equipment

3. The following American National Standards Institute (ANSI) standards:

- a. ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems
- b. ANSI C37 – Low-Voltage Power Operated Circuit Breakers
- c. ANSI/IEEE C12.1 Code for Electric Metering

4. The following U.L. Standards:

- a. UL 50 - Enclosures for Electrical Equipment
- b. UL 67 - Panelboards
- c. UL 98 - Enclosed and Dead-Front Switches
- d. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures
- e. UL 857 - Underwriters Busway Standard
- f. UL 891 – Standard for Switchboards
- g. UL 943 - Standard for Ground Fault Circuit Interrupters
- h. UL 1066 - Low-Voltage Power Operated Circuit Breakers

1.4 SUBMITTALS

A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:

- 1. Thermal Magnetic Molded Case Circuit Breakers
- 2. Branch Circuit Panelboards
- 3. Enclosed Circuit Breakers

1.5 MINOR MODIFICATIONS

A. Provide modifications to circuit breaker trip rating within the frame size at no additional cost, until shop drawings are reviewed and submitted.

1.6 FIELD SUPERVISION

A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

A. General

- 1. UL 489 listed.
- 2. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.
- 3. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.
- 4. Provide multi-pole breakers with common trip.

5. When the circuit breaker has tripped, the handle shall move to a position between the "on" and "off" positions. Provide a visual indication that the circuit breaker has tripped.
6. The ampere rating shall be clearly marked on the face of the circuit breaker.
7. Series rated fuse/circuit breaker installations are not acceptable.
8. Make provisions to add circuit breaker handle locks.
9. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.
10. New circuit breakers installed in existing panelboards shall be UL listed for use in panelboard.

B. Thermal Magnetic Molded Case Branch Circuit Breakers

1. Below 250Amps – Unless otherwise noted, operation shall be from a fixed thermal magnetic trip unit. Permanent trip unit containing individual thermal and magnetic trip elements.
2. 250Amps and above - Include field adjustable electronic Long Time, Short Time, and Instantaneous trip unit.
3. 400Amps and above - Include field installed interchangeable rating plugs.
4. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.
5. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.
6. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.
7. Circuit breakers shall be bolt-on. Plug-on acceptable in load centers on residential applications only.
8. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.
9. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.
10. Design Make: Square D QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).
11. Acceptable Manufacturers:
 - a. Eaton
 - b. ABB
 - c. Siemens

C. Arc Mitigation and Safety Options

1. Shall be provided on all circuit breakers 1200 Amps or larger.
2. Alternate Maintenance Setting Switch (AMS)
3. Designed for the temporary arc-flash incident energy reduction during maintenance activities.
4. For each feeder circuit breaker, provide a manual switch on the compartment door to switch the circuit breaker short-time tripping characteristics to instantaneous with minimum pick-up setting, in order to reduce the danger from potential arc-flash at downstream equipment.
5. Provide a lock feature for the AMS switch so that it may be locked in either the Off or On maintenance mode position.
6. Provide a blue LED indicating light to indicate AMS switch is in the maintenance mode.
7. Wire contacts on all AMS switches to a common alarm input to plant control system.
8. Provide for remote AMS switches or indication, as needed.
9. If circuit breaker integral trip unit cannot be controlled as specified, provide discrete relay with shunt-trip or equivalent to provide specified performance.

2.2 BRANCH CIRCUIT PANELBOARDS

- A. 240 Volt rated, maximum 400 amperes.
- B. Copper bus bars with high dielectric thermoplastic insulators.
- C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.
- D. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.
- E. 100% rated neutral of the same material as the main bus.
- F. Provide ground bus of the same material as the main bus.
- G. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.
- H. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.
- I. Fronts
 - 1. Surface or flush mounted as called for on the Panelboard Schedule.
 - 2. ANSI 49 gray electrodeposited enamel.
 - 3. Fronts shall be one piece with door, and continuous hinge to the enclosure.
 - 4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike.
 - 5. Provide a clear plastic directory card holder on the inside of the door.
- J. Design Make: Square D NQ Series
- K. Acceptable Equivalents:
 - 1. Eaton Pow-R-Line Series
 - 2. ABB ReliaGear Series
 - 3. Siemens P1 Panelboard Series

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Circuit breakers shall be as specified above.
- B. Ratings as indicated on plans and as required by the installation.
- C. Short Circuit Withstand ratings of the assembly shall be equal to that of the circuit breaker.
- D. Provide NEMA rated enclosure as called for on the drawings, and as required by the environment.
- E. Externally operable handle, with provisions for padlocking in the OFF and On position.
- F. Gray baked enamel finish except for stainless steel, NEMA 4X enclosures.

- G. Knockouts at the top and bottom of NEMA 1 enclosures.
- H. Design Make: Square D
- I. Acceptable Manufacturers:
 - 1. Eaton
 - 2. ABB
 - 3. Siemens

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide identification for all equipment and devices as indicated in section 260100.
- B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.
- C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items as required.
- D. Provide minimum NEC working clearance for all equipment.
- E. Verify cable/lug sizes for terminations. Where a feeder is sized larger than the lug provide replacement lug or in line splice as directed by Owner's Representative.
- F. Provide testing in accordance with ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems.

3.2 CIRCUIT BREAKERS

- A. Install circuit breakers in panelboards and switchboards as called for on the plans and as recommended by the manufacturer.
- B. Adjust circuit breaker pick-up level and time delay settings to the values called for on the drawings indicated in the coordination study designated by the Engineer.
- C. Submit documentation that a qualified representative from the equipment manufacturer has inspected and approved the installation.

3.3 BRANCH CIRCUIT AND DISTRIBUTION PANELBOARDS

- A. Securely support all panelboard enclosures to walls. Install true and level.
- B. Install panelboards with top of the highest circuit breaker handle at 6'-6" to the centerline.
- C. Provide (5) five empty ¾" conduits and (1) one empty 1 ½" conduit from each flush mounted panelboard backbox to the accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.

- D. Make all branch circuit and feeder connections.
- E. Provide channel support between the wall and backbox for panelboards installed on outside walls.
- F. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.
- G. Measure steady state load currents on each panelboard feeder. Rearrange branch circuits in the panelboard to balance the load within 20% of each other. Maintain proper phasing.
- H. Provide identification as required per section 260100.

3.4 ENCLOSED CIRCUIT BREAKERS

- A. Install enclosed circuit breakers in locations shown on plans. Install true and level.
- B. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.
- C. Provide identification as required per section 260100.

END OF SECTION 262400

SECTION 262913 - SWITCHES, CONTACTORS AND MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. Disconnect Switches
 - 2. Lighting Contactors
 - 3. Motor Control Equipment
 - 4. Low Voltage Fuses

1.3 QUALITY ASSURANCE

- A. All low voltage power distribution equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and installation practices specified herein shall comply with the applicable requirements of:
 - 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 240 - Overcurrent Protection
 - b. 404 - Switches
 - c. 430 - Motors, Motor Circuits, and Motor Controllers
 - 2. The following National Electrical Manufacturers Association (NEMA) Standards:
 - a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches
 - b. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
 - c. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - d. NEMA 250 - Enclosures for Electrical Equipment
 - 3. The following American National Standards Institute (ANSI) standards:
 - a. ANSI/IEEE C12.1 Code for Electric Metering

4. The following U.L. Standards:
 - a. UL 50 - Enclosures for Electrical Equipment
 - b. UL 98 - Enclosed and Dead-Front Switches

1.4 SUBMITTALS

- A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:
 1. Disconnect Switches
 2. Lighting Contactors
 3. Motor Control Equipment
 4. Low Voltage Fuses

1.5 MINOR MODIFICATIONS

- A. Provide modifications to fuse sizes within the frame size at no additional cost, until shop drawings are reviewed and submitted.

1.6 FIELD SUPERVISION

- A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Three pole, single throw, or as called for on the drawings.
- B. Quick-make, quick-break switch operating mechanism.
- C. Mechanical service life (switching cycles) / typical: 10000
- D. 600VAC rated, current rating as called for on the drawings.
- E. Defeatable dual cover interlock external override mechanism to open the disconnect switch door without opening the disconnect switch.
- F. All current carrying parts shall be plated to resist corrosion.
- G. Lugs shall be removable and rated for 75°C temperature rating.
- H. Switch blades shall be visible when the switch is in the open position and the door is open.
- I. Switch shall be padlockable in the OFF and ON positions.

- J. Provide fusible switches with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.
- K. Enclosure shall be steel with gray baked enamel paint.
- L. Provide NEMA type enclosures as called for on the drawings. Provide NEMA Type 3R for all rooftop and exterior switches.
- M. NEMA type 1 enclosures shall be equipped with knockouts.
- N. Design Make: Square D
- O. Acceptable Equivalents:
 - 1. Eaton
 - 2. Siemens

2.2 MOTOR CONTROL EQUIPMENT

A. General

- 1. Provide motor starters, disconnect switches, etc., as listed on the Electric Equipment and Control Schedule on the drawings.
- 2. Starters, contactors and controllers shall comply with NEMA standards having general purpose NEMA 1 or 1B enclosure unless otherwise called for. Provide explosion proof, weather resistant or watertight construction as required. Starters shall be minimum NEMA size 0 with overloads in each phase sized per NEC, nameplate motor full load amperage, service factor, and motor operating conditions.
- 3. Pad lock arrangements shall be provided to lock the disconnect device in the "off" position. Magnetic starters shall be provided with a control power transformer with 120V secondary and primary and secondary fusing and be sized to accept the loads imposed there on. Starters shall have transformer type pilot lights and 6 volt long life bulbs. Each starter subject to electrical interlock and/or automatic control shall have necessary auxiliary contacts.
- 4. Auxiliary devices: Provide pushbutton stations, pilot lights, devices, relays, transformers, selector switches, electric thermostats, auxiliary starter contacts as required for functions called for. Provide separate relay for each speed to operate electric dampers or other devices as required for multispeed motor circuit.
- 5. Manual Motor Starter: Provide all starters with thermal overload(s); and pilot light(s), and handle lock-out provisions. Gang starter with selector switch for multispeed applications. Provide single or 2-pole as required:
 - a. 120 volt, single-pole, surface mounted: Square-D FG-1P.
 - b. 120 volt, single-pole, flush mounted: Square-D FS-1P.
 - c. 240 volt, two-pole, surface mounted: Square-D FG-2P.
 - d. 240 volt, two-pole, flush mounted: Square-D FS-2P.
 - e. 120 volt, single-pole, two speed, surface mounted: Square-D FG-11P.
 - f. 120 volt, single-pole, two speed, flush mounted: Square-D FS-101P.
 - g. 240 volt, two-pole, two-speed, surface mounted: Square-D FG-22P.
 - h. 240 volt, two-pole, two-speed, flush mounted: Square-D FS-202P.
 - i. 120 volt, single-pole, H-O-A selector, surface mounted: Square-D FG-72P.
 - j. 120 volt, single-pole, H-O-A selector, flush mounted: Square-D FS-72P.
 - k. 240 volt, two-pole, H-O-A selector, surface mounted: Square-D FG-72P.

- l. 240 volt, two-pole, H-O-A selector, flush mounted: Square-D FS-72P.
 - m. 120 volt, single-pole, surface mounted, explosion proof: Square-D FR-1H.
 - n. 240 volt, two-pole, surface mounted, explosion proof: Square-D FR-2H.
 - o. Manual Motor Starter - Speed Controller: Shall be similar to "Manual Motor Starter", above, except two-gang with motor speed control sized to handle motor indicated, with positive full on and full off bypass of speed control unit.
 - 6. Manual Starter with Relay: Shall be similar to "Manual Motor Starter", above, except two-gang with relay sized for load indicated, and hand-off-automatic switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with Mechanical Contractor.
- B. Magnetic Starters
 - 1. Shall be single-speed, across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings.
 - 2. Starters shall be mounted in NEMA 1 enclosures unless otherwise indicated.
 - 3. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring.
 - 4. Starter shall have straight-through wiring. Coils shall be of molded construction and shall be replaceable from the front without removing starter.
 - 5. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.
 - 6. Provide hand-off-auto selector switch, start-stop pushbuttons and "run" pilot light in cover. Wire for maintained contact unless otherwise noted.
- C. Combination Magnetic Starter: Shall be similar to "Magnetic Starter", above, except shall include fusible circuit breaker disconnect switch connected ahead of starter. The disconnect handle shall be in control of the disconnect device with the door open or closed. Disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".
- D. Combination Two-Speed Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except with two starters, and six thermal overload units coordinated to match torque and horsepower characteristics of the motor. Starter shall be designed for variable torque operation, and shall be provided with high-low-off-auto selector switch and high and low pilot lights mounted in the cover. Wire for maintained contact unless otherwise noted.
- E. Combination Reduced Voltage Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except auto-transformer closed transition reduced voltage type with auto-transformer protection by winding over-temperature device.
- F. Packaged Control Unit: Shall be furnished under Division 22 or 23, and connected by Electrical Contractor. Generally consists of one or more starters, disconnect switches and additional control devices prewired.
- G. Contactor: Shall be similar to "Magnetic Starter", above, except without thermal overload units.
- H. Duplex Motor Controller
 - 1. General Operation
 - a. Controller consists of two starters in a common enclosure with separate fused disconnect switches for each starter.

- b. An integral alternation circuit shall be provided which alternately operates first one motor and then the other on each successive closing of an external control device.
 - c. If one motor is running and its associated disconnect is opened, an overload relay trips or the starter is de-energized for any reason; the other motor will automatically be started.
 - 2. Magnetic starters shall be single-speed; across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings.
 - 3. Magnetic starters shall be mounted in NEMA 1 enclosures unless otherwise indicated.
 - 4. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring.
 - 5. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.
 - 6. Provide hand-off-auto selector switch, start-stop pushbuttons and "run" pilot light in cover for each motor. Wire for maintained contact unless otherwise noted.
 - 7. Provide one fused control circuit transformer.
 - 8. Controller shall be prewired with a terminal block for connection of external control devices.
- I. Design Make: Square D Class 8XXX
- J. Acceptable manufacturers:
- 1. Square D
 - 2. Eaton
 - 3. Siemens

2.3 LIGHTING CONTACTORS

- A. 480V rated contacts, minimum of 30A or larger rating as called for on the drawings.
- B. Electrically operated, electrically held
- C. Provide with 120V coil
- D. Provide with NEMA 1 enclosure or enclosure type if specified otherwise on drawings.
- E. Provide with number of poles as called for on the drawings
- F. Shall be field convertible for NO/NC operation
- G. Design Make: Square D Class 8903
- H. Acceptable manufacturers:
 - 1. Eaton
 - 2. Siemens

2.4 LOW VOLTAGE FUSES

- A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide one complete sets of fuses for all fusible disconnect switches, plus 3 spare fuses of each size. Deliver spare fuses to the Owner and obtain receipt.
- B. Acceptable manufacturers: Fuses 600 amperes and below: Bussman Type FRN-R (300 volts), Type FRS-R (600 volts) or Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide identification for all equipment and devices as indicated in section 260100.
- B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.
- C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items as required.
- D. Provide minimum NEC working clearance for all equipment.
- E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

3.2 DISCONNECT SWITCHES

- A. Install disconnect switches in locations shown on plans. Install true and level.
- B. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.
- C. Provide identification as required per Section 260100.
- D. Provide fuses in all fusible switches.
- E. All roof mounted disconnect switches shall be a minimum NEMA 3R rating.
- F. Provide stainless steel hardware and uni-strut racking for all roof mounted disconnect switch supports. Do not install disconnect switches on roof curbs below the roof flashing level. Maintain roof warranty for all disconnect switch and associated raceway support installations.
- G. Disconnect switches may be mounted to HVAC equipment where approved by the equipment manufacturer and not interfere with access panel or internal components.

3.3 LOW VOLTAGE FUSES

- A. Install low voltage fuses in disconnect switches as called for on the plans.

- B. Turn all spare fuses over to the Owner and obtain receipt.

3.4 MOTOR CONTROL EQUIPMENT

- A. Provide overload and fuses. Coordinate sizes with division 22 or 23 contractor.
- B. Terminate control wiring. Coordinate with division 22 or 23 contractor.
- C. Prior to releasing the starter and disconnect order the division 26 contractor shall obtain verification in writing from the division 22 and 23 contractors that all starter and disconnect sizes and types are correct. The division 26 contractor shall bear all cost if written approval is not obtained prior to releasing the order and size changes are required.

END OF SECTION 262913

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, connections and controls, as indicated in the Contract Documents. Types of luminaires in this project include LED.
- B. Provide startup of all lighting control systems by a factory certified manufacturer's representative in order to maintain all warranties. The contractor shall complete all startup request forms and complete all pre-startup installations a minimum of 2-weeks in advance or as otherwise required by the manufacturer. Provide initial system settings and owner training.
- C. Provide Lighting System Functional Testing as described in this section by a factory authorized manufacturer's representative hereby referred to as the Testing Agent.
- D. Refer to the General and Supplementary Conditions, Division 1 Specifications Sections for proposed phasing of this project. Provide manufacturer certified startup of all lighting control systems and Lighting System Functional Testing in each phased project area as required to turn each area over independently. The appropriate number of site visits to accomplish this phased scope of work shall be included in the base bid.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. LED Luminaires
 - 2. LED Drivers
 - 3. Emergency Driver
 - 4. Emergency Switching Module
 - 5. Room Controllers
 - 6. Low-Voltage Switches
 - 7. Occupancy Sensors
 - 8. Dimmer Switches
 - 9. Diffusers
 - 10. Lighting System Functional Testing

1.3 SUBMITTALS

- A. Submit shop drawings as described in Section 260010. Shop drawings shall include photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and ballast(s). All luminaire types and lighting control system components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.
 - 1. Information on each luminaire shall include:
 - a. Manufacturer and Catalog Number.

- b. Dimensioned Construction Drawing(s).
 - c. Standard Catalog "Cut" Sheet.
 - d. Photometrics.
 - e. Lens/Louver Type.
 - f. Driver Type and Rating.
 - g. Socket Type.
 - h. Lamp Type.
 - i. Maintenance Data
 - 2. Emergency Driver
 - 3. Emergency Switching Modules
 - 4. Room Controllers and Wiring Diagrams
 - 5. Occupancy Sensors
- B. Submit for approval information detailing startup of the lighting control systems and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they certify said individual(s) to perform this work. Submittal will be rejected if this information is not included.
- C. Submit for approval a testing plan for all lighting control systems. Testing plan shall, at a minimum, observe and record all items described in the "Lighting System Functional Testing" part of this section and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.
- 1. Lighting System Functional Testing
 - a. Submittal of Functional Testing company name
 - b. Light meter to be used
 - c. Functional Testing Report after final adjustments are made
- D. Warranty Information
- 1.4 QUALITY ASSURANCE
- A. Luminaires shall be standard products of manufacturers regularly engaged in the manufacture of the specific type luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the luminaires shall have a minimum of five (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.
- B. Codes and Standards
- 1. NEC:
 - a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.
 - 2. NEMA:
 - a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.

3. UL:
 - a. All interior lighting luminaires and components shall be UL listed and labeled.
 - b. Comply with all applicable UL standards including UL 486A and B.
 4. CBM:
 - a. Fluorescent and HID ballasts shall comply with Certified Ballast Manufacturers Association standards and carry the CBM label.
 5. All work shall comply with applicable local code requirements of the authority having jurisdiction.
- C. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost.
- D. Luminaires shall be as specified in the "Luminaire Schedule." Luminaire types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample luminaire from the factory for any products not listed as acceptable for approval. The Owner's Representative reserves the right to disapprove any luminaire type submitted which is not equal in quality, appearance or performance to the luminaire specified.
- E. All luminaires shall meet the Total Luminaire Efficiency (TLE) requirements of the New York State Energy Conservation Construction Code.

1.5 SEQUENCE OF OPERATION

- A. Configure set-points and provide necessary programming to the local Room Controller(s) or stand-alone line voltage or low-voltage controls devices to operate as listed below.
- B. Initially Unoccupied Room with Multiple Luminaires:
1. Turn on manual switch for each lighting zone (single, multi-level, daylight) to initially turn on luminaires (Per NYS Energy Conservation Code).
 2. Within a daylight zone, lighting output dims up/down via output from a photocell(s) to adjust and maintain a 40-footcandle minimum light level in the daylight zone.
 3. Occupancy sensor utilizes infrared or dual-technology (infrared/ultrasonic) to detect occupants and keep luminaires on at 100% output level.
 4. Upon occupants leaving room, occupancy sensor keeps luminaires on for a set time delay (20-minutes). If no occupants are detected over the course of the time delay, occupancy sensor turns all luminaires off.
 5. Upon occupants re-entering room, light switch shall be manually used to turn the luminaires back on.
 6. Sequence then repeats.
- C. Initially Unoccupied Corridor, Restroom, or Stairwell:
1. Key switch per. plans for each lighting zone (single, multi-level, daylight) to initially turn on luminaires (Per International Energy Conservation Code).

2. Occupancy sensor utilizes passive Infra-Red and Ultrasonic technology to detect occupants to control dimming.
3. Upon occupants leaving the area, occupancy sensor keeps luminaires on for a set time delay (20-minutes). If no occupants are detected over the course of the time delay, the room controller shall maintain the light levels in paths of egress shall not be reduced more than 50%.
4. Upon occupancy sensor detection of occupants re-entering the area, luminaires output shall be automatically turned back up to 100%.
5. Sequence then repeats.

PART 2 - PRODUCTS

2.1 LED LUMINAIRES

A. General:

1. Manufacturers shall be a registered with the Department of Energy (DOE) as a Quality Advocate and taken the pledge to be listed on the LED lighting facts website.
2. Luminaire measurements have been standardized and are in compliance with IESNA Standard LM-79 test procedure.
3. LED's have been standardized and are in compliance with IESNA Standard LM-80 and demonstrate L70 life after 50,000 hours.
4. Luminaires and/or replacement lamps shall be either Energy Star certified or Design Lights Consortium listed where noted on the luminaire schedule to qualify for NYSERDA or Utility provider rebate incentives. Submitted luminaires not currently on the DLC qualified products list (<http://www.designlights.org/>) will be rejected.
5. Manufacturers shall prove color consistency across all LED's via 4 step MacAdam Ellipse.
6. Luminaires shall be tested at an ambient temperature of +25 degrees for a minimum of 6000hrs.
7. Maximum junction temperature of 80°C.
8. Minimum drive current of 350mA. Maximum drive current of 700mA.
9. All LED luminaires shall have a minimum Color Rendering Index (CRI) of 80.
10. Luminaires shall a minimum 5 year warranty.
11. Refer to Luminaire Schedule on drawings for complete Luminaire makes and models.

2.2 LED DRIVERS

A. Driver:

1. Driver shall be of the constant current type.
 - a. Voltage: 120/277 as noted on drawing
 - b. Constant current
 - c. Driver Current: 350mA – 700mA.
 - d. Maximum THD: 10%
 - e. Minimum Power Factor: 0.9
2. Acceptable Manufacturers.
 - a. eldoLED

- b. Philips Advance - Xitanium
- c. Lutron Hi-Lume
- d. Sylvania/Osram - Optotronic

B. Dimmable Driver (0-10v):

1. Driver shall be of the constant current type.
 - a. Voltage: 120/277 as noted on drawing
 - b. Driver Current: 350mA – 700mA.
 - c. 0-10v dimming capable down to 10%.
 - d. 0-10v dimming capable down to 1%.
 - e. Maximum THD: 10%
 - f. Minimum Power Factor: 0.9
2. Acceptable Manufacturers.
 - a. eldoLED
 - b. Philips Advance – Xitanium
 - c. Lutron – Hi-Lume A series
 - d. Osram/Sylvania - Optotronic

2.3 EMERGENCY SWITCHING MODULE

A. Emergency Switching Module Type A:

1. Switching module shall be installed in conjunction with AC ballast/driver intended for normal luminaire operation. Designed to automatically switch over to emergency circuit upon loss of normal power via internal voltage sensing device.
2. Allows standard switching of Luminaire on normal power circuit.
3. Inputs:
 - a. Normal power switched circuit
 - b. Normal power unswitched circuit
 - c. Emergency power unswitched circuit
4. Output: Connection to AC ballast/driver
5. 0-10 VDC dimmer override to full brightness upon loss of normal power
6. Rated: 120-277V, 10-amps for single luminaire installation only
7. UL 924 listed for Emergency Lighting and Power Equipment
8. Design Make: Bodine GTD10DIM Series or Approved Equal

B. Emergency Switching Module Type B:

1. Switching module shall be installed in conjunction with normal and emergency power circuits intended for switched and automatic emergency luminaire operation. Designed to automatically switch over to emergency circuit upon loss of normal power via internal voltage sensing device.
2. Allows standard switching of Luminaire on normal power circuit.
3. Inputs:
 - a. Normal power switched circuit
 - b. Normal power unswitched circuit

c. Emergency power unswitched circuit

4. Output: Connection to lighting circuit maximum of 16 amps
5. 0-10 VDC dimmer override to full brightness upon loss of normal power
6. Rated: 120-277V, 16-amps for multiple luminaires on the circuit
7. UL 924 listed for Emergency Lighting and Power Equipment
8. UL 1008 Listed Transfer Switch
9. Design Make: Bodine GTD20A or Approved Equal

2.4 ROOM CONTROLLERS

- A. Modular, stand-alone one room lighting control system (0-10V dimming and switching) with control of multiple user presets and room occupancy and daylight sensing for daylight harvesting.
- B. Concealed mounting, self-contained, multi-channel lighting controller designed to communicate with occupancy and photo sensor inputs without the use of external power packs.
- C. Shall allow for on-site commissioning controls via an infrared handheld remote control.
- D. Lighting loads: Refer to floor plans for quantity of lighting channels per room. Where any room exceeds three channels, provide multiple room controllers networked together for proper system operation.
- E. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so the individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.
- F. Each load shall at minimum be configurable to operate in the following sequences based on occupancy:
 1. Auto-on/Auto-off
 2. Manual-on/Auto-off
- G. Manual override and LED indicated for each load.
- H. Compatible with 120/277 VAC systems.
- I. Maximum 20A combined 20A combined load per Room Controller.
- J. All digital parameter data programmed into each room controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- K. Room controller shall include:
 1. Real time current monitoring
 2. Efficient 250 mA switching power supply
 3. RJ-45 network ports with integral strain relief and dust covers
 4. One dimming output per relay
 - a. The 0-10-volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.

- b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. The LED level indicators on connected dimmer switches shall utilize this new maximum and minimum trim.
 - c. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0—100% dimming range defined by the minimum and maximum calibration trim.
 - d. Calibration and trim levels must be set per output channel.
 - e. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
- 5. Fade rates for dimming loads shall be specific to connected switch buttons, and the load shall maintain a default value for any connected buttons that do not specify a unique value.
- L. Class 2 dimming control signal: 0-10VDC, sinks up to 100mA per channel for control of compatible drivers.
- M. UL 2043 Plenum rated.
- N. IR window built-in to room controller for commissioning with remote control.
- O. Provide (1) infrared remote control for startup, programming, and commissioning.
- P. Provide with digital input/output interface that includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC.
- Q. Five year warranty.
- R. Design Make: Wattstopper LMRC-210 Series with LMIO-101 Digital I/O Interface
- S. Approved Equivalents:
 - 1. Crestron GLPP Series
 - 2. Douglass Controls
 - 3. Hubbell NX Series

2.5 LOW-VOLTAGE SWITCHES FOR ROOM CONTROLLERS:

- A. Low-Voltage Switch
 - 1. On/Raise & Off/Lower dimming control button with led status indicator
 - 2. Dimming switch with seven bi-level LED's to indicate load levels using 14 steps.
 - 3. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 4. All digital parameter data programmed into each wall switch shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
 - 5. Two RJ-45 ports for connection to the Room Controller network and other devices.
 - 6. Multiple digital wall switches may be installed in a room by simply connecting the to the room controller network. No additional configuration shall be required to achieve multi-level switching.
 - 7. Ramp rate may be adjusted for each dimmer switch.

8. Color shall be white.
9. Five year warranty.
10. Shall be of the same manufacturer as the room controller.
11. Design Make: Wattstopper LMDM-101 Series
12. Acceptable Manufacturer's:
 - a. Crestron
 - b. Douglass Controls
 - c. Hubbell

B. Low-Voltage Key Switch

1. Three position, momentary contact, key switch
2. Ratings:
 - a. 15 Amps
 - b. 120/277 VAC
3. Provide with a digital input/output interface as required to connect to the room controller network.
4. Color by Architect.
5. Five-year warranty.
6. Shall be of the same manufacturer as the room controller.
7. Design Make: Pass & Seymour 1250L Momentary Key Switch with LMIO-101 Digital Input/Output Interface
8. Acceptable Manufacturer's:
 - a. Crestron
 - b. Douglass Controls
 - c. Hubbell

2.6 OCCUPANCY SENSORS

A. General:

1. All occupancy sensor layouts have been done using the "design make" sensors. Contractor shall be responsible for providing additional sensors and all associated equipment required to provide coverage for required areas.

B. Wall Mounted Sensors

1. Switchbox type (single circuit):
 - a. 120-277 volt, 800/1200 watts
 - b. 600 sq. ft. of coverage, 180 degree viewing angle.
 - c. Passive infrared technology.
 - d. Adjustable time delay from 30 seconds to 30 minutes.
 - e. Adjustable sensitivity from 20% to 100%.
 - f. Manual on switch operation (vacancy mode).
 - g. Internal photocell.
 - h. Decorator style, ivory color.
 - i. Install in single gang switch box.
 - j. Design Make: Wattstopper CS-50 series.

- k. Acceptable Manufacturers:
 - 1) Eaton Greengate
 - 2) Hubbell
 - 3) Douglass Controls
- 2. Switchbox Dimming Type (single circuit):
 - a. 120-277 volt, 800/1200 watts
 - b. 900 sq. ft. of coverage, 180 degree viewing angle, passive infrared technology.
 - c. Adjustable time delay from 30 seconds to 30 minutes.
 - d. Adjustable sensitivity from 20% to 100%.
 - e. Manual on switch operation (vacancy mode).
 - f. Decorator style, white color.
 - g. Install in single gang switch box.
 - h. Internal photocell.
 - i. Include with PowPak dimming module with 0–10V control
 - j. Design Make: Lutron Maestro 0-10V dimming sensor
 - k. Acceptable Manufacturers:
 - 1) Eaton Greengate
 - 2) Hubbell
 - 3) Douglass Controls
- 3. Switchbox type (two circuit):
 - a. 120-277 volt, 800/1200 watts
 - b. 600 sq. ft. of coverage, 180 degree viewing angle.
 - c. Passive infrared technology.
 - d. Adjustable time delay from 30 seconds to 30 minutes.
 - e. Adjustable sensitivity from 20% to 100%.
 - f. Two manual on switches for independent control of two separate circuits.
 - g. Decorator style, ivory color.
 - h. Install in single gang switch box.
 - i. Design Make: Wattstopper CS-350 Series
 - j. Acceptable Manufacturers:
 - 1) Eaton Greengate
 - 2) Hubbell
 - 3) Douglass Controls
- C. Ceiling Mounted Sensors
 - 1. Type OS-A Ceiling Mounted Sensors
 - a. Minimum 450 square feet of coverage, 360 degree viewing angle.
 - b. Passive infrared technology. Adjustable sensitivity.
 - c. Adjustable time delay from 5 to 30 minutes.
 - d. Install semi-flush in single gang switch box above the ceiling.
 - e. Standalone Sensors:
 - 1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC

- 2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.
- 3) Compatible with optional low voltage switch for manual-on operation.
- 4) Design Make: Wattstopper CI-300
- 5) Approved Equivalents:
 - a) Eaton Greengate OAC-P-1500-R
 - b) Hubbell OMNIIRRP
 - c) Douglass Controls

f. Sensors connected to Room Controllers:

- 1) Two RJ-45 ports for connection to the Room Controller and other devices.
- 2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
- 3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.
- 4) Shall be of the same manufacturer as the Room Controller
- 5) Design Make: Wattstopper LMPC-100 Series
- 6) Acceptable Manufacturers:
 - a) Crestron
 - b) Hubbell
 - c) Douglass Controls

2. Type OS-B Ceiling Mounted Sensors

- a. Minimum 1,000 square feet of coverage, 360 degree viewing angle.
- b. Dual technology (Ultrasonic/PIR or Microphonic/PIR). Field selectable for either setting or both. Adjustable sensitivity.
- c. Adjustable time delay from 5 to 30 minutes.
- d. Installs surface mounted in 4" octagon J-box above the ceiling.
- e. Standalone Sensors:
 - 1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
 - 2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.
 - 3) Compatible with optional low voltage switch for manual-on operation.
 - 4) Design Make: Wattstopper DT-300
 - 5) Approved Equivalents:
 - a) Eaton Greengate OAC-DT-1000-R
 - b) Hubbell OMNIDT1000RP
 - c) Douglass Controls
- f. Sensors connected to Room Controllers:
 - 1) Two RJ-45 ports for connection to the Room Controller and other devices.
 - 2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

- 3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.
- 4) Shall be of the same manufacturer as the Room Controller
- 5) Design Make: Wattstopper LMDC-100 Series
- 6) Acceptable Manufacturers:
 - a) Crestron
 - b) Hubbell
 - c) Douglass Controls

3. Type OS-C Ceiling Mounted Sensors

- a. Nominal 10' X 75' of coverage for corridors.
- b. Ultrasonic technology.
- c. Adjustable time delay from 30 seconds to 15 minutes.
- d. Adjustable sensitivity.
- e. Manual sensor bypass.
- f. Install surface mounted in single gang switch box above the ceiling.
- g. Provide with relay power pack.
- h. Design make: Wattstopper W-2000H
- i. Acceptable Manufacturers:
 - 1) Eaton Greengate
 - 2) Hubbell
 - 3) Douglass Controls

2.7 PHOTO SENSOR

- A. Digital daylighting sensor shall work with the Room Controllers describe in this section to provide automatic dimming daylight harvesting capabilities.
- B. Continuously monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight.
- C. Shall provide the option, when daylight contribution is sufficient, of turning the lights off or dimming the lights to a field-selectable minimum level.
- D. Shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
- E. Shall provide adjustable cut-off time. Cut –off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
- F. Wall switch override shall allow occupants to control lighting level with dimming wall switches.
- G. Automatically establishes application specific set points following manual calibration using a wireless configuration tool or PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF set points for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

- H. Install in location recommended by the manufacturer.
- I. Field of View: 60 Degree cone.
- J. Sensitivity: 1-6,553 foot-candles (10-70,536 lux).
- K. LED status and configuration indicators.
- L. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool.
- M. One RJ-45 port.
- N. Connects to room controller via Cat.5e patch cable without the need for external power packs.
- O. Five year warranty.
- P. Shall be of the same manufacturer as the room controller.
- Q. Design Make: Wattstopper LMLS-500 Series
- R. Acceptable Manufacturers:
 - 1. Crestron
 - 2. Hubbell
 - 3. Douglass Controls

2.8 DIMMER SWITCHES

- A. 120V – 277V Line Voltage Fluorescent 3-Wire Dimmers:
 - 1. Refer to drawings for 1-way or 3-way dimmers, provide applicable model.
 - 2. Mechanical air-gap switch to disconnect load power
 - 3. Vertical linear slider for dimming
 - 4. Intended for 0–10V dimming for fluorescent and LED luminaires
 - 5. Rated for 8 amps at 120 volts or 6 amps at 277 volts.
 - 6. Contractor to verify dimmer is manufacturer certified with the dimmable fluorescent ballast.
 - 7. Design Make: Lutron Diva DVF-103P Series or Approved Equal
- B. 120V Line Voltage Dimmers for Lamps:
 - 1. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model.
 - 2. Mechanical air-gap switch to disconnect load power
 - 3. Vertical linear slider for dimming
 - 4. Intended for 120V, 60Hz dimmer for LED, Halogen, Fluorescent. and Incandescent dimmable lamps.
 - 5. Rated for 150W LED
 - 6. Rated for 600W Incandescent/Halogen
 - 7. Forward phase shift
 - 8. Includes low-end trim adjustment slide
 - 9. Design Make: Lutron DVCL Series or Approved Equal

C. 120V Line Voltage Dimmers for LED luminaires run off a driver:

1. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model.
2. Mechanical air-gap switch to disconnect load power
3. Vertical linear slider for dimming.
4. Intended for 120V, 60Hz dimmer for ELV, LED, CFL, halogen and incandescent dimmable lamps.
5. Rated for 500W LED, 250W CFL
6. Reverse phase shift
7. Design Make: Lutron DVRP Series or Approved Equal

D. Magnetic Low-Voltage Dimmers:

1. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model.
2. Mechanical air-gap switch to disconnect load power
3. Vertical linear slider for dimming
4. Dimmers shall not cause a magnetic low voltage transformer to operate above the transformers rated operating current or temperature.
5. Rated for 450W
6. Design Make: Lutron DVLV Series or Approved Equal

E. 0-10VDC Dimmers:

1. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model with matching wallplate.
2. Provide accessory 120-277V input power pack to power accessory sensors as indicated and 10V control power for dimming switch
3. Vertical linear slider for dimming
4. Intended for 0-10V dimming for fluorescent and LED luminaires
5. Controls 120-277V without a power pack, 8 Amp 120-277V rated. Internal power supply generates 0-10V output.
6. Provides 3-way preset switching functionality
7. Design Make: Lutron Diva 0-10V DDTV Series w/ Lutron PP-DV Powerpack

F. Approved Equivalents:

1. Hubbell - Rocker Slide Dimmer Series
2. Sensor Switch – Contractor Select Series
3. Leviton – Decora Dimmer Series

2.9 LOW-VOLTAGE WIRING FOR LIGHTING CONTROLS

A. 0-10VDC Wiring

1. UL Type CMP plenum rated cable
2. 0-10VDC wiring shall be white outer jacket with 2-conductor purple and gray jacket insulation on the internal 18AWG solid copper conductors.
3. Design Make: Liberty AV Solutions 18-2C-LVBP-WHT or Approved Equal

B. Unshielded Twisted Pair (UTP) Wiring

1. UL Type CMP plenum rated cable
2. RJ-45 factory terminated RJ-45 connectors

3. ANSI/TIA-568-C.1 certified Cat. 6 Cable
4. Max. length 100-meters
5. Design Make: Belden, West Penn Wire, Hubbell, Leviton

2.10 DIFFUSERS

A. Lenses:

1. Extruded 100 percent virgin acrylic material with a minimum weight of ten ounces per square foot.
2. Type 12 - Clear material with 0.125 inch overall thickness with .080 Inch penetration comprised of 3/16 inch square based female cones aligned 45 degrees to the length and width of the panel.
3. Type 19 - Clear material with 0.156 inch overall thickness with 0.080 inch penetration comprised of 3/16 inch square based male cones aligned parallel and perpendicular to the length and width of the panel.
4. White matte - White material with 0.125 inch overall thickness.
5. White overlay - White material with 0.040 inch overall thickness.
6. The maximum deflection at the center of a 2 foot x 4 foot lens shall be no greater than 0.250 inch. Arched or warped lenses will not be accepted.
7. Parabolic Louvers
 - a. Medium cell louver - One piece injection molded acrylic, with all parabolic surfaces prepared with a primary undercoat, highly specular vacuum metalized finish, and encapsulated in a protective acrylic lacquer coating. Cell dimensions shall be nominal 1-1/2 inches x 1-1/2 inches x 1 inch deep, and shall provide approximately 38 degree shielding with a louver efficiency of not less than 52 percent. This louver shall have a VCP index rating of 0.93 for semi-specular silver finish. Panel finish shall be specular silver.
8. Baffles and Louvers
 - a. Cross Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 inches apart. White enamel finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and of lengths to form a continuous baffle with no visible joints. Where inside and outside corners are required, the blades shall be mitered.
 - b. Parabolic Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 inches apart. Clear anodized finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and lengths to form a continuous baffle with no visible joints. Where inside and outside corners are required, the blades shall be mitered.
 - c. Directional Louver - Constructed and fabricated of aluminum with a "cold bonding joint method for integral vibration free and precise alignment of cells. Louver finish shall be custom color as directed by the Architect.

2.11 LUMINAIRE SCHEDULE

- ### A. Luminaire schedule is found on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PRE-INSTALLATION MEETING

- A. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation meeting after receipt of approved submittals to review the following:
 - 1. Confirm the location and mounting of all digital lighting control devices, with special attention to placement of occupancy and photo sensors.
 - 2. Review the requirements for low-voltage control wiring and termination.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

3.3 COORDINATION

- A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer's recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type), quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.
- B. General
 - 1. Install interior luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation', NEMA standards, and with recognized industry practices.
 - 2. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.
 - 3. Make installation such that the luminaire is free of finger marks, flaws, scratches, dents or other imperfections.
 - 4. Arrangement
 - a. Align edges of luminaires with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.
 - b. For wall to wall installed luminaires, field measure length required after completion of the wall construction and prior to ordering the luminaires. Fabricate in largest lengths allowable.

5. Recessed Mounting

- a. Verify ceiling construction and material prior to ordering luminaires. Provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt luminaire to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type luminaires, each Luminaire shall be supported completely independent of the ceiling system by way of 12-AWG galvanized steel support wires. Support wires shall be attached from all four corners of the Luminaire housing to the building structure. Each support shall be capable of supporting 100 pounds. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity.

6. Stem Mounting

- a. Use self-aligning hangers in canopies for hanging luminaires true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four times luminaire weight. Align continuous rows of luminaires maintaining luminaires level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on centers as called for by the manufacturer. There shall be a minimum of two stems per individual four foot luminaire, and three stems per individual eight foot luminaire for steel luminaires. Extruded aluminum luminaires shall have hangers as called for by the manufacturer.
- b. Provide brackets from the manufacturer of the same finish and material as the luminaires to present a seamless continuous row mounting appearance. Provide continuous row mounting brackets between all adjoining luminaires.

7. Surface Ceiling Mounting

- a. Mount surface luminaires tight to surface without distorting surface. Space luminaires in continuous rows to correspond to ceiling joint intersections. Continuous row luminaires may be fed by a single outlet where luminaires contain approved wireways and suitable wiring is used. Provide hangers for each luminaire, each rated to support four times the luminaire weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4 foot centers with a minimum of two hangers per individual four foot luminaire and three hangers per individual eight foot luminaire. Hangers shall be supported from the building structure and independently from ceiling system or other building services.
- b. Fasten luminaires securely to structural supports.

3.4 DELIVERY, STORAGE, AND HANDLING

- A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.

- B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.
- C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace with new.

3.5 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.
- B. The contractor shall provide the lighting control systems manufacturer with three weeks written notice of the system startup and adjustment date.

3.6 REUSE AND REPAIR OF EXISTING LUMINAIRES

- A. Reuse existing luminaires only where called for. Perform the following work, as required, to upgrade existing luminaire. Replace faulty, leaking, or noisy ballast. Replace broken, damaged, worn, or faulted lamp sockets. Provide new luminaire wire. Provide new acrylic lens system to match existing, where existing is broken. Re-lamp luminaires. Completely damp clean lens and interior of luminaires.
- B. If ballasts have leaked, remove material deposited in luminaire. Assume material was PCB contamination, or a test samples to show material is not PCB and submit a report. Dispose of material as required by EPA, including clean-up materials used. Dispose of ballast which does not have non PCB label in PCB containers and have containers taken to EPA approved incinerators. Follow all EPA regulations for transporting material.
- C. New luminaires may be provided to replace existing luminaires scheduled to remain or be reused, subject to shop drawing approval.

3.7 REMOVAL OF BALLAST IN EXISTING LUMINAIRES

- A. Assume ballast contains PCB materials unless labeled otherwise or test samples to show materials are not PCB; submit test report. Remove all ballast from existing luminaires indicated on contract documents. Dispose of all ballast which do not have non-PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing luminaire, remove material deposited in luminaire and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owners representative.

3.8 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

- A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing luminaires indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.9 OCCUPANCY SENSORS

- A. Provide all necessary mounting brackets, wiring, low voltage transformers and control relays required to provide control of areas indicated.
- B. Provide initial time delay and sensitivity settings per owner's representative.
- C. Install in location as recommended by the manufacturer.
- D. Refer to "Lighting System Functional Testing" part of this section for additional information.

3.10 CONTROL WIRING

- A. Provide all required low-voltage control wiring for lighting control system components.
- B. Provide RJ-45 factory terminated Cat. 6 or better Unshielded Twisted Pair (UTP) cable with RJ-45 connectors to connect switching, photo control, and occupancy sensing devices on the Room Controller network. Cables shall manufacturer approved for the connectivity solution.
- C. Provide 0-10VDC wiring for dimming from Room Controller and dimming switches to the drivers.
- D. Control Wiring Installation:
 - 1. All interior cabling shall be installed concealed inside the wall cavities and ceiling space.
 - 2. Provide a continuous raceway system in accordance with NEC Article 800 for horizontal cable runs through all inaccessible ceiling (including drywall) and wall cavity spaces. All flexible raceway system runs shall be securely attached to ceiling joists and wall studs 3-feet O.C and removal and addition of cables in the future.
 - 3. UTP Cables shall be supported by Cable Hangers 3-foot on center. When installed in cable tray zip-tie to cable tray away from STP, coaxial cables, and optical fiber cables. Provide additional stacked Cable Hangers when filled greater than 50%.

3.11 LIGHTING SYSTEM FUNCTIONAL TESTING

- A. Lighting system functional testing shall comply with the following requirements:
 - 1. Provide plan markup which indicates the exact location of each sensor, direction of aim, and certify on the plan that the direction of aim and placement are in compliance with manufacturer's requirements. Include this plan with the Operation & Maintenance Manuals.

2. Occupancy Sensor Controls:
 - a. Certify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations.
 - b. All devices shall be tested. Verify the following:
 - 1) Where occupant sensor controls include status indicators, verify correct operation.
 - 2) The controlled lights turn off or down to the permitted level within the specified time.
 - 3) The lights turn on only when manually activated.
 - 4) The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
3. For Time – Switch Controls:
 - a. Verify that timers are properly programmed with weekday, weekend and holiday schedules.
 - b. Provide documentation to the Owner of time-switch controls programming including weekday, weekend, and holiday schedules and set-up and preference program settings. Include a copy in testing documentation package for approval by the Engineer.
 - c. Verify time of day and day of week are properly set.
 - d. Verify that any battery back-up is installed and energized.
 - e. Verify that any override timer is set for less than 2 hours.
 - f. Simulate occupied condition and verify the following:
 - 1) All lights can be turned on or off by respective area control switch.
 - 2) Light switches control only those lights in the enclosed area where the switch is located.
 - g. Simulate unoccupied condition and verify the following:
 - 1) Non-exempt lights turn off.
 - 2) Manual override switches allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.
 - h. For Daylight Responsive Controls:
 - 1) Verify that the control sensing devices have been properly located, field calibrated and set for accurate control set points and threshold lighting levels.
 - 2) Daylight controlled lighting loads adjust to light levels set points in response to available daylight.
 - 3) The location of calibration adjustment equipment is readily accessible only to authorized personnel.
 - 4) Record all set points and verify with calibrated light meter the actual field recorded lighting control levels.
 - 5) Upon request, repeat measurements in the presence of the Design Professional or their authorized representative to validate lighting level control response.

4. Create a log of deficiencies noted during testing. Correct all deficiencies and update log with corrective action records.
5. Complete and submit as part of the Operation and Maintenance Manuals the submitted and approved lighting testing plan.

B. Test Form:

1. Instruction: Contractor to complete either the following form or the form contained in the approved testing plan for each room in the project that receives lighting controls. Include completed forms in the Operation and Maintenance Manuals.

<i>Room Name/Number:</i>	<i>Date:</i>	
<i>Testing Agent's Name:</i>		
<i>Testing Agent's Signature:</i>		
<i>Testing Agent's Company & Position:</i>		
<i>Occupancy Sensor Controls</i>	<i>Initials</i>	<i>N/A</i>
Verify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations such that occupants within the space properly trigger lighting operation without false trigger from adjacent areas.		
Verify that the status indicators on the occupancy sensor are operating correctly.		
Verify that the controlled lights turn OFF or down to the permitted level within the specified time.		
Verify that the controlled lights turn ON only when manually activated.		
Verify that the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.		
Record sensitivity level and delay settings for occupancy sensor control:		
<i>Time - Switch Controls</i>	<i>Initials</i>	<i>N/A</i>
Verify that the timers are properly programmed with weekday, weekend, and holiday schedules.		
Record time schedule as programmed:		
Verify that the time of day and day of week are properly set.		
Verify that battery back-up is installed and energized.		
Verify that the override timer is set for less than 2 hours.		
Simulate occupied condition: I verify that all lights can be turned on or off by respective area control switch.		
Simulate occupied condition: I verify that the lighting switches control only those lights in the enclosed area where the switch is located.		
Simulate unoccupied condition: I verify that all non-exempt lights turn off.		
Simulate unoccupied condition: I verify that the manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.		
<i>Daylight Responsive Controls</i>	<i>Initials</i>	<i>N/A</i>
Verify that the control sensing devices have been properly located, field calibrated, and set for accurate control set points and threshold lighting levels.		
Verify that the daylight controlled lighting loads adjust to light levels set points in response to available daylight.		

Verify that the location of calibration adjustment equipment is readily accessible only to authorized personnel.		
Record set point (foot-candles):		
Record lighting control level with calibrated light meter (foot-candles):		
Record cut-off time (minutes):		
Record fade rate (units/second):		

3.12 TRAINING

- A. Upon completion of the system startup, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the lighting control system. Include sign in sheet with Operation & Maintenance Manuals.

3.13 WARRANTY

- A. All lighting and lighting controls equipment included in this section shall be fully tested and guaranteed for a period of five years after Owner's Representative written acceptance.

3.14 FINAL CLEANING

- A. Prior to acceptance, damp clean diffusers, glassware, trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

END OF SECTION 265100

SECTION 283100 - FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Labeling of addressable devices to be approved by owner and each addressable device shall be provided with a custom label designation (e.g. M1-44) in black text on an adhesive backed plastic label. Labeling on device to be by Electrical Contractor (EC).
- C. During the periods of active construction, within the project area, the contractor shall remove any and all existing smoke detectors and provide temporary heat detectors in their place. Upon completion of construction new detectors shall be provided at these locations. Refer to floor plans for additional information.
- D. During the periods of active construction, within the project area, the contractor shall remove any and all existing notification appliances and notification appliances in their place, minimum candela shall be 30cd. Upon completion of construction new detectors shall be provided at these locations. Refer to floor plans for additional information

1.2 DESCRIPTION OF WORK

- A. The buildings in this project each have an existing Simplex 4100ES series fire alarm system. Modify and expand the existing fire alarm control panel, point addressable initiation device signaling line circuit (SLC), and non-point addressable notification appliance circuit (NAC).
- B. This section includes minimum requirements for the following:
 - 1. Fire Alarm Control Panel
 - 2. Remote Annunciator Panel
 - 3. Notification Appliance Circuit Extender Panel
 - 4. Monitor Modules
 - 5. Control Modules
 - 6. Input Modules
 - 7. Manual Pull Stations
 - 8. Photoelectric Smoke Detectors
 - 9. Fixed Temperature Heat Detectors
 - 10. Carbon Monoxide Detectors
 - 11. Projected Beam Smoke Detector
 - 12. Audible/Visual Signal Devices
 - 13. Visual Signal Devices
 - 14. Digital Communicator

1.3 QUALITY ASSURANCE

- A. All installations shall be accompanied in a professional manner by qualified personnel regularly engaged in have a minimum of 5 year of experienced in this type of Work. All fire alarm installers shall possess a state license for installation of fire alarm systems where required.
- B. All raceways shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- C. Materials specified herein shall comply with the applicable requirements of:
 - 1. The following Articles of the National Electric Code (NFPA 70)
 - a. Article 760 - Fire Alarm Systems
 - 2. The following National Fire Protection Agency (NFPA) standards:
 - a. NFPA 72 - National Fire Alarm Code
 - b. NFPA 90A - Installation of Air Conditioning and Ventilating Systems
 - c. NFPA 101 - Life Safety Code
 - 3. The following U.L. Standards:
 - a. UL 864/UOJZ, APOU - Control Units for Fire Protective Signaling Systems
 - b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
 - c. UL 268A - Smoke Detectors for Duct Applications
 - d. UL 521 - Heat Detectors for Fire Protective Signaling Systems
 - e. UL 228 - Door Holders for Fire Protective Signaling Systems
 - f. UL 464 - Audible Signaling Appliances
 - g. UL 1638 - Visual Signaling Appliances
 - h. UL 38 - Manually Activated Signaling Boxes
 - i. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems
 - j. UL 1481 - Power Supplies for Fire Protective Signaling Systems

1.4 SUBMITTALS

- A. Provide standard product data for all equipment indicating the type, size, rating, style, catalog number, and listing of the equipment.
- B. Provide calculations for sizing all batteries and power supplies. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
- C. Provide power supply calculations listing total current and inrush total current for FACP, and all Notification Appliance Power Supplies and Power Extender Panels.
- D. Architectural floor plans and drawings showing system details including specific location of FACP, all system devices, device ID label addresses, raceway sizes, raceways routings cabling in raceways, end of line devices, power supplies and any other system components.

- E. Provide a complete riser diagram indicating all devices with addresses, number of initiation and signal loop circuits, class of wiring system, and type of wiring.

1.5 SYSTEM DESCRIPTION

- A. Point addressable fire alarm system with manual and automatic initiation devices.
- B. System shall be supervised to continuously monitor the integrity of the circuit conductors and power supplies.
- C. Performance of the fire alarm system circuits shall be in accordance with Class B, Style B operation for Initiating Device Circuits (IDC) and Class B, Style Y operation for Notification Appliance Circuits (NAC's).
- D. The fire alarm control panel shall permit on-site programming to accommodate facility expansions, renovations, or fire alarm system modifications. All memory shall be non-volatile.
- E. The control panel shall have 24 VDC output power supplies for notification appliance circuits. System shall be capable of adding additional power supplies as required to power all notification appliances.
- F. Summary Reports:
 - 1. The Fire Alarm Control Panel shall be capable of displaying and printing summary reports. The summary reports shall include:
 - a. A list of all alarm points not in their normal state.
 - b. A list of all points in the system, including their current status.
 - c. A list of data for all control by event programs.
 - d. A list of data for all time initiated programs.
- G. Alarm Priority:
 - 1. Alarms shall be processed at three levels of priority:
 - a. Fire alarms shall have the highest priority.
 - b. Other alarms that require interaction by the attendant shall have the second level of priority.
 - c. Monitored points which do not require interaction by the attendant shall be the lowest level of priority.
- H. System Access:
 - 1. Access to the system shall be controlled by at least three levels of security to prevent programming modifications by unauthorized personnel.
 - a. The lowest level of access, shall permit the attendant to view the system display, print alarms and perform life safety control by event functions. The Attendant has minimal access to the system functions.
 - b. The mid-level access shall permit the attendant to change user programmable parameters.
 - c. The highest level of access shall permit the modification of system software. This level shall be accessed only by a qualified representative of the equipment

manufacturer.

1.6 SEQUENCE OF OPERATION

- A. Upon an abnormal condition on the fire alarm system, the appropriate LED (alarm, supervisory, or trouble) shall flash. The panel audible alarm shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. All abnormal events shall be logged into the database, along with the date and time.
- B. Operation of any smoke detector, heat detector, or manual pull station alarm initiating device shall cause the following to happen:
 - 1. Sound all audible alarm signals throughout the building in a temporal Code. Activate all visual strobe lights throughout the building. Strobes shall continue to operate until Fire Alarm Control Panel is reset.
 - 2. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and print at all system printers. The visual indication shall remain until the alarm condition is reset.
 - 3. Notify the UL listed central station via dial up digital communicator.
 - 4. Notify the UL listed central station via dial up digital communicator.
 - 5. Operate alarm relay contacts to release all magnetically held doors throughout the building.
 - 6. Operate the fan shut-down relay for the HVAC systems in the same smoke compartment or smoke zone.
 - 7. Operate all smoke dampers in the same smoke compartment or smoke zone. Dampers shall close 30 seconds after their respective fan systems have shut down.
 - 8. Subsequent initiating alarms shall repeat the respective sequence of operations.
- C. Operation of any carbon monoxide detector shall cause the following to happen:
 - 1. Signal an alarm signal to the fire alarm control panel and remote annunciator.
 - 2. All carbon monoxide detector self-contained audible base shall provide an temporal code 4 alarm.
 - 3. All addressable fire alarm panel connected carbon monoxide detectors shall be interconnected to trip all amber lens visible strobes in white housing in the same building. Alarms shall continue until Fire Alarm Control Panel is reset.
 - 4. All addressable fire alarm panel connected carbon monoxide detectors shall be interconnected to trip other CO detector self-contained audible alarms in the same building. Alarms shall continue until Fire Alarm Control Panel is reset.
 - 5. Notify the UL listed central station via dial up digital communicator.
 - 6. Notify the UL listed central station via dial up digital communicator.
 - 7. Subsequent initiating alarms shall repeat the respective sequence of operations.
- D. Operation of any sprinkler system supervisory device shall cause the following to happen:
 - 1. Sound a district pulsed audible alarm at the fire alarm control panel.
 - 2. Flash the yellow common trouble LED.
 - 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.
 - 4. Notify the UL listed central station via dial up digital communicator.
 - 5. Notify the UL listed central station via dial up digital communicator.
 - 6. Subsequent supervisory alarms shall repeat the respective sequence of operations.

- E. The Fire Alarm System wiring and power supplies shall be electrically supervised and report trouble conditions to the fire alarm control panel. Any opens, shorts or grounds on the system wiring shall cause the following to happen:
1. Sound a distinct pulsed audible alarm at the fire alarm control panel.
 2. Flash the yellow common trouble LED.
 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.
 4. Notify the UL listed central station via dial up digital communicator.
 5. Notify the UL listed central station via dial up digital communicator.
 6. Subsequent trouble alarms shall repeat the respective Sequence of Operation.
- F. Alarm Silencing:
1. Pressing the "Alarm Silence" button shall cause all notification appliances to be deactivated. A yellow LED located in the fire alarm control panel shall illuminate to indicate the alarm has been silenced.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

- A. Existing to remain Simplex 4100ES.

2.2 NOTIFICATION APPLIANCE CIRCUIT (NAC) EXTENDER PANEL

- A. Existing to remain Simplex 4009 IDNAC or Approved Equal

2.3 MANUAL PULL STATIONS

- A. Semi-flush, single action, break glass type.
- B. Constructed of red lexan with raised white lettering reading "Pull For Fire".
- C. Upon activation, handle shall lock in the alarm condition. A key shall be required to reset the manual pull station. Cylinders shall be keyed to match the fire alarm control panel.
- D. Unless directly connected to a central station alarm service, municipal alarm system, or local fire alarm dispatch station, provide a clearly legible sign above each manual pull station stating "Local Alarm Only - Call Fire Department By Telephone".
- E. Provide U/L listed NFPA approved STI lexan covers for all pull stations.
- F. Provide intelligent monitor module.
- G. Design Make: Simplex 4099 Series

2.4 PHOTOELECTRIC SMOKE SENSOR

- A. Detector shall operate on a light scattering principal. The detector shall have a photo-optic chamber with an infrared light emitting diode and a high speed light sensing photo diode. Capable of sensing visible products of combustion.
- B. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.
- C. Sensor shall be microprocessor based, with electronic point addressing to indicate to the system which device is in alarm.
- D. The sensor shall be continuously monitored to measure any changes in sensitivity due to dirt, smoke or humidity. Any buildup of foreign material shall cause trouble signal at the control panel indicating that maintenance is required.
- E. Sensor shall be capable of automatic device mapping and day/night sensitivity adjustment.
- F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field wiring. The detector shall be tamper resistant and shall be removable only with a special tool.
- G. Provide U/L Listed NFPA approved wire guards in Gym.
- H. Provide auxiliary relays and 24 VDC power for elevator capture or smoke evacuation control where indicated.
- I. Design Make: Simplex True Alarms 4098 Series

2.5 FIXED TEMPERATURE HEAT DETECTOR

- A. Self-restoring thermal detector.
- B. Rated at 135°F fixed temperature. Provide 200°F fixed temperature in boiler room and as indicate on plans.
- C. Design Make: Simplex True Alarms 4098 Series

2.6 ADDRESSABLE CARBON MONOXIDE (CO) DETECTOR

- A. The FACP shall receive separate trouble status, current threshold conditions, and alarms from the CO and smoke or heat detectors.
- B. Flush mounts over a standard 4"x4" two-gang backbox.
- C. Audible alarm for CO signal shall be different than smoke alarm signal.
- D. Single analog addressable consumes only one address. CO detector receive both communications and sensor power from the FACP battery backed power source.
- E. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.
- F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field

wiring. The detector shall be tamper resistant and shall be removable only with a special tool.

- G. CO detector allows interconnection where provided with a separate addressable input module or single piece audible base/CO detector. Combination systems shall be listed in accordance with UL 2075 and UL 864.
- H. Includes CO gas warning module (temporal code 4) for a repeated sequence of four cycles of 100 msec on with 100 msec off, followed by 5 seconds off per NFPA 720, Standard for the Installation of Carbon Monoxide (CO) Warning Equipment in Dwelling Units.
- I. UL 2034 CO alarm detection.
- J. Design Make: Simplex, System Sensor, or Approved Equal.

2.7 ADDRESSABLE OUTPUT MODULE

- A. Addressable device with a form "C" dry relay contact used to control external appliances such as door closers, fans, dampers etc.
- B. Provide a remote LED alarm and key operated test switch for each damper connection. Install remote test switches in visible (below ceiling space) and accessible locations adjacent each damper.
- C. Relay contact rating:
 - 1. 24 VDC = 2amps (pilot duty)
 - 2. 120 Vac = .5 amps
- D. Polling and alarm/active status provided by on board red and green LEDs.
- E. Design make: Simplex 4090 Series

2.8 ADDRESSABLE INPUT MODULE

- A. Addressable device used to connect 2 class B analog initiating device circuits.
- B. Input circuit wiring requirements
 - 1. Maximum allowable wire resistance - 50 ohms per circuit
 - 2. Maximum allowable wire capacitance - .1uF per circuit
- C. Polling and alarm/active status provided by on board red and green LEDs.
- D. Design make: Simplex 4098 Series

2.9 DUCT TYPE SMOKE DETECTORS

- A. Smoke detector shall be solid state, unipolar type with dual chamber construction and operate on the ionization principle.
- B. Capable of detecting both visible and non-visible products of combustion.

- C. Self-compensating circuitry to provide stability against aging and dust.
- D. Field adjustable sensitivity, pre-set in the factory.
- E. Enclosure suitable for mounting on an air duct, with a sampling tube that extends into the duct air stream.
- F. Suitable for installation within an air-duct system with air velocities from 300-4,000 feet per minute.
- G. Provide a remote LED alarm and key operated test switch for each duct smoke detector. Install remote test switches in visible (below ceiling space) and accessible locations adjacent each duct smoke detector.
- H. Design Make: Simplex True Alarms 4098 series

2.10 VISUAL SIGNAL DEVICE

- A. Provide backbox for recessed installations except for installations on existing walls.
- B. 24 VDC.
- C. Visual strobe shall have the following characteristics:
 - 1. ADA compliant.
 - 2. Adjustable White light output of 15, 30 or 75 candela as indicated on drawings. If no setting is indicated on the drawings set to 75cd.
 - 3. Flash rate from 1 Hz to 3 Hz.
 - 4. Pulse duration of 0.2 seconds.
 - 5. Housing color: Red
 - 6. Label on housing: Red text "FIRE"
 - 7. Provide with wireguard when installed in Gym, Gym Halls, and Locker Rooms.
- D. Design Make: Simplex 49VO Series

2.11 CARBON MONOXIDE VISUAL SIGNAL DEVICE

- A. Provide backbox for recessed installations.
- B. 24 VDC.
- C. Visual strobe shall have the following characteristics:
 - 1. Amber colored snap in lens.
 - 2. Set to 75 candela.
 - 3. Flash rate from 1 Hz to 3 Hz.
 - 4. Pulse duration of 0.2 seconds.
 - 5. Housing color: White
 - 6. Label on housing: Red text "ALERT"
- D. Design Make: Simplex TrueAlert 49VO-WWA-A (-BA) Addressable Notification Appliances.

2.12 AUDIO-VISUAL SIGNAL DEVICE

- A. Provide backbox for recessed installations except for installations on existing walls.
- B. 24 VDC.
- C. Audio output shall be rated for 93 dB at 10', 520Hz compatible. For extensions to existing systems field verify audible alarm type in existing building and provide to match existing signal type.
- D. Visual strobe shall have the following characteristics:
 - 1. ADA compliant.
 - 2. Adjustable White light output of 15, 30 or 75 candela as indicated on drawings. If no setting is indicated on the drawings set to 75cd.
 - 3. Flash rate from 1 Hz to 3 Hz.
 - 4. Pulse duration of 0.2 seconds.
 - 5. Housing color: Red
 - 6. Label on housing: Red text "FIRE"
 - 7. Provide with wireguard when installed in Gym, Gym Halls, Locker Rooms, and Bathrooms.
- E. Design Make: Simplex 49AV series

2.13 MAGNETIC DOOR HOLDERS

- A. Magnetic door holders shall be provided as part of the electrical contract.
- B. Provide surface mounted 24VDC or 120 VAC. Power shall be from separate power supply and not the FACP.
- C. Electrical Contractor shall mount and connect all magnetic door holders.

2.14 BATTERIES AND CHARGER

- A. Existing to remain.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.
 - 2. Provide all 120 volt, 60 cycle AC required to power the system and all remote power supplies.
 - 3. Wiring to all initiation and signal circuits shall be two wire class B. A fault on a circuit loop shall cause a trouble alarm to initiate for its associated zone at the fire alarm control panel.

4. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".
5. Detection and initiating equipment shall be listed by UL or approved by FM.
6. Install smoke detectors a minimum of 3 feet away from any air supply or return diffuser.
7. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.
8. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.
9. Mount FACP and all sub panels at working height.
10. Provide and wire fan shutdown relay contacts in series with starters ahead of all control devices.
11. All controlled devices such as smoke dampers, fire dampers, elevator control and door control shall be supervised to within 4' of the controlled device.

B. Audible/Visible Device Installation:

1. Field verify audible alarm type in existing building and provide to match existing signal type.
2. Visual strobes shall be 75-candela output in all other locations unless otherwise noted.
3. Devices shall be installed at eighty inches (80") minimum above the floor, or six inches (6") below the ceiling, whichever is lower, in accordance with ADA guidelines.
4. Audible devices intended for operation in public spaces shall have a sound level of not less than seventy-five (75) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.
5. Audible devices intended for operation in private spaces shall have a sound level of not less than forty-five (45) dBA at ten feet (10'), nor more than 110 dBA at the minimum hearing distance from the device.
6. All audible emergency alarm signals shall be at least 15 dbA over the existing sound level within a space or shall exceed the maximum sound level by 5 dbA for at least 60 seconds, whichever is louder. Within areas occupied by persons with hearing impairments, audible emergency alarms must have the intensity and frequency to provide notification of an alarm condition.
7. Do not exceed 80% loading on any NAC power circuit.

C. Wiring:

1. Install all wiring in accordance with manufacturer's recommendations and the National Electric Code.
2. All interior wiring in exposed finished locations shall be installed in surface metal raceway. All interior wiring installed above accessible corridor ceiling tiles shall be run in EMT conduit. All interior wiring installed in unfinished basements, mechanical rooms, boiler rooms, and electrical rooms shall be installed inside EMT conduit. Paint all junction box covers in the raceway system RED. All surface metal raceway backboxes shall be RED factory enclosures.
3. All wire shall be copper.
4. Type AC or MC Fire Alarm Cable is not permitted as a wiring method for this project.

5. Wire and cable shall be #14 AWG size, solid copper, THHN/TWN for horns, manual stations, smoke or heat detectors, waterflow switches, valve supervisory switches and other initiating and indicating devices. Communication loop wiring shall be shielded in accordance with the Manufacturer's recommendations.
6. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.
7. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.
8. The Fire Alarm System wiring shall be installed in a workmanlike manner, subject to the approval of the project manager.
9. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.
10. All wiring shall be numbered and color coded in accordance with this Specification.
11. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is one (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

D. Routing:

1. All fire alarm system conduits shall be installed either parallel or perpendicular to building structural members.
2. All fire alarm system conduits shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and shall not interfere with the operation of any existing mechanical or electrical equipment.
3. All fire alarm system conduits and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.
4. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device backboxes shall be readily accessible for testing, service and maintenance.

E. Wall, Floor and Ceiling Penetrations:

1. All conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.
2. All conduit penetrations of walls, floors, and ceiling shall be sealed around the conduits, restoring the walls, floors and ceilings to their original condition, fire resistance and integrity.

F. Concealment:

1. Conduit shall be concealed except where shown on the drawings.
2. All conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes shall be concealed in ceiling spaces, electrical shafts or closets in all finished areas.
3. Conduit, raceways, junction boxes, panels, electrical enclosures, relays and device backboxes may be exposed in unfinished areas.
4. All fire alarm system components, including devices, junction boxes, electrical enclosures, relays and device backboxes shall be provided so as to be readily accessible for inspection, testing, service and maintenance.

G. Terminations:

1. All fire alarm conductor terminations shall be on numbered terminals or terminal strips. All fire alarm conductor terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
2. All connections and end-of-line devices shall be accessible for inspection, testing and servicing.
3. Terminations to terminals other than barrier/pressure plate type terminals shall use crimp-on ring-type or Y-type spade connectors.
4. Splices shall be permitted only when routing of existing conductors prohibits point-to-point terminations in existing junction boxes, terminal cabinets, etc. All such splices shall be provided with new terminal strips with proper labeling in junction boxes, terminal cabinets, etc.

H. Mounting and Labeling of Devices:

1. All fire alarm devices shall be rigidly mounted, using appropriate backboxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.
2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.

I. Color Coding and Wire Numbering:

1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.
2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.
3. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.
4. Color coding shall be as follows:

CIRCUITS	COLOR CODES
Alarm Initiating Circuits	Yellow (-) and Orange (+), red (alarm) blue (alarm)
Horns, 24VDC	Slate (-) and Brown (+)
Smoke Detector	Yellow (-) Orange (+) red (alarm) blue (alarm)
Heat Detectors, Pull Stations	Purple (alarm) Black (alarm), connected to the same zone
Fan Shutdown	Blue (-) White (+)
Strobes, 24VDC	Violet (-) and Pink (+)
System AC Power	Black and White
Sprinkler Horn	Black and White
Valve Supervision	Orange and Yellow
DC Power, Door holds	Black (-) and Red (+)

3.2 INTERRUPTIONS TO EXISTING FIRE ALARM SYSTEM

A. General:

1. Do not remove any portion of the existing fire alarm system from operation while installing new work without written approval of the Owner's Representative.
2. Pupil occupied spaces must have existing systems maintained during school operation.
3. In order to accomplish the above requirements, temporary wiring and relocations of some existing and/or new equipment may be necessary. These temporary locations should be approved by the Owner's Representative and arranged so as to avoid safety problems.

3.3 TESTING

A. General:

1. After complete installation of the equipment and submittal of as-built drawings, the Contractor shall perform complete tests of the system. After these tests have been completed, the Contractor shall request final acceptance inspection and tests in the presence of the Project Manager and local authority. Coordination of final acceptance test date and times with those to be present is the responsibility of the Contractor. The Contractor shall demonstrate that all conditions of the plans and specifications have been met. The tests shall include proper operation of all devices and testing of supervised circuits. The installation will be checked against the as-built drawings. The Contractor shall furnish all testing materials and instruments. A punch list will be developed and the Contractor shall correct punch list items. There will be a reinspection of punch list items. If additional reinspections are found necessary to assure compliance with the Contract, they shall be made at the Contractor's expense.
 - a. The Contractor shall provide, at no additional cost to the Contract price, the following services by the Manufacturer's representative:
 - 1) Prior to the final inspection, "pre-test" the entire fire alarm system to assure that all new equipment is properly installed and functions in accordance with plans and specifications.
 - 2) The Manufacturer's representative shall certify that the entire new and existing installation was tested and performed satisfactorily.
2. Final acceptance tests shall be coordinated by the contractor and performed in the presence of the owner's representative as follows:
 - a. Operation of the fire alarm control panel and indicating components in accordance with factory recommended procedures.
 - b. Operational tests of all devices (i.e., detector, waterflow indicator, manual pull box, and valve supervisory device) in accordance with the factory recommended procedures.
 - c. Audible/visible testing of all indicating appliances. Tests shall include sound level (dBa) and light intensity (lumens). Audible testing shall be performed and documented for each space with any doors closed.
 - d. Checks of each initiating circuit or device address for correct indications at the control unit, and any remote annunciator.

- e. A checkout report shall be prepared by the contractor and submitted to the Owner's Representative. The checkout report shall include a listing of detector sensitivity for each detector. The report shall summarize the results of all tests and shall serve as the contractor's certification that the system is properly installed and fully functioning
- B. Installation contractor shall provide a "Statement of Compliance Letter" to Authority Having Jurisdiction prior to scheduling any acceptance testing, per NYS Fire Code. "Statement of Compliance Letter" shall indicate that the fire alarm system was installed per all applicable codes and standards as well as per the contract documents. Acceptance testing shall not be scheduled without providing the "Statement of Compliance Letter" to the AHJ.
- C. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.
- D. Prior to acceptance testing the contractor shall complete and submit the "Record of Completion" form as identified in NFPA 72.
- E. An acceptance test of the complete system shall be conducted by the contractor and fire alarm equipment vendor/installer as directed by the owner after the system has performed a 100% Pre-Test. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved.
- F. Coordinate all testing of sprinkler tamper, pressure, and flow switches with the fire protection contractor.

3.4 IDENTIFICATION

- A. All system devices shall be labeled in the field.
- B. For each smoke detector, heat detector, flame detector, duct mounted type smoke detector, manual pull station and/or other alarm initiating device, provide the following:
 - 1. Adhesive backed, vinyl cloth, numbered labels, identifying the device specifically by system address.
 - 2. Labels shall be white background color with solid black numbers. Numbers shall be not less than 5/8" high x 1/8" stroke wide.
 - 3. Design Equipment: Seton Nameplate Co.- Style M3847 or equivalent.
- C. For each shut down relay and/or auxiliary control relay and for specific remote lamps, provide the following:
 - 1. Adhesive backed, engraved lamicoid type labels specifically identifying what the fan shut down relay is shutting down, what relay is controlling or what the remote lamp is connected to.
 - 2. Labels shall be black face with white sandwich color, nom: 1/2" tall x 2" wide, with capital letters not less than 3/16" tall engraved into the surface.
 - 3. Design Equipment: Local fabrication by contractor.
- D. Provide labels for all smoke detectors that activate elevator recall, smoke hatch operation or fireman's car operation.

- E. All labels shall be visible once device is installed.
- F. Provide label on each power supply indicating power supply designation, 120 volt panel and associated circuit breaker number.
- G. All concealed covers for all system outlet and pull boxes installed shall be factory or field painted red.
 - 1. On the inside face of each outlet box cover, Contractor shall provide labeling, indicating; System address, Circuit Number, Horn/Speaker/Strobe Circuit Number, etc.
- H. Provide identification of each circuit breaker feeding on each FACP, Notification Appliance Power Supply Panel and Notification Appliance Power Supply Extender Panel indicating that the circuit feeds the fire alarm system per NFPA 72 by marking in RED "Fire Alarm System".

3.5 CLEANING AND ADJUSTMENT

- A. Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by the manufacturer.
- B. Occupancy Adjustments: Within one year of the date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit the actual occupied conditions.

3.6 PROGRAMMING REQUIREMENTS

- A. Provide documentation of all FACP messages. FACP messages must be approved by the engineer and owners representative, prior to start of system programming. Provide Custom messages as directed.
- B. FACP descriptors utilize room/space designations and numbers to be used by the facility after occupancy and those descriptors shall be approved by the engineer and Owner's representative. Descriptors shall be no longer than (1) full line of characters on the FACP display and shall contain the room number and room use type.
- C. Contractor shall allow for two fire alarm system re-programming as directed by the Owner's representative. Contractor shall include all time and travel expenses for (2) two all day site visits for system re-programming during the warranty period.
- D. Provide all required alarm and supervisory alarm output settings to the owners selected central monitoring agency.

3.7 RECORD DOCUMENTS

- A. Provide complete set of as-built record drawings and documents.
- B. Record Documents shall include all documents required by the Submittal Section of this specification updated to reflect as-built project conditions.

- C. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:
1. All documents required by the Submittal Section of this specification updated to reflect as-built project conditions
 2. Bill of Material.
 3. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative. Provide written operator instructions for basic system operation, interpretation of system outputs, operation of manual evacuation signaling and ancillary controls and the use of drill functions (if applicable).
 4. Detailed description of routine maintenance and testing as required and recommended for each type of device installed. Maintenance guide shall include:
 - a. Listing of each individual device that requires periodic testing and maintenance.
 - b. Step by step procedures for the testing and maintenance for each device listed.
 - c. Schedule for the testing and maintenance as recommended by NFPA 72 for each device listed.
 5. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved. Certificate of Completion, Fire Alarm System Inspection and testing form and all other system acceptance documents as described in NFPA-72.

3.8 WARRANTY AND INSTRUCTION

- A. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.

END OF SECTION 283100

SECTION 312100 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Preparing subgrades for slabs.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Subbase course for concrete slabs.

- B. Related Sections:

- 1. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
 - 2. Division 31 Section "Dewatering" for lowering and disposing of ground water during construction.

1.3 UNIT PRICES

- A. Work of this Section is affected by unit prices for earth moving specified in Division 01 Section "Unit Prices."
- B. Quantity allowances for earth moving are included in Division 01 Section "Allowances."

1.4 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by special inspector and/or geotechnical engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

- 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by special inspector and/or geotechnical engineer. Unauthorized excavation, as well as remedial work directed by engineer, shall be without additional compensation.
- E. Structures: Buildings, footings, foundations, retaining walls, slabs, or other man-made stationary features constructed above or below the ground surface.
- F. Subbase Stone Course: Aggregate layer supporting the slab-on-grade.
- G. Subgrade: Uppermost surface of an excavation immediately below subbase, or suitable granular fill materials.
- H. Structural Fill: Soil materials used to raise existing grades beneath slabs-on-grade.
- I. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Controlled low-strength material, including design mixture.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Geotextile: 12 by 12 inches (300 by 300 mm).
- C. Qualification Data: For qualified testing agency.
- D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D 2487.
 - 2. Laboratory compaction curve according to ASTM D 1557.
- E. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.6 QUALITY ASSURANCE

- A. Pre-excavation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

- A. Utility Locator Service: Notify utility locator service or "Call Before You Dig" for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- C. Subbase Stone: Crusher run stone, which is free of clay, organics and friable or deleterious particles meeting the requirements of New York State Department of Transportation, Standard Specifications, Item 304.12, Type 2 Subbase.
- D. Structural Fill: Same material as subbase stone.

2.2 GEOTEXTILES

- A. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2; AASHTO M 288.
 - 2. Grab Tensile Strength: 247 lbf (1100 N); ASTM D 4632.
 - 3. Sewn Seam Strength: 222 lbf (990 N); ASTM D 4632.
 - 4. Tear Strength: 90 lbf (400 N); ASTM D 4533.
 - 5. Puncture Strength: 90 lbf (400 N); ASTM D 4833.
 - 6. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
 - 7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 - 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXCAVATION, GENERAL

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
 - 1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus **1 inch (25 mm)**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.5 SUBGRADE INSPECTION

- A. Notify special inspector and/or geotechnical engineer when excavations have reached required subgrade.

- B. If special inspector and/or geotechnical engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted structural fill or controlled low strength material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than **7 tons** to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to **3 mph (5 km/h)**.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by special inspector and/or geotechnical engineer, and replace with compacted structural fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by special inspector and/or geotechnical engineer, without additional compensation.

3.6 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of **3000 psi**, may be used when approved by engineer.

3.7 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under steps and ramps, use suitable granular fill to raise grades, then subbase stone of thickness indicated on drawings.
 - 2. Under building slabs, use suitable granular fill to raise grades, then subbase stone of thickness indicated on drawings.
 - 3. Under footings and foundations, use structural fill.
- C. Place soil fills on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than **8 inches (200 mm)** in loose depth for material compacted by heavy compaction equipment, and not more than **4 inches (100 mm)** in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - 1. Under structures, building slabs, steps, and ramps, scarify and recompact top **12 inches (300 mm)** of existing subgrade and each layer of backfill or fill soil material at 95 percent.

3.12 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

- B. Grading inside Building Lines: Finish subgrade to a tolerance of **1/2 inch (13 mm)** when tested with a **10-foot (3-m)** straightedge.

3.13 SUBBASE STONE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place subbase stone course on subgrades or structural fill, if required, free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact subbase stone course under cast-in-place concrete slabs-on-grade as follows:
 - 1. Install separation geotextile on prepared subgrade or structural fill, if required, according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place subbase stone course **6 inches (150 mm)** or less in compacted thickness in a single layer.
 - 3. Place subbase stone course that exceeds **6 inches (150 mm)** in compacted thickness in layers of equal thickness, with no compacted layer more than **6 inches (150 mm)** thick or less than **3 inches (75 mm)** thick.
 - 4. Compact each layer of subbase stone course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.14 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 - 2. Determine that fill material and maximum lift thickness comply with requirements.
 - 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
 - 4. See statement of special inspections for additional testing and inspections.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of building slab, but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length, but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.15 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000