Northeastern University
Boston, MA

Statement of Work
Basis of Design

Rev 2 – 10/14
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1. Heating, Ventilating and Air Conditioning (HVAC)

1.1 General

1.1.1 Standards

Scope of work shall include all labor, materials, tools, equipment, transportation, hoisting, rigging, insurance, etc., to perform the work as indicated on the drawings and herein specified for a complete installation.

The general contractor and the HVAC contractor shall make all provisions for protection and safety of all construction employees and all other occupants of the building as they may be affected by the construction process, including but not limited to the ventilation systems, duct control, noise control, etc.

All work shall be in accordance with national, state, and local codes and ordinances.

All substitutions are to be approved by the Northeastern Design / Project Team.

Provide all hangers and supports as required to support all new piping, ductwork, and equipment.

Pay for all permits and fees, obtain all approvals.

All work shall be guaranteed for a period of one (1) year after completion date. Date to be determined by the owner.

Shop drawings of pertinent HVAC equipment shall be submitted for review by the architect. Record shop drawings shall be submitted for architect use as well, in the form of three (3) electronic and three (3) paper copies.

Any utility outages or system shutdowns for construction shall be scheduled at least three days in advance with the owner prior to commencing of work.

It shall be the responsibility of the HVAC contractor to study all drawings and details so that the installation of all new work can be fully coordinated. The HVAC contractor shall visit the site to satisfy himself that all provisions have been made for all aspects of the project. If discrepancies exist between drawings and/or site conditions, the HVAC contractor shall notify the architect prior to signing of contract.

All demolition of inactive HVAC systems within the contract limits shall be by coordinated by the general contractor and performed by the HVAC contractor.

All cutting, core drilling, etc., required for the installation of the new HVAC systems shall be by the HVAC contractor.

HVAC work is indicated diagrammatically. Location of diffusers, registers, and grilles shall be as indicated on the architect’s reflected ceiling plan.

Piping and ductwork shall be concealed unless otherwise noted. Exposed piping and ductwork shall be arranged for neat appearance and shall be shown on shop drawings for approval.
before installation.

Provide access doors located so that fusible links and other damper components may be inspected, replaced, and/or serviced and so that reheat coils and ductwork may be cleaned.

Provide volume dampers or acceptable air balancing devices at each low pressure branch from main duct and at each duct runout to an individual diffuser, register, or grille in supply and exhaust ducts.

All mechanical equipment shall be isolated from the building structure by means of noise and vibration isolators.

Install room thermostats 4'-0" above finished floor in accordance with ADA requirements except in corridors.

All MEP/FP services exposed within spaces without ceiling shall be painted. Architect/NU shall determine if duct is to be painted based on project type and location.

1.2 Materials and Equipment

1.2.1 Ductwork Materials

Provide new supply and exhaust air ductwork per SMACNA “HVAC Duct Construction Standards – Metal and Flexible.” All supply ductwork shall be constructed of G90 galvanized sheet metal unless otherwise noted. All new supply ductwork shall be externally insulated with 1 ½" wall, 1.5 pcf density flexible duct insulation with FSK vapor barrier. All ducts shall be sealed to SMACNA seal class A and leakage class 4. All exposed ductwork within program space without ceilings to be painted to match existing or per direction of architect.

Supply ductwork to have a pressure class of +6"W.G. from AHU to air terminal boxes and +2"W.G. from boxes to diffusers.

Exhaust ductwork to have pressure class of -4"W.G. from EAHU to air terminal boxes/air valves and -2"W.G. from air boxes/air valves to diffusers.

Provide stainless steel W/ -6"W.G. pressure class for fume hood and BSC’s exhaust up to medium pressure ganged exhaust main. Provide welded stainless steel on roof systems.

1.2.2 Laboratory System (Phoenix)

Provide a laboratory airflow control system, furnished and installed to control the airflow into and out of laboratory rooms. The exhaust volume of a laboratory fume hood shall be constant volume, based on the Northeastern standard dynamic barrier fume hood. The BMS shall control the laboratory space temperature and occupancy status. Fume hood air flow control valves could be selected as a 2 position valve, based on occupancy sensor status. The laboratory control unit shall maintain temperature control, minimum ventilation, airflow balance, and laboratory pressurization in relation to adjacent spaces (positive or negative). All laboratory airflow control
system devices shall be by a single manufacturer.

The airflow control device shall be a Venturi valve equal to the Phoenix controls Accell II model.

The airflow control device shall be pressure independent over its specified differential static pressure operating range.

The airflow control device shall maintain accuracy within +/- 5%

The airflow control device shall be class B. The airflow control device, for corrosive airstreams such as fume hoods, shall have baked-on corrosion resistant phenolic coating. The device’s shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring grade stainless steel. The internal nuts, bolts, and rivets shall be stainless steel. All shaft bearing surfaces shall be made of Teflon or PPS composite.

Constant volume valves for fume hoods shall maintain position constant volume pressure independent, adjustable, volume setpoint. It shall be factory calibrated and set for desired airflow rate. It shall also be capable of field adjustment for future changes of desired airflow rate.

Each airflow control valve shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least +1% of signal over the entire range of measurement. Electron valves shall be further calibrated and their accuracy verified to +5% of signal at eight different airflows per valve.

All airflow valves shall be individually marked with valve specific and factory calibration data, as a minimum.

1.2.3 Piping and Pipe Insulation

New piping shall be steel or copper pipe to ASTM standards, and Northeastern University standards.

Hot water and/or chilled water piping shall be Type L copper (all sizes) or steel: - All sizes soldered with Silvabrite solder. Vic fittings are acceptable only on chilled water piping.

All new piping systems shall be insulated with 1 ½” thick fiberglass with ASJ.

1.2.4 Air Distribution Devices

Provide diffusers, registers, and grilles as shown and schedule on the drawings and herein specified by Tuttle & Bailey or Metalaire.
All air distribution devices shall be aluminum construction unless otherwise specified herein or schedule on drawings.

All diffusers, registers, and grilles must be compatible with the design ceiling/wall type.

Hang and support air distribution devices independently of the ceiling construction

**Ceiling Supply Diffusers**

Ceiling or sidewall supply air diffusers shall be of the restricted multi-orifice jet induction and air mixing type, consisting of louvered sections with build-in diffusing vanes, as manufactured by Tuttle & Bailer Type RCTC or Metalaire Series 5000 IV.

The vanes shall be arranged to discharge air from adjacent channels at a 45° angle in opposite directions to the plane of discharge to ensure rapid mixing of primary and room air. Each individual diffusing vane shall be welded in two places to the adjacent louver sections to make a rigid integral unit. The vanes shall extend to the discharge edges of the louver. Where louver sections abut core frame, the louver ends shall be welded to core frame. The louver ends shall be rounded and hemmed before welding to core frames.

Diffusers shall be constructed with an integral collar extending at least 1” above the core to accommodate an internal duct connection. Collar corners shall have welded angles on the outside to prevent leakage and ensure that internal duct connection can be made secure.

Research labs shall utilize low velocity type diffusers. Tritek shall be acceptable for perforated duct, duct socks, etc.

Where dampers are provided, the raised mounting frame shall be sufficiently high enough to accommodate the installation of the damper with the frame and extend 1” above the damper to permit the internal duct connection.

**Return and Exhaust Register**

Lab return/exhaust registers shall be equal to Tuttle & Bailey Model T77D or Metalaire Model RHD, and shall be made of steel or aluminum with one set of fixed blades, 42° deflection.

All return and exhaust registers installed in all toilet rooms, locker rooms, and showers, and other areas subject to moisture shall be similar to above except constructed of all aluminum, including opposed blade dampers, equal to Tuttle & Bailey Model A77D.

**Sidewall Adjustable Supply**

Sidewall supply registers shall be equal to Tuttle & Bailer
Model T547 or Metalaire Model H4004SD, and shall be made of steel or aluminum, with mitered corners, double adjustable deflection core, and horizontal front louvers.

**High Capacity Radial Ceiling Diffuser**

Diffuser intended to disperse supply air at low velocity without induction. The diffuser shall incorporate a flat, non-aspirating face flush to the ceiling or mounting surface and deep back pan plenum with perforated dispersion grid standing off diffuser face. Equal to Anemostat Model HCR, Tuttle & Bailey Vector, or Tritek.

The diffuser air discharge shall be a radial, outward contiguous air stream that forms and fills a 90° arc in continuous planes, perpendicular to the longitudinal axis of the diffuser. The air discharge stream shall allow installation of continuous rows of diffusers that abut each other without air steam interference between adjacent diffusers. Each diffuser shall incorporate a manual pattern controller to trim adjust the pattern.

Multi-blade, grille-like assemblies requiring field adjustment of each individual blade to obtain desired pattern are not acceptable.

The radial diffusers shall be constructed from steel or aluminum, the finish of the face assembly shall be baked-on epoxy. The finish of the back pan assembly shall be arctic white baked-on epoxy.

1.2.5 Conduit and Piping Runs

When surface mounted conduit/piping run-outs are required to points of connections, they shall be dropped vertically in corners and offset horizontally to noted locations. Intent is to keep wall surface areas clear of verticals drops.

1.2.6 In-Duct Hot Water Heating Coils

In-duct hot water heating coils shall be manufactured by:

- Trane
- Aerofin
- Heat Craft
- TSI
- Precision

Water heating coil shall be of the extended surface type, constructed of copper tubing minimum 5/8” O.D., 0.035” thick, and having plate fins of aluminum extending at right angles to the tubes.

Tubes shall be pressure bonded into the fin collars by expanding the tubes. No solder bonding shall be used. All copper-to-copper joints shall be made with high temperature silver brazing material.
Plate fins shall be corrugated. Fins shall be spaced no closer than twelve per inch integral spacing collars that cover the tube surface. Minimum fin thickness shall be 0.095”.

Hot water coils shall be tested for 250 psig, maximum 300°F, and 400 psig air pressure under water. All coils shall be performance certified in accordance with ARI 410.

1.2.7 Fume Hoods

Fume hoods installed shall be Kewaunee Dynamic Barrier. Hoods shall have the following piping routed to each one:

- Water
- Compressed Air
- Vacuum
- High Vacuum
- Nitrogen
- Natural Gas

As specified by client

1.2.8 Automatic Temperature Controls

The temperature control system shall be directed by Northeastern University, consisting of DDC controls to fill the intent of the design and provide for a complete and operable system.

**Room Sensor/Controls**

- Room thermostats shall have occupant adjustment of +/- 2°F
- Thermostat locations and type shall be reviewed by architect and owner prior to installation

**Hot Water Re-Heat**

- Update graphics at existing BMS to reflect CFM values & fan systems supporting specific rooms.

1.2.9 Air Testing Balancing and Adjusting

The HVAC contractor shall procure the services of the balancing and testing contractor approved by Northeastern University, who specializes in the balancing and testing of heating, ventilating, and air conditioning systems, to balance and adjust all moving equipment, air distribution/exhaust systems and test all water systems.

Balance supply air and return/exhaust air terminal boxes, diffusers, grilles, and reheat coils service the project area to within 5% of specified values, and to maintain correct directional room air migration.

Test calibration of thermostat and environmental monitoring sensors.

Provide all testing instruments used for balancing air and water systems. All instruments shall have been calibrated within a period of six (6) months prior to balancing. Types, serial number, and dates of calibration
of all instruments shall be listed in the final air and water balance reports.

Provide all manpower, instruments, temporary connections, and all other materials required to accomplish the balancing and testing specified.

In the event the HVAC contractor fails to balance the systems for correct directional airflow and within 5% of the capacities or quantities indicated on the drawings, and it becomes necessary for the owner to balance them correctly, the cost of this work will be backcharged to the HVAC contractor.

Test forms used by balancing engineers and technicians shall be set up to include the following information:

- Each sheet shall have the job name and address, the name of the balancing contractor, owner, architect, engineer, the instruments used to perform the test, and the test date.
- All of the specified design parameters as well as actual balanced values.

1.3 Basis of Design

Fume hood venturi valves should be 2-position constant volume (occupied/unoccupied) based on detection of an associated occupancy sensor. This is to be confirmed with Northeastern prior to design. When the sensor detects movement, the fume hood exhaust valve shall be indexed to occupied mode. Sensor is indexed to unoccupied when no movement is sensed for 10 minutes.

Make-up supply Phoenix valves shall modulate based on the occupied hood exhaust valves. The supply valves shall modulate proportional to the exhaust valves to maintain a negative CFM offset with relation to additional lab spaces, offices, and corridors.

Supporting lab space Phoenix valves shall be indexed to occupied mode based on an associated occupancy sensor. The valves shall modulate in proportion in order to maintain a positive CFM offset.

Associated reheat coils shall modulate to maintain a room setpoint of 70°F. For cooling mode of supporting lab spaces, the phoenix valves shall increase supply and exhaust airflow and maintain the set CFM offset.

Fail positions for associated equipment, per Northeastern standards, are as follows:

- Supply Air Valve – Fail Last Position
- Exhaust Air Valve – Fail Open
- Supply Air Reheat Valve – Fail in place
2. **Plumbing**

2.1 Materials and Equipment

2.1.1 Piping, Fittings, Joints, and Valves

**Laboratory Waste and Laboratory Vent System**
Schedule 40 fire retardant polypropylene, ASTM D4101, 2” and smaller to be mechanical joint system. Larger than 2” shall be fused joints as manufactured by Orion, Enfield, R.G. Sloan, or Asahi.

**Natural Gas Pipe and Fittings**
Black steel pipe schedule 40 and conforming to ASTM A120-74 (Seamless Type). Fittings shall be black malleable screwed type conforming to ANSI B16.3-71.

Valves 3” and small shall be Apollo Series 70-100-07 threaded bronze valve, 600 PSI WOG, or approved equal by Northeastern University.

**Nitrogen and Argon Pipe and Fittings**
All piping shall be welded, drawn, and annealed Type 304 Stainless Steel tubing 16 gauge thickness to 2-1/2” size. Based on user purity of the lab gases, copper could be used. If used, piping must be brazed and purged during installation.

Fittings shall be Type 316 stainless steel conforming to ASTM B31.1 and B31.2 or Swage-Lock, Gyrolock, or Parter tube fittings. Fittings and pipe to be one manufacturer to assure proper fit and total system conformance.

Joints shall be either flanged or swage connections to valves, equipment, and where indicated on the contract drawings.

**Laboratory Vacuum & Laboratory Air**
Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88 and ASTM B16.22. All joints shall be brazed and purged with inert gas (N₂).

Isolation/Shut-off valves 2” and small shall be all bronze ball valves Watts Series B-6000 or Apollo 77-200, full port Teflon seated ball and 2-piece valve body designed for 600 PSI water and shall have threaded ends with sweat adapters. 3-piece valves shall be utilized for brazed applications. Substitutes must be approved by Northeastern University.

**Non-Potable Water & Tempered Water Systems**
Hard drawn Type L copper with wrought copper or cast brass fittings with 95-5 lead-free solder joints. Pro Press
mechanical fittings are acceptable on non-potable & tempered water systems.

Isolation/Shut-off valves 2” and smaller shall be all bronze ball valves Watts Series B-6000 or Apollo 77-200, full port Teflon seated ball and 2-piece valve body designed for 600 PSI water and shall have threaded ends with sweat adapters. Pro Press shall be acceptable on domestic, non-potable, and tempered water systems.

**RODI Water Piping**

Piping shall be SRD11 Series polypropylene with a wall thickness conforming to ASTM-2837 with butt fusion joints rated for 150 PSI at 68°F as manufactured by George Fischer, ASAHI, or SIMTECH.

Valves shall be diaphragm type, ½” to 2”. Polypropylene with an allowable working pressure of 150 PSI at 68°F water, spigot ends, EPDM diaphragm, position indicator, George Fischer type 315PPM, ASAHI, or SIMTECH

### 2.1.2 Pipe Hangers and Supports

**Drainage Piping**

Horizontal Supports: Provide B-Line Systems INC. Figure B3100 clevis hangers with supporting rods and adjustable turnbuckles.

Insulation Shields: Provide oversized hangers with 12-inch long galvanized insulation shields on rainwater piping

**Structure Attachments**

Clamps: B-Line Systems, Globe, Grinnell, and Michigan

Inserts: Empire, Grinnell, Michigan and Unistrut, or Carpenter & Patterson 650 UL-Listed

Ceiling Bolts: For installation in metal decks, Carpenter & Patterson Figure 143

Insulation Shields: Carpenter & Patterson Figure 265P

**Insulation**

Insulation thickness shall be as follows:
- Cold Water Piping: ½ inch
- Hot Water Piping: 1 inch
- Hot Water Return Piping: 1 inch

### 2.1.3 Testing of Systems

**Pressure Test**

Before attachment of system components, such as pressure actuating switches for alarms, manifolds, pressure gauges, relief valves, etc., but after installation of the laboratory gas termination and vacuum outlets, with
rest caps in place, and before closing of the walls and ceilings, each piping system shall be subject to a minimum test pressure of 150 psig with oil free dry air or nitrogen.

This test shall be maintain until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen.

Leaks, if any, shall be repaired and the section retested.

**Final Pressure Test**
After testing each individual system as specified above, the assembled stations outlet valves and all other system components such as pressure actuating switches for alarms, manifolds, pressure gauges, relief valves, shall be installed and all laboratory gas piping systems shall be subject to a 24 hour standing pressure test at 20% above normal line pressure

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### 3. Electrical

#### 3.1 General

**3.1.1 Scope of work**

- Lighting fixtures and lamps
- Conduit and cable
- Wiring devices and plates
- Connection to existing panel boards
- Outlet, pull and junction boards
- Branch circuit breakers
- Panelboards
- Grounding
- Multi-outlet assembly
- Hangers, supports, inserts, sleeves
- Firestopping, smokeproofing, waterproofing
- Demolition and removal of existing electrical equipment
- Fire Alarm devices
- Furnishing of access panels (as required)
- Testing, cleaning, and adjusting
- Fees, permits, royalties, guarantees.
- Shop drawings
- Record drawings
- Empty conduit system for telephone and data
- Cutting, coring through walls and floors.

#### 3.1.2 Grounding

Provide grounding for all electrical equipment and devices in accordance with applicable requirements of the National Electrical Code (NEC) and IEEE Standards, as indicated on drawings.

Bonding jumpers shall be installed at all locations required by NEC.
A green grounding conductor of proper size shall be installed and connected with the feeder circuit conductors, to wiring devices, circuits, and lighting fixtures. Connections to the equipment may be bolted or screwed using corrosion resisting bolts or screws.

3.2 Materials

3.2.1 Lighting Fixtures

Existing lighting fixtures to be removed. Fixtures to be retained at Northeastern’s discretion.

All fixtures shall be furnished complete with sockets, wiring trims, hangers, frames, lamps, ballasts, etc.

Mounting height and locations of all lighting fixtures shall be determined from architectural ceiling plans and elevations.

All lighting fixtures to be re-lamped and ballasts shall be of the energy saving type, to match existing building standards.

Existing lighting fixtures to be cleaned and verify proper operation before re-installation.

3.2.2 Branch Circuit Wiring

All branch circuits signal wiring shall be copper rated at 600 volts, installed in conduit or EMT.

Minimum size for branch circuit and power wiring shall be #12 AWG for remote control signal circuit and interlock wiring may be #14 AWG.

Insulation types shall be wiring, THHN for lighting branch circuit and THWN for remote control, signal circuits and fire alarm wiring. THWH shall be used for underground and wet locations.

Color coding for identification shall match existing color coding.

Number associated with each branch circuit outlet identifies the branch circuit to which the device served by the outlet is to be connected. The circuit numbers indicated are utilized to denote limits of branch circuits only, and are not intended to limit the panelboard circuitry.

For branch circuit homeruns, MC cable shall transition to conduit/wireways and wire before entering the panelboard.

3.2.3 Conduit

All wiring, unless otherwise noted, shall be installed in rigid metal conduit, EMT, or flexible metal conduit, subject to restriction of NEC. Minimum size ¾ inches.
EMT fittings shall be cold-rolled steel compression or mechanical fastened. Die cast filling shall not be used.

When surface mounted conduit run-outs are required to points of connections, they shall be dropped vertically in corners and offset to noted locations. Intent is to keep wall surface clear of vertical drops.

3.2.4 Outlet Boxes

Outlet boxes shall be one piece galvanized construction meeting NEC requirements, or proper size and suitable for location indicated on the drawings.

Outlet boxes in wall partitions shall not be installed back-to-back, unless properly firestopped.

Outlet boxes shall be 4’ square with 1 gang or 2 gang plaster extension rings as required and manufactured by the following:
- Crouse-Hinds Company: Appleton
- Steel City Electric Company: RACO

3.2.5 Pull and Junction Boxes

Pull boxes and junction boxes shall be constructed of Code gauge galvanized steel and shall be installed at points required by code whether indicated on the drawings or not. Minimum dimension shall not be less than NEC requirements.

Provide flat plain covers with suitable flat head machine screws or slotted truss head bolts

3.2.6 Wiring Devices

Furnish and install wiring devices to match base building standards. Devices shall be specification grade, complete with all accessories indicated in contract documents.

Catalog numbers specified for this section are Hubbell. Other manufacturers are acceptable at Northeastern’s approval.

Duplex receptacles shall be U-ground, rated for 125V, 20 amperes, specification grade. All device plates shall be marked as to panel and circuit location.

Duplex receptacles with ground fault interrupter characteristics shall be U-ground, rated for 125V, 20 amperes, specification grade, feed-through type. Ground fault receptacles shall meet the requirements of UL 943, 2006. All receptacles in toilets or bathrooms within 6'-0" of sink locations, exterior outlets, utility vault, in wet areas shall be ground fault type. Hubbell #HBL GF5362, or approved equal by Northeastern University.

Switches shall be full size, heavy duty, AC type, rated for 20 amperes – 120/277 Volts
Duplex receptacles with ground fault interrupter characteristics shall be Hubbell #HBL GF8300 or approved equal.

Color of all wiring devices shall be as selected by the architect, except for receptacles on emergency systems shall be red and standby systems shall be orange.

3.2.7 Surface Mounted Raceway System

Manufacturer for multi-outlet assembly shall be as follows:
- Wiremold Prewired Systems – Series 4000
- Steel with epoxy coated factory finish

Raceway
Raceway shall have 2 wiring compartments with field removable cover. Raceway shall have a nominal wall thickness of 0.078”

Raceway covers shall be a minimum of 18” in length to facilitate future modification. Covers must be removable with a standard straight blade screwdriver without marring.

Raceway shall be manufacturer of steel factory applied epoxy finish.

Raceway covers shall have holecut provision for telecommunications outlets, voice and data/LAN outlets.

3.2.8 Telephone/Data System

An empty telephone/data conduit and outlet system shall be provided for connection to the existing building communications. From each designated outlet, an empty box and conduit with pull string shall be extended above ceiling.

Conduits and sleeves shall be based on number of cables possible to each telecommunication outlet. Each single gang device plate may be supplied by two cables and each double gang device plate may be supplied by four cables, conduits, and sleeves shall be provided as follows:
- Two cables – ¾”
- Four cables – 1”
- Eight cables – 1 ¼”
- Ten cables – 1 ½”
- Fourteen cables – 2”

The intent is to provide a fully accessibly empty conduit system for future installation of communications wiring.

3.2.9 Panelboards

**Bus**
Main bus bars shall be copper sized in accordance
with UL standards to limit temperature rise on any current carrying part to a maximum of 65°C above an ambient of 40°C maximum.

A bolted copper ground bus shall be included in all panels

Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices

Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection

**Branch Circuit Panelboards**

Bolt-on type, heavy duty, quick-make, quick-break, single and multi-pole circuit breakers of specified types shall be provided for each circuit with toggle handles that indicate when unit has tripped. All Panelboards shall be marked with engraved ID as well as feeder location. All branch circuit Panelboards shall be clearly marked as to the circuit’s purpose and location.

Circuit breakers shall be thermal magnetic type with common tie handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 ampere frame and through 100 ampere trip sizes shall take up the same pole spacing. 20 ampere, single pole circuit breakers shall be UL listed as type SWD for lighting circuits.

Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.

**Enclosure**

Enclosures shall be at least 20 inches wide and 5 ¾ inches deep made from galvanized steel. Provide minimum gutter space in accordance with the National Electric Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, an auxiliary gutter shall be provided, sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided. All panelboard covers shall be door in door type.

Enclosures shall be provided with removable blank ends.

All Panelboards shall have NEMA 1 general purpose enclosures unless otherwise noted.

**Finish**

Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of gray ANSI 49
3.2.10 Busway Plug-in Units

Plug-in units shall be factory pre-assembled, and shall be of the types and ratings indicated on plans.

Plug-in units shall be mechanically interlocked with the busway housing to prevent their installation or removal while the switch is in the ON position. The enclosure of any plug-in unit shall make positive ground connection to the duct housing before the stabs make contact with the bus bars. All plug-in units shall be equipped with a defeatable interlock to prevent the cover from being opened while the switch is in the ON position and to prevent accidental closing of the switch while cover is open. The plugs shall be provided with a means for padlocking the cover closed and padlocking the disconnect device in the OFF position.

The operating handle and mechanism of the plug-in unit shall remain in control of the disconnect device at all times permitting its easy operation from the floor by means of a hookstick or chain. Plug-in units shall be equipped with a means for direct positioning or hanging, so that the weight is borne by the duct before the stabs make contact with the bus bars. For safety reasons, no projections shall extend into the busway housing other than the plug-in stabs. All plug-in units shall be interchangeable without alteration or modification of plug-in duct.

Plug-in units shall be circuit breaker type with integral time delay/thermal trip protection in one assembly and shall meet all requirements of UL Standard 489. Circuit breakers connected to normal power busways shall be solid state type with ground fault protection.