I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. The mandrel shall be segmented with outer diameter no less than ¼ inch smaller than the inside diameter of the conduit, and shall be 10 inches in length. If obstructions are indicated, remove obstructions and retest.

3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

4. Quality control for conduits shall be performed in accordance with 270500 Section 3.6.10.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260543
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
4. Warning labels and signs.
5. Instruction signs.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE


B. Comply with NFPA 70.

1.5 COORDINATION


B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.4 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Micarta Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):

   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior concrete and masonry primer.
      2) Finish Coats: Exterior semigloss acrylic enamel.

2. Exterior Concrete Unit Masonry:
a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
   1) Block Filler: Concrete unit masonry block filler.
   2) Finish Coats: Exterior semigloss acrylic enamel.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange snap-around label.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:

1. Fire Alarm System: Red.
5. Mechanical and Electrical Supervisory System: Green and blue.
7. Control Wiring: Green and red.

C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.


F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

H. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-(13-mm-) high letters on 1-1/2-inch-(38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. No "dymo label" equipment ID allowed.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.
d. Transformers.
e. Emergency system boxes and enclosures.
f. Disconnect switches.
g. Motor starters.
h. Push-button stations.
i. Power transfer equipment.
j. Contactors.
k. Remote-controlled switches, dimmer modules, and control devices.
l. Power-generating units.
m. Intercommunication and call system master and staff stations.
n. Television/audio components, racks, and controls.
o. Fire-alarm control panel and annunciators.
p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
q. Monitoring and control equipment.
r. Uninterruptible power supply equipment.
s. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.
D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with non reversible attachment appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Colors for 208/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

2. Colors for 480/277-V Circuits:
   b. Phase B: Orange.
   c. Phase C: Yellow.

3. Field- Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

4. Install a green Equipment Grounding Conductor in each conduit.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

J. Install wire markers on conductors at the panelboard and at each load connection. Identify with panelboard or other source name and branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams. For receptacle and lighting circuits, install the marker at each outlet.
K. Control and alarm wiring shall be identified using wire markers. Each wire shall be uniquely identified within the control system of which it is part and uniquely identified from other control alarm system in the facility. Markers shall be self-adhering, wrapped around the conductor twice and sleeved with clear shrink sleeves installed over the marker.

L. All junction boxes containing conductors of one circuit only shall be neatly labeled with indelible black ink, indicating panelboard, bus way, enclosure, switchboard, or other source terminal point, including circuit number as applicable. For junction boxes containing multiple circuits, require conductors be tagged as in “K” above.

M. All motors shall be identified with a permanently attached durable tag with motor designation and function.

N. All junction boxes for the fire alarm system shall be painted red. Each junction box for any other special system shall be marked as a part of the system inherently.

END OF SECTION 260553
SECTION 260923 - LIGHTING CONTROL DEVICES

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. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor photoelectric switches.
3. Indoor occupancy sensors.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Square D; Schneider Electric.
6. TORK.
7. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST.
2. Contact Rating: 30-A inductive or resistive, 240-V ac.
3. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
5. Astronomic Time: All Selected channels.
6. Battery Backup: For schedules and time clock.
2.2 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conduvctors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

END OF SECTION 260923
SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


C. Field quality-control test reports.

D. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
5. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. 1. Internal Coil Connections: Brazed or pressure type.
    2. Coil Material: Copper.
2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

G. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

L. Wall Brackets: Manufacturer's standard brackets.

M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

N. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
1. 9 kVA and Less: 45 dBA.
2. 30 to 50 kVA: 45 dBA.
3. 51 to 150 kVA: 50 dBA.
4. 151 to 300 kVA: 55 dBA.

2.2 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.3 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Installed transformer shall have adequate cooling space on all sides. Installation shall comply with NEC 450-9 and other applicable instructions or guidelines for transformer cooling.

D. Contractor shall measure and adjust as required, the secondary voltage at the secondary terminals of each transformer supplied by the project. Adjust to within +/-2% of the nominal system voltage using the transformer taps.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200
SECTION 262416 - PANELBOARDS

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. This Section includes the following:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RMS: Root mean square.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. UL listing for series rating of installed devices.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
1. Ambient Temperature: Not exceeding 122 deg F

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to
   facilities occupied by Owner or others unless permitted under the following
   conditions and then only after arranging to provide temporary electric service
   according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption
      of electrical service.
   2. Do not proceed with interruption of electrical service without Owner's
      written permission.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other
   construction that penetrates walls or is supported by them, including electrical
   and other types of equipment, raceways, piping, and encumbrances to
   workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into
   bases. Concrete, reinforcement, and formwork requirements are specified in
   Division 03.

C. Measure each phase current at each panel with the panel at expected
   maximum demand. Require balancing of the phase currents at each panel to
   within +/-5% of the calculated average bus current, or as close as possible.
   Provide written record of the balanced bus current values.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that
   are packaged with protective covering for storage and identified with labels
   describing contents.
   1. Locks for panelboards shall be keyed alike.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Eaton Corporation; Cutler-Hammer Products.
   c. Siemens Energy & Automation, Inc.
   d. Square D.

2.2 MANUFACTURED UNITS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.
   a. Outdoor Locations: NEMA 250, Type 3R.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

7. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.


C. Phase and Ground Buses:
   1. Provide fully rated copper bussed panelboards. Series rated and/or aluminum bussed panelboards are not acceptable.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material.
   1. Main and Neutral Lugs: Mechanical type.
   2. Ground Lugs and Bus Configured Terminators: Compression type.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-in circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Circuit breaker shall be of the same manufacturer.

B. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

2. GFCl Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.

C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
4. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

E. Fuses are specified in Division 26 Section "Fuses."

F. Install bolt-in circuit breakers. Plug-in circuit breakers are not acceptable.

G. Provide two and three pole breakers with common trip, and shall not require more space than the equivalent number of single-pole breakers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices.

1. Set field-adjustable switches and circuit-breaker trip ranges.
F. Install filler plates in unused spaces.

G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416
SECTION 262726 - WIRING DEVICES

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. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Snap switches and wall-box dimmers.
   3. Wall-switch

B. Related Sections include the following:
   1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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

C. Comply with NFPA 70.

D. All wiring devices shall be specification grade.

E. Provide 125 Volts 20 Amp receptacles on 20 Amp branch circuit, 15 Amp receptacles are not allow.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
2. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 5352 (duplex).
   c. Leviton; 5352 (duplex).
   d. Pass & Seymour, 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Hubbell
   b. Cooper; GF20
   c. Leviton
   d. Pass & Seymour; 2084.
2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
   c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
   d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover

2.6 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.
3. TVSS Devices: Blue.
4. Wiring device cover plate shall be satin finish stainless steel.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install in the vertical position with the ground up.
   2. Install in the horizontal position with the neutral up.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Wiring device cover plate shall be satin finish stainless steel.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

J. Wall switches (toggle switches, light switches) shall be grounding type. For single throw switches install with "ON" in the "up" position.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726
SECTION 262813 - FUSES

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. This Section includes the following:

1. Cartridge fuses rated 600 V and less for use in switches and controllers.
2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
a. Let-through current curves for fuses with current-limiting characteristics.
b. Time-current curves, coordination charts and tables, and related data.
c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

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

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

E. All fuses shall be of the same manufacturer.

F. All power fuses shall be equipped with a blown-fuse indicator that provides visible evidence of fuse operation while installed in the fuse mounting.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Quantity equal to 10 (%) percent of each fuse type and size, but no fewer than 6 of each type and size.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Ferraz Shawmut, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Service Entrance: Class L, time delay.

B. Feeders: Class L, time delay.

C. Motor Branch Circuits: Class RK5, time delay.

D. Other Branch Circuits: Class RK5, time delay.
3.3 INSTALLATION
   A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
   B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION
   A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813
SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Nonfusible switches.
3. Bolted-pressure contact switches.
4. High-pressure, butt-type contact switches.
5. Molded-case circuit breakers.
7. Enclosures.

1.3 DEFINITIONS

A. GD: General duty.
B. GFCI: Ground-fault circuit interrupter.
C. HD: Heavy duty.
D. RMS: Root mean square.
E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
4. UL listing for series rating of installed devices.
5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For testing agency.

E. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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

C. Comply with NFPA 70.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 122 deg F

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
4. Square D/Group Schneider.

B. Fusible Switch, 600A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 600A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.
2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
5. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I²t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

C. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

E. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Infrared Scanning:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
   b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
   c. Instruments, Equipment and Reports:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816
SECTION 262913 - ENCLOSED CONTROLLERS

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. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
2. Reduced-voltage controllers.

B. Related Sections include the following:

1. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer’s technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

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

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Owner’s written permission.

1.7 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Eaton Corporation; Cutler-Hammer Products.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens/Furnas Controls.
6. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays
shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.


2.3 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.

2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard Gray paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION 262913
SECTION 265100 - INTERIOR LIGHTING

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. This Section includes the following:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.
   5. Retrofit kits for fluorescent lighting fixtures.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

A. BF: Ballast factor.
B. CRI: Color-rendering index.
C. CU: Coefficient of utilization.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Luminaire: Complete lighting fixture, including ballast housing if provided.
G. RCR: Room cavity ratio.
1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
7. Life, output, and energy-efficiency data for lamps.
8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

   a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
   
   b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.


C. Field quality-control test reports.

D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.
1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

C. Provide luminaries of the same configuration (Lay-in troffers, down light cans, outdoor floods, etc.) and luminaries represented by multiple luminarie type designations, but intended to match each other, shall be product of the same manufacturer.

D. Any new retrofit/assembly or “kit” shall be UL listed as such.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Ballasts: Manufacturer’s standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.

B. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer’s standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without
use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 42 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.85 or higher.
7. Power Factor: 0.98 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.

C. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

D. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
   2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

F. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 30 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
12. Provide instant-start ballasts, and bulbs with a minimum life of 10,000 hours.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EXIT SIGNS
A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
   1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
   2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. Lighting fixtures shall be supported on at list two opposite corners from the building structure, not from drop ceilings, ductwork or cable trays.

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100
FEATURES & SPECIFICATIONS

INTENDED USE — The VT™ troffer combines the aesthetics and high performance levels of volumetric lighting, with the best value for offices, schools, retail locations and hospitals. Available in one-, two- or three-lamp configurations, with T5 or T8 lamps, this series provides the ultimate in design flexibility. Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.

CONSTRUCTION — Rugged, one-piece cold-rolled steel coated polyester, painted after fabrication with embossed faces (smooth also available; see Options).

Impact-modified, single clear acrylic diffuser provides excellent shielding and wide distribution.

End plates include integral T-bar clips.

Fixture may be mounted and wired in continuous rows.

Total fixture height is only 4 3/8”.

OPTICS — Volumetric illumination is achieved by creating an optimal mix of light to walls, partitions, vertical and horizontal work surfaces — rendering the interior space, objects and occupants in a more balanced, complementary, luminous environment.

Linear faceted reflector cavity softens and distributes light into the space while minimizing luminous contrast between the fixture and ceiling.

Sloped end plates provide a smooth, luminous transition between fixture end ceiling while enhancing the perception of fixture depth.

ELECTRICAL — Highly efficient program-start electronic ballasts, Class I, thermally protected, resettable, HIP, non-PEC, UL Listed, CSA Certified, sound rated A.

Luminaries are suitable for damp locations. AWJ, 1FM or THHN wire used throughout, rated for required temperatures.

Step level dimming option allows system to be switched to 50% power for compliance. 50% option is available for use with SIMPLOYS™ lighting intelligence system, with multi-level dimming. See SIMPLOYS Lighting Controls specification sheets for more information.

Ballast disconnect provided where required to comply with U.S. and Canadian codes.

INSTALLATION — Unique grid interfacing arrangement provides mounting into standard 1" and 9/16" tee bar or screw slot grids. 9/16" allows fixture trim to be level with architectural ceiling tiles.

Drywall ceiling adaptors available.

LISTING — UL Listed to U.S. and Canadian safety standard.

Patents pending.

WARRANTY — Fixture guaranteed for one year against mechanical defects in manufacture.

Note: Specifications subject to change without notice.

ORDERING INFORMATION — Lead times will vary depending on options selected. Consult with your sales representative.

Example: 2VT8 2 32 ADP MVOLT GEB101S LP835

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<th>Specifications</th>
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<td>Length: 48 (122.0)</td>
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<td>Width: 24 (61.0)</td>
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<td>Depth: 4 3/8 (11.1)</td>
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<td>All dimensions are inches (centimeters).</td>
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<th>Accessories: Order as separate catalog numbers:</th>
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<tr>
<td>DG6024 - Drywall ceiling adaptor, used installation</td>
</tr>
<tr>
<td>2VT4 F916 - Trim to adjust fixture mounting flush with 9/16&quot; T-bar; for 2x4 fixture</td>
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Notes:

1 Available with LP835 and 5445H0 only.
**PHOTOMETRICS**

**2VTB 2.32 ADP:** 2800 lumens per lamp; s/m 1.2 (along), 1.4 (across); test no. LTL18809.

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**2VT5 2.28 ADP:** 2600 lumens per lamp; s/m 1.2 (along), 1.4 (across); test no. LTL18909.

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<th>pf</th>
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</tbody>
</table>

**MOUNTING DATA**

9/16

15/16

9/16 with accessory 2VT4 F916

Screw Slot

---

**LITHONIA LIGHTING**

An Acuity Brands Company

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FEATURES & SPECIFICATIONS

INTENDED USE — Low-profile, self-luminous, provides general illumination for recessed applications; ideal for restricted plenum spaces. Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.

ATTRIBUTES — Designed exclusively for use with T8 lamps, electronic ballasts, and sockets.

CONSTRUCTION — Smooth hemmed sides and smooth, inward formed end flanges for safe handling. Lighter weight fixture allows for safe, easy installation.

Standard steel door frame has superior structural integrity with premium extruded appearance and precision flash-mitered corners. Solid steel doors allow easy lens replacement without frame disassembly (fits lenses up to 1.50" thick). Powder coated, steel latches provide easy, secure door closure.

Superior mechanical light seal requires no foam gasketing. Integral T8 bar clips secure fixture to T8 bar system. Housing formed from cold-rolled steel. Acrylic shielding material 100% UV stabilized. No adhesives used in this product.

FINISH — Five-stage ion-phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts finished with high-gloss, baked white enamel.

ELECTRICAL — Standard ballast is electronic, thermally protected, rectifier, Class F, or HPS, non-PCB, UL Listed. CSA listed ballast, universal voltage and sound rated A.

Luminaires are suitable for damp locations. AWV, TTH, or THIN were used throughout, rated for required temperatures.

LISTING — Standard: UL. Optional: Canada — CSA or CUL; Mexico — NOM.

WARRANTY — Guaranteed for two years against mechanical defects in manufacture. U.S. patents: 6,210,023; 6,231,213; 2,288,471.

Note: Specifications subject to change without notice.

---

**ORDERING INFORMATION**

For shortest lead times, configure products using **bolded** options.

**Example:** GT8 2.32 A12 MYOLT GEB105

---

**GT8 2' x 4'**

2, 3 or 4 Lamps

---

**Specifications**

- **Length:** 48 (1218)
- **Width:** 24 (609)
- **Depth:** 3-3/16 (81)
- **Weight:** 22 lbs (9.9 kg)

All dimensions are inches (millimeters).

---

**2GT8**

<table>
<thead>
<tr>
<th>Series</th>
<th>Trim type</th>
<th>Number of lamps</th>
<th>Lamp type</th>
<th>Door frame</th>
<th>Diffuser type</th>
<th>Voltage</th>
<th>Options</th>
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<tr>
<td>2GT8 2&quot; wide</td>
<td>Blank Grid F</td>
<td>2</td>
<td>32WTR (48&quot;)</td>
<td>Blank</td>
<td>A12</td>
<td>120</td>
<td>1/4 One 4-lamp ballast</td>
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<td></td>
<td></td>
<td>3</td>
<td></td>
<td>FN</td>
<td>A12125</td>
<td>127</td>
<td>1/3 One 3-lamp ballast</td>
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<td>4</td>
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<td>NM</td>
<td>GEB105</td>
<td>Electronic ballast, &lt;10% THD, instant start</td>
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<td>RM</td>
<td>GEB105S</td>
<td>Electronic ballast, &lt;10% THD, rapid start</td>
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<td>RW</td>
<td>EL</td>
<td>Emergency battery pack (nominal 300 lumens)</td>
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<td>RW</td>
<td>EL14</td>
<td>Emergency battery pack (nominal 1400 lumens)</td>
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<td>RW</td>
<td>GEB</td>
<td>Internal fast blow fuse</td>
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<td></td>
<td>RW</td>
<td>GMF</td>
<td>Internal slow blow fuse</td>
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<td>RW</td>
<td>LST</td>
<td>Tandem-aged fixture pairs (shared ballasts)</td>
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<td></td>
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<td></td>
<td>RW</td>
<td>PWS1836</td>
<td>6 provine, 3/8&quot; dia., 18-gauge, 1 circuit</td>
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<td>RW</td>
<td>PWS1836</td>
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<td>RW</td>
<td>LPS</td>
<td>Lamped, 700 series, 350W</td>
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<td>LP</td>
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<td>RW</td>
<td>JP</td>
<td>Fail-safe and stretch-wrapped without individual casings; grid trim only</td>
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<td>RW</td>
<td>CSA</td>
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<td>NOM</td>
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---

**NOTES:**

1. Available with flush door frames only.
2. MYOLT standard for 118-277V applications, 50-60 Hz operation. Some options require voltage specified.
MOUNTING DATA
Continuous type mounting of flanged units requires CFE and CSM trim options (see Options).

NOTE:
1. Recommended rough-in dimensions for F-trim fixtures 24"x48" (Refer to 4-1/2"x6") Swing gate range 1-1/2" to 3-1/2". Swing gate-swing gate span 23-1/2" to 26-1/2". Swing gate-swing gate points require additional 1-1/2" over nominal fixture height.

PHOTOMETRICS
Calculated using the zonal cavity method in accordance with E301 (UMT) procedure. Floor reflectances are 90%.
Lamp configurations shown are typical. Full photometric data on these and other configurations available upon request.

2GT8 2 32 A12
Report LTL 7421
Lumens per lamp - 2850 - Lumin. eff. - 81.7%
S/MH (along) 1.2 (across) 1.4
Coefficient of Utilization

2GT8 3 32 A12 1/3
Report LTL 7421
Lumens per lamp - 2850 - Lumin. eff. - 80.1%
S/MH (along) 1.2 (across) 1.4
Coefficient of Utilization

2GT8 4 32 A12 1/4
Report LTL 7425
Lumens per lamp - 2850 - Lumin. eff. - 78.5%
S/MH (along) 1.2 (across) 1.4
Coefficient of Utilization

Zonal Lumens Summary

Zonal Lumens Summary

Zonal Lumens Summary

LITHONIA LIGHTING
An Acuity Brands Company

Fluorescent: One Lithonia Way Conyers, GA 30012 Phone: 800-265-0736 Fax: 770-931-8121 www.lithonia.com ©2009-2014 Acuity Brands Lighting, Inc. All rights reserved. Rev. 12/20/11
## Ordering Guide

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<th>Specifications</th>
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### LiteSpeed Quick-Ship

Many configurations of this fixture are available in our LiteSpeed 10-day quick-ship program. The "10-day" icon in the descriptions below shows which options are available in LiteSpeed LiteSpeed orders are shipped within 10 working days of receipt of a released, cleared order. An "LS" prefix is required in front of the ordering number to have the order handled as LiteSpeed. Other configurations not indicated here may be available for 10-day shipment; contact Customer Service for availability. Some restrictions may apply to large orders. All LiteSpeed fixtures are supplied in textured white finish (TCCWM).

### Baffle & Diffuser Options

- **PBCWM**
  - Radiused Parabolic Baffle finished Matte White. 30 cells producing 30° lengthwise shielding.

- **PBCWM/O**
  - Radiused Parabolic Baffle finished Matte White, with Overlay. For additional diffusing of lamp(s), Matte White acrylic overlay provided to lay over baffle blades.

- **PBSS**
  - Radiused Parabolic Semi-specular Baffle. 30 cells producing 30° lengthwise shielding.

- **PBSS/O**
  - Radiused Parabolic Semi-specular Baffle, with Overlay. For additional diffusing of lamp(s), Matte White acrylic overlay provided to lay over baffle blades.

- **SGL**
  - Soft Glow. Extruded frosted acrylic, follows contour of fixture housing.

### Ballast Options

To have the fixture enabled for Lutron EcoSystem compatibility:
- **LPD/CVE**
  - EcoSystem low-profile dimming electronic ballast. Installed at the factory, along with all audit EcosysteM wiring. For other configurations of the Lutron EcosysteM components, including custom device connection feeds to enable connection to ceiling-mounted sensors and control devices, consult litecontrol.com/cs or contact the factory.
- **LPD/DO**
  - Universal Lighting Technologies dimming ballast (T8 & T5)
- **LPD/MCG**
  - Advance Mark VII dimming ballast (T5/MH)

### Questions to Ask

1. Want information, including desired fixture lengths?
2. Lamp type?
3. Ballast options?
4. Controls solutions?
5. Other options? 6. 120 or 277 volt?
Tandem Wiring & Circuiting Options

1CWO: Fixture is wired with a single circuit so that all lamps are switched together.

TW-2CWO: Fixtures wired with two circuits. A 2-lamp in cross section fixtures, the fixture is wired such that the inline lamps are switched separately. 3-lamp in cross section fixtures, the fixture is wired such that the inline center lamps are switched separately from the inline outer lamps.

Specifications

HOUSING: Die-formed steel with downlight opening. 3 11/16" x 41 1/4", in each four-foot section of fixture.
Diffuser opening starts at 3 3/8" from each fixture end. At the center of eight-foot fixtures, openings are spaced 6 3/4" end-to-end, to match spacing between openings in joined fixtures.

END CAPS: Required at each end of row and at both ends of an individual fixture. Standard end caps are die-cast square end caps with no exposed fasteners. A die-cast "screw-style" end cap (ECSS) is available as an option. All end caps finished to match housing.

REFLECTORS: Die-formed high-reflectance aluminum side reflectors. Optional Distribution Separator Reflectors (DSR) allows three-lamp fixtures to deliver separately switched uplight and downlight.

LAMPING: Available in one-, two-, and three-lamp T5, T8HO, or T8. Lamp access/ replacements is from above - removal of baffle is not required.

BALLAST: Low-profile Ballast (LP/ELB), electronic, high power factor, thermally protected Class P, Sound Rated A, less than 10% THD, manufactured by a UL Listed manufacturer, as available, determined by LITECONTROL. Ballasts with a voltage range of 120 to 277 will be used when fixture configuration and baffle availability allows. The minimum number of ballasts will be used.

TANDEM WIRING: When selected from Ordering guide below, fixtures wired to switch in-line lamps separately, providing two or three (three-lamp fixtures only) levels of light.

PRE-WIRING: Fixtures are supplied with #12 AWG type THHN wire for branch circuits. One end will have factory-installed push-in quick-connects. The other end will be stripped back 1/2" for quick connection in field. For fixtures with special circuits such as night light and emergency, in-field wiring may be required. See Pre-wiring information for details.

BALLAST DISCONNECT: Fixtures supplied with a ballast disconnect device to enable compliance with the NEC.

ROW JOINING: Fixture ends headers are threaded in two locations to allow easy row joining without removing reflectors. Support points are centered above the midpoint of joint "on seam" for aligned, symmetrical appearance.

SYSTEM CONNECTORS: Corners, tees, and crosses available. Connectors are extruded aluminum with no exposed fasteners or knockouts. Each system connector shall have a rigid cross-member with a 0.87" diameter stem hole at center to accept any of LITECONTROL's pendant assemblies. Die-cast joint connectors included with each corner, tee or cross.

SUSPENSION: Yoke with field adjustable aircraft cable attaches directly to the end header. Mounting points in rows are exactly "on module" at 48" and 96" including at ends of rows.

CERTIFICATION: Fixture and electrical components shall be UL and/or CUL Listed and shall bear the I.B.E.W. A.F. of L Label. This fixture is Cradle to Cradle Certified™ Silver by MBDC.

Note: LITECONTROL reserves the right to change specifications without notice for product development and improvement.

Planning for installation

Row diagram

1" (25) Fixture Length Fixture Length Fixture Length 1" (25)

<table>
<thead>
<tr>
<th>Fixture Length=4', 8'</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Indicates pendant locations</td>
</tr>
</tbody>
</table>

| Standard (sculpted) end cap adds 1" length to each end of row or individual fixture. |

| Optional ECSS (shelf-style) end cap adds 3 1/2" length to each end of row or individual fixture. |

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Cradle to Cradle Certified™ is a certification mark of MBDC.
To have the fixture supplied with the daylight harvesting control solution:
Add - CS/dhl to the ordering code to have a fixture-integrated daylight sensor by Watt Stopper installed at the factory, along with the appropriate electronic dimming ballast and internal wiring. For row-configured installations, one fixture integrated daylight sensor controls the entire row. See the separate CS/dhl Technical Sheet for details. Contact factory for technical assistance.

Example of Control Solutions catalog number
P-ID-59108-SGL-CWM-LPD/ELB-1CWQ-CS/dhl-120-FAI/ACC is the catalog number for a 4-lamp (2 lamp in cross-section) 6-foot long indirect/direct T8 fixture with a soft glow lens, finished Matte White, with low-profile electronic dimming ballast, one-circuit branch wiring and quick connects, includes daylight harvesting control solution (daylight sensor), 120 volts, mounted with field adjustable aircraft cable.

CS/av Option
To order fixtures with the CS/av control solution, the correct fixture code is needed along with a separate code for the CS/av system. Please refer to the CS/av Technical Sheet for details on ordering the system.

For the fixture order:
ADD CS/av/PR Instead of tandem wiring and circuiting in the fixture catalog number for fixtures that are perpendicular to the presentation area, to control the front 8' of luminaires in each row
ADD CS/av/PL Instead of tandem wiring and circuiting in the fixture catalog number for fixtures that are parallel to the presentation area, to control the entire front row of fixtures

Ensure that the lamping shown in the fixture code (2-lamp or 3-lamp in cross-section) matches the information in the CS/av system code. Luminaires rows with CS/av/PR will require two feeds which will be supplied as a dual feed at one end, where available, to maximize installation savings.

CS/us Option
To have the fixture supplied with the ultrasonic occupancy sensor control solution:
Add - CS/us to the ordering code to have a fixture integrated ultrasonic occupancy sensor by Watt Stopper installed at the factory. The sensor is installed in the center of an 8-foot fixture, and provides automatic on/off control of the fixture based on motion detection. See the separate CS/us Technical Sheet for details. Contact factory for technical assistance.

Example of Control Solutions catalog number
P-ID-59108-SGL-CWM-LPD/ELB-1CWQ-CS/us-120-FAI/ACC is the catalog number for a 4-lamp (2 lamp in cross-section) 6-foot long indirect/direct T8 fixture with a soft glow lens, finished Matte White, with low-profile electronic dimming ballast, one-circuit branch wiring and quick connects, includes ultrasonic occupancy control solution (ultrasonic occupancy sensor), 120 volts, mounted with field adjustable aircraft cable.

System connectors

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P-ID-5900-C90-TCWM is a typical catalog number for a 90° corner connector finished Textured Matte White.
## Photometric data for TSHO lamps

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### ZONAL LUMEN SUMMARY

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### LUMINANCE SUMMARY (FL)

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**Click on Quick Find 59id**

LITECONTROL

100 Hawks Avenue, Hanson, MA 02341
781 294 0100 E 781 293 2849 litecontrol.com
## Photometric data T8 lamps

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### Floor Cavity Reflectance

- 20%

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### Floor Cavity Reflectance

- 20%

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<th>ZONE</th>
<th>LUMENS</th>
<th>% LAMP</th>
<th>LUMINARIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>180°</td>
<td>3401</td>
<td>58.64</td>
<td>67.24</td>
</tr>
<tr>
<td>90°</td>
<td>1621</td>
<td>27.55</td>
<td>32.28</td>
</tr>
<tr>
<td>45°</td>
<td>5922</td>
<td>95.58</td>
<td>100.00</td>
</tr>
</tbody>
</table>

### LUMINANCE SUMMARY (LU)

<table>
<thead>
<tr>
<th>ANGLE</th>
<th>0°</th>
<th>45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>45°</td>
<td>1159</td>
<td>1211</td>
</tr>
<tr>
<td>90°</td>
<td>1041</td>
<td>169</td>
</tr>
<tr>
<td>135°</td>
<td>898</td>
<td>984</td>
</tr>
<tr>
<td>180°</td>
<td>753</td>
<td>801</td>
</tr>
<tr>
<td>225°</td>
<td>526</td>
<td>553</td>
</tr>
</tbody>
</table>

### Floor Cavity Reflectance

- 20%

---

**LITECONTROL**

100 Hawks Avenue Hanson, MA 02341
781 294 0100 f:781 293 2849 litecontrol.com

---

Click on "Quick Find 59id" on litecontrol.com
FIXTURE E

Fluorescent • T5/T5HO Recessed2

MOUNTING: Fixed aiming position with electronic ballast. Fixtures may be mounted to end without gaps between them. Mounting holes located within ballast compartment. See Mounting Details above and on next page.

Optional Brackets: (see illustration on opposite page)
Rough-in Bracket (RB) - Bracket (2 per fixture) is designed to be used prior to hard ceiling completion to locate and accept fixture body. Provided as standard for Flangeless - (F1) Mount.
Retro-fit Bracket (RF) - Bracket (2 per fixture) is designed for fixtures to be mounted in an existing hard ceiling.

TYPE: Recessed reflector profile for wash wall applications. For indoor use only. Open Aperture.

PERFORMANCE: Asymmetric distribution provides a concentration of light on target surface for smooth illumination. Maximum candlpower aimed 15° above nadir less than 10%. Spot light within the 0-15° zone and less than 2% spot light within the 90-180° zone.

ELECTRICAL - Integral electronic T5/PF ballast, with end of lamp file protection circuit, less than 10% THD. Thermally protected. Provide 120V supply wire. Ballast compartment includes conduit entry at each end for through-wiring when mounted and to end. Access to ballast is gained via removable center reflector section. Specify Quick Connect (QC) wiring option for fast through-wiring of multiple sections.

PROFILE: P1 (basic) - Anodized, extruded aluminum specular reflector contained within extruded aluminum housing with solid aluminum endcaps and stainless steel hardware.

FINISHES: Bright anodized specular reflector with electrostatically painted housing and stainless steel hardware.

• Winona Lighting reserves the right to make design revisions without prior notice.

PRODUCT SPECIFICATION

<table>
<thead>
<tr>
<th>MOUNTING</th>
<th>FLANGE TYPE</th>
<th>TYPE</th>
<th>LAMP CODE</th>
<th>VOLTAGE</th>
<th>PROFILE</th>
<th>FINISH</th>
<th>OPTIONS</th>
<th>CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Hard Ceiling</td>
<td>Universal Hard Ceiling</td>
<td>Indoor</td>
<td>124T5</td>
<td>120-120V</td>
<td>P1 (basic)</td>
<td></td>
<td></td>
<td>STD</td>
</tr>
<tr>
<td>MLU2 - Individual</td>
<td>F1 - flangesless</td>
<td>M2 -</td>
<td>124T5</td>
<td>277V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MLU2 - flanged</td>
<td>F1 - flanged</td>
<td></td>
<td>124T5</td>
<td>277V</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>MLU2 - intermediate</td>
<td></td>
<td></td>
<td>124T5</td>
<td>277V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MLU2 - right</td>
<td></td>
<td></td>
<td>124T5</td>
<td>277V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grid Ceiling</td>
<td></td>
<td>124T5</td>
<td>277V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grid Ceiling</td>
<td></td>
<td>124T5</td>
<td>277V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Visit www.winonalighting.com for the most complete and current information.

352 winona lighting | windirect | 3760 west fourth street • winona, mn 55997 | 507.454.5113 | fax 507.452.8528 | www.winonalighting.com
## CONTINUOUS MOUNTS

**F1 Flanged**

<table>
<thead>
<tr>
<th>Lamp Code</th>
<th>Wattage</th>
<th>Individual P1-Flangedless</th>
<th>Individual P1-Flanged</th>
<th>Continuous Lft or Right</th>
<th>Continuous Intervalto</th>
</tr>
</thead>
<tbody>
<tr>
<td>13T5</td>
<td>34-9/16&quot;</td>
<td>34-9/16&quot;</td>
<td>35-5/16&quot;</td>
<td>34-9/16&quot;</td>
<td>34-9/16&quot;</td>
</tr>
<tr>
<td>13T5HO</td>
<td>34-9/16&quot;</td>
<td>34-9/16&quot;</td>
<td>35-5/16&quot;</td>
<td>34-9/16&quot;</td>
<td>34-9/16&quot;</td>
</tr>
</tbody>
</table>

## INDIVIDUAL MOUNTS

- **ML2U - F0 (flangeless)**
- **ML2U - F1 (flanged)**

## MOUNTING / END CONDITIONS

**GRID CEILING MOUNTS ML2ST / ML2NT**

**ML2ST-F3**
Standard 15/16" T-Bar (standard tile)

**ML2NT-F3**
Narrow 9/16" T-Bar (standard tile)

**ML2ST-F4**
Standard 15/16" T-Bar (stepped tile)

**ML2NT-F4**
Narrow 9/16" T-Bar (stepped tile)

**Slotted 9/16" T-Bar (stepped tile)**

**CHD CEILING**

<table>
<thead>
<tr>
<th>Actual Length - L</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 3/4&quot;</td>
<td>8 lbs.</td>
</tr>
<tr>
<td>47 3/4&quot;</td>
<td>12 lbs.</td>
</tr>
</tbody>
</table>
FEATURES & SPECIFICATIONS

INTENDED USE
Surface or stem-mounted lensed fixture for general illumination in commercial offices and retail applications. Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility Table for suitable uses.

CONSTRUCTION
Housing formed from cold-rolled steel. Plasma seam welded corners provide a clean finish and eliminate light leaks. Standard steel door frame has superior structural integrity with premium extruded appearance and precision flash mitered corners. Steel door allows easy lens replacement without frame disassembly. Power-painted steel latches provide easy, secure door closure. Superior mechanical light seal requires no foam gasketing.

Finish: Five-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts finished with high-gloss, baked white enamel.

OPTICS
Standard pattern #12 lens is 100% virgin acrylic. Other lenses and diffusers available.

ELECTRICAL
Standard ballast is electronic, thermally protected, resetting, Class P, HPF, non-PCB, UL Listed, CSA Certified ballast. Universal voltage. Sound rated A.

Luminaire is suitable for damp locations. AWM, TFN or THHN wire used throughout, rated for required temperatures.

LISTING
Standard: UL and CSA Certified.

WARRANTY
Guaranteed for one year against mechanical defects in manufacture.

ORDERING INFORMATION

For shortest lead times, configure product using standard options (shown in bold).

Example: M 2 32 A19 MVOLT GEB101S

### Modular Commercial
**M 1X4**

**STRAIGHT LAMPS**
1, 2 or 3 lamps

---

**Specifications**
- **Length:** 48 (1219)
- **Height:** 4-3/4 (121)
- **Width:** 12-1/4 (311)
- **Weight:** 19 lbs. (8.6 kg.)

All dimensions are inches (millimeters). Specifications subject to change without notice.

<table>
<thead>
<tr>
<th>Frame type</th>
<th>Diffuser</th>
<th>Voltage</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>(blank)</td>
<td></td>
<td>347</td>
<td>MVOLT GEB101S</td>
</tr>
<tr>
<td>Flush steel, white</td>
<td>#12 pattern acrylic</td>
<td></td>
<td>One 3-lamp ballast</td>
</tr>
<tr>
<td></td>
<td>#12 pattern acrylic, 125° thick</td>
<td></td>
<td>Electronic ballast, &lt;10% THD, instant start (T8 only)</td>
</tr>
<tr>
<td>FM, FN, FW, RN,</td>
<td>A1212S</td>
<td></td>
<td>Electronic ballast, &lt;10% THD, rapid start (T8 only)</td>
</tr>
<tr>
<td>RM, RW</td>
<td>A19 #19 pattern acrylic, 156° thick</td>
<td></td>
<td>GEB10PS Electronic ballast, &lt;10% THD, program start (T5/T5HO only)</td>
</tr>
<tr>
<td></td>
<td>PC1S 1/2 x 1/2 x 1/2 plastic louver, silver</td>
<td></td>
<td>EL14 Emergency battery pack (nominal 1900 lumens)</td>
</tr>
<tr>
<td></td>
<td>PC2S 1-1/2 x 1-1/2 x 1-1/2 plastic louver, silver w/ flange</td>
<td></td>
<td>GLR Internal fast-blow fuse</td>
</tr>
<tr>
<td></td>
<td>PC3S 3/4 x 3/4 x 1/2 plastic louver, silver</td>
<td></td>
<td>GMF Internal slow-blow fuse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LP735 Lamped; 700-series: 3500K</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LP741 Lamped; 700-series: 4100K</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LP835 Lamped; 800-series: 3500K</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LP941 Lamped; 800-series: 4100K</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FTC Top of fixture fully enclosed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CRE Continuous row, end (KD in shroud end)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CRM Continuous row, middle (KD in both ends)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NOM NOM Certified</td>
</tr>
</tbody>
</table>

---

**Fluorescent**

**Sheet #: M-1x4**

**WRAP-260**

---

1 Order as separate catalog number.
2 Swivel stem hanger (specify length in 2" increments).
**MOUNTING DATA**

For unit or row installation. Surface or stem mounting.

UNIT INSTALLATION — Minimum of two hangers required.

ROW INSTALLATION — One hanger per fixture plus one per row required.

**DIMENSIONS**

All dimensions are inches (millimeters). Specifications subject to change without notice.

---

**PHOTOMETRICS**

Calculated using the zonal cavity method in accordance with IESNA LM-61 procedure. Floor reflectances are 20%. Lamp configurations shown are typical. All data based on 25°C. Full photometric data on these and other configurations available upon request.

**TEST NO.: LTL16651**

LUMINAIRES CATALOG NO.: M 2 32 12 A12 MVOLT GEB10B5

LUMENS PER LAMP: 2600

<table>
<thead>
<tr>
<th>phi</th>
<th>50%</th>
<th>50%</th>
<th>50%</th>
<th>50%</th>
<th>50%</th>
<th>50%</th>
<th>50%</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>75</td>
<td>75</td>
<td>74</td>
<td>74</td>
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<td>1</td>
<td>67</td>
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<td>65</td>
<td>65</td>
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<tr>
<td>2</td>
<td>55</td>
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<td>4</td>
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<td>8</td>
<td>32</td>
<td>32</td>
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<td>9</td>
<td>30</td>
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<td>10</td>
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<td>28</td>
<td>28</td>
<td>28</td>
<td>28</td>
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<td>28</td>
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</tbody>
</table>

Zonal Lumen Summary

<table>
<thead>
<tr>
<th>Zone</th>
<th>Luminous % Lamp % Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>6° - 30°</td>
<td>1203.3</td>
</tr>
<tr>
<td>6° - 60°</td>
<td>1510.3</td>
</tr>
<tr>
<td>6° - 90°</td>
<td>1628.5</td>
</tr>
<tr>
<td>6° - 120°</td>
<td>1688.4</td>
</tr>
</tbody>
</table>

*Calculated in accordance with NEMA Standards LE-5.*

---

**LITHONIA LIGHTING**

An Acuity Brands Company

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Lithonia Lighting

Fluorescent

One Lithonia Way, Conyers, GA 30012

Phone: 888-855-7763

www.lithonia.com
FEATURES & SPECIFICATIONS

INTENDED USE
Ideal where high brightness and good illumination levels are required such as retail, light industrial and warehouses.

ATTRIBUTES
Available in one lamp or two lamp configuration.

CONSTRUCTION
Heavy-duty channel, die-formed from code-gauge steel.
Study channel cover secured by captive quarter-turn latch for easy access to wireway.
Combination endplate/channel connector furnished with each fixture.

FINISH
Five-stage phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts finished with high-gloss, baked white enamel.

ELECTRICAL
Thermally protected, resetting, Class P, UL Listed and CSA Certified ballast is standard. Sound rating depends on lamp/ballast combination.
47/60Hz, 277V wire throughout, rated for required temperatures.

INSTALLATION
For unit or row installations, surface or suspended mounting.

LISTING
UL listed to US and Canadian safety standards. Optional: Mexico NOM.
Damp location listed.
Listed for 25 degree C ambient temperature.

WARRANTY
Guaranteed for one year against mechanical defects in manufacture.
Specifications subject to change without notice.

ORDERING INFORMATION
Lead times will vary depending upon options selected. Consult your sales representative.

Example: C 32 MVOLT GEB1015

<table>
<thead>
<tr>
<th>C</th>
<th>Number of lamps</th>
<th>Lamp type</th>
<th>Voltage Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>T8</td>
<td>MVOLT 12²</td>
</tr>
<tr>
<td>17</td>
<td>22</td>
<td>T8 (34&quot;)</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>T8 (36&quot;)</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>32</td>
<td>T8 (40&quot;)</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>96</td>
<td>SLIMLINE (96&quot;)</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>SLIMLINE (36&quot;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>SLIMLINE (45&quot;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>SLIMLINE (60&quot;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>SLIMLINE (90&quot;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>T12</td>
<td>MVOLT 12²</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>T12 (24&quot;)</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>T12 (36&quot;)</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>T12 (48&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

| Accessories: Order as separate catalog number. |
|---|---|
| SQ | Swivel stem hanger (specify length in 2" increments) |
| 18 | Ceiling spacer (adjusts from 1-1/2" to 2-1/2" from ceiling) |
| CONGC | 12" screw-on channel connector |
| WGC1NST | Wireguard, 4" wide |
| HC36 | Chain hangers (1 pair, 36" long) |
| HRC | Hooker T-bar hanger (flush to ceiling) |

<table>
<thead>
<tr>
<th>NOTES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MVOLT standard for 120-277V applications, 50-60 Hz operation. Some options require voltage specified.</td>
</tr>
<tr>
<td>2. T8 lamps only.</td>
</tr>
<tr>
<td>3. Slime lamps only.</td>
</tr>
<tr>
<td>4. Not available in slimline.</td>
</tr>
<tr>
<td>5. Specify voltage.</td>
</tr>
<tr>
<td>6. Order two for 8 fixtures.</td>
</tr>
</tbody>
</table>
C General-Purpose Strip

MOUNTING DATA
For unit or raw installation, surface or suspended mounting.
Unit installation — Minimum of two hangers required.
Row installation — Two hangers per channel required. One per fixture plus one per row if CONLOC installed.
Hooker® (HRC) and HC Hangers — Minimum two per channel (unit and row)
See ACCESSORIES below for hanging devices.

PHOTOMETRICS
Calculated using the zonal cavity method in accordance withIESNA LM11 procedure. Host reflectances are 20%. Lamp configurations shown are typical. All data based on 25°C. full photometric data on these and other configurations available upon request.

C 2 32
TEST NO: LTL 5181
LUMENS PER LAMP: 2000

<table>
<thead>
<tr>
<th>Coefficients of Utilization</th>
<th>pf</th>
<th>00%</th>
<th>05%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50%</td>
<td>30%</td>
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<td></td>
<td>50%</td>
<td>30%</td>
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<tr>
<td></td>
<td></td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
</tr>
</tbody>
</table>

C 2 36
TEST NO: LTL 16316
LUMENS PER LAMP: 6300

<table>
<thead>
<tr>
<th>Coefficients of Utilization</th>
<th>pf</th>
<th>00%</th>
<th>05%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>50%</td>
<td>30%</td>
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<td>30%</td>
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<td>20%</td>
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<tr>
<td></td>
<td></td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Zonal Lumen Summary
Zone 1: Lumen % Lamp % Fixture

Energy (Calculated in accordance with NEMA standard (E-5))

<table>
<thead>
<tr>
<th>LITEN</th>
<th>LAMP</th>
<th>BALKAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>68.2</td>
<td>42.7</td>
<td>68.5</td>
</tr>
</tbody>
</table>

* Comparative yearly lighting energy cost per 1000 lumens

LITHONIA LIGHTING
An Acuity Brands Company

FLUORESCENT: One Lithonia Way, Cary, NC 27513 Phone: 800.859.7760 Fax: 770.979.6789 www.lithonia.com

© 1999-11 Acuity Brands Lighting, Inc. All rights reserved. Rev. 03/02/14
FEATURES

OPTICAL SYSTEM
- Self-flanged matte-diffuse high-impact polymer finishing trim with a durable, proprietary, vapor deposition finish.
- Patented Bounding Ray™ Optical Principle design (U.S. Patent No. 5,800,050) provides lamp before lamp image and smooth transition from top of the reflector to bottom.

MECHANICAL SYSTEM
- Housing accommodates a maximum 1-1/2' ceiling thickness.
- Light engine and driver are accessible from above or below ceiling and can be upgraded to accommodate future technology improvements.
- 16-gauge galvanized steel mounting bars with continuous 4' vertical adjustment are shipped pre-installed. Post installation adjustment possible without the use of tools from above or below ceiling.
- Galvanized steel junction box with hinged access covers and spring latch. Three combination 1/2"-3/4" and one 1/2" knockout for straight-through conduit runs. Capacity: 2 (4in, 4out) No. 12 AWG conductors rated for 90°C.
- Secondary housing adjustment system for precise, final ceiling to flange alignment.

ELECTRICAL SYSTEM
- Solid state LED light engine available in 3500° or 4100K color temperatures.
- Class P, thermally protected 0-10V solid-state dimming driver is standard.
- Rated system life of 50,000 hours at 70% output.
- Thermally activated insulation detector.
- Emergency battery pack and SIMPLY5™ energy management system available.
- Luminaire should be installed in applications where ambient temperatures do not exceed 50°C. Ambient temperatures that exceed 50°C will result in reduced lamp life and will void warranty.

LISTING
- Fixtures are UL Listed for thru-branch wiring. Non-IC recessed mounting and damp locations. Listed and labeled to comply with Canadian Standards. Tested to IESNA LM-79 and LM-80 standards.

ORDERING INFORMATION
Choose the boldface catalog nomenclature that best suits your needs and write it on the appropriate line.
Order accessories as separate catalog numbers (shipped separately).

<table>
<thead>
<tr>
<th>ECSS4</th>
<th>DLED-130</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Series</th>
<th>Color temperature</th>
<th>Nominal lumen output</th>
<th>Aperture</th>
<th>Trim color</th>
<th>Finish</th>
<th>Voltage</th>
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<tbody>
<tr>
<td>ECSS</td>
<td>35/ 3500K/</td>
<td>99 990 lms</td>
<td>4</td>
<td>AR Clear</td>
<td>LD Matte</td>
<td>128</td>
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<tr>
<td></td>
<td>41/ 4100K/</td>
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<td>PR Pewter</td>
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<td></td>
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<td>WTR Wheat</td>
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<td>347P</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DSR Stepped</td>
<td>Semi-</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>WR White</td>
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<td></td>
<td>WDSR Wheat</td>
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</table>

<table>
<thead>
<tr>
<th>Options</th>
</tr>
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<tbody>
<tr>
<td>SF Single fuse</td>
</tr>
<tr>
<td>EL Emergency battery pack with integral test switch</td>
</tr>
<tr>
<td>ELC Emergency battery pack with remote test switch</td>
</tr>
<tr>
<td>TRW White flange</td>
</tr>
<tr>
<td>TRBL Black flange</td>
</tr>
<tr>
<td>MFLG Microflange™ trim</td>
</tr>
<tr>
<td>SQMT Square metal trim</td>
</tr>
<tr>
<td>LRC Provides compatibility with Lithuania Reloc® System. Access above ceiling required.</td>
</tr>
<tr>
<td>CP Chicago Plenum approved</td>
</tr>
<tr>
<td>NSD Sensor Switch nLight™ dimming relay</td>
</tr>
<tr>
<td>ELRHL High-lumen emergency battery pack with remote test switch</td>
</tr>
</tbody>
</table>

Notes:
1. Only available with SQMT metal trim option.
2. Height of fixture increases 3".
3. SIMPLY5™ includes 9' S5 MLC Reloc wiring system (shipped separately). See simpleS for more information.
4. Available in 120V or 277V only.
5. For dimensional changes, refer to Technical Bulletins tab.
6. Not available with stepped trim.
7. For compatible Reloc systems, refer to Technical Bulletins tab.
8. One SA relay with one 0-10 VDC dimming output, shipped installed. Refer to nSPX-D.

Example: ECSS 35/09 4AR LD 120
4" ECSS Ecos™ Square Open Reflector

<table>
<thead>
<tr>
<th>Distribution curve</th>
<th>Distribution data</th>
<th>Output data</th>
<th>Coefficient of utilization</th>
<th>Single luminaire data 30° above floor</th>
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**ECSS 35/09 4AR LD, 34W LED, 900 delivered lumens, 1.3 s/mh, Input watts: 34, Test no. LTL18182**

<table>
<thead>
<tr>
<th>Angle (°)</th>
<th>Luminous Content</th>
<th>% Lamping</th>
<th>pw</th>
<th>20%</th>
<th>70%</th>
<th>50%</th>
<th>50% beam</th>
<th>10% beam</th>
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<tbody>
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<td>481</td>
<td>0°-30°</td>
<td>0</td>
<td>0</td>
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<td>10°</td>
<td>478</td>
<td>0°-50°</td>
<td>2</td>
<td>98</td>
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<td>89</td>
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<td>15°</td>
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<td>50°</td>
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**ECSS 35/09 4DSR LD, 34W LED, 900 delivered lumens, 1.3 s/mh, Input watts: 34, Test no. LTL18183**

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<tr>
<th>Angle (°)</th>
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<td>36</td>
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Photometric performance is measured in accordance with IESNA LM-79.

For expanded options and updated photometric information, please visit www.gothamlighting.com or contact the factory directly.

NOTES:
1. For electrical characteristics, refer to Technical Bulletins tab.
2. Tested to current IES and NEMA standards under stabilized laboratory conditions. Various operating factors can cause differences between laboratory data and actual field measurements. Dimensions and specifications are based on the most current available data and are subject to change without notice.
3. Consult factory or IES file for microgroup baffle, black core and other photometric reports.

DLED-130
All Rights Reserved.
PARI ARCHITECTURAL ROUND PENDANT 2
LED

APPLICATION:
Retail, hospitality and commercial task and decorative lighting

CONSTRUCTION:
Extruded aluminum ballast housing
Stamped aluminum top plate and components
Spun aluminum canopy, fits standard 4" octagonal J-box
Blown satin cased, etched glass
Extruded aluminum heat sink

OPTICS:
LED:
Color Temp: 2700K (2725K ±175)
3000K (3045K ±175)
CRI: 82 typ
Life: 50,000 hrs
Lumen Maintenance: >70% of initial lumens @ 50,000 hrs

MOUNTING:
Canopy mounted, 10' feed cord standard

LABELING:

PROJECT:

TYPE:

Electrostatic sensitive device, observe precautions for handling

10 year limited warranty
(see website for details)

10

ELECTRICAL

Driver Operating Watts Amps
Electronic 120v 7.4 .06

Class 2 constant current driver, 700 mA

ORDERING INFORMATION:

<table>
<thead>
<tr>
<th>Model</th>
<th>Wattage</th>
<th>Lamp Type</th>
<th>Driver</th>
<th>Finish Glass</th>
<th>Body</th>
<th>Mounting</th>
<th>Voltage</th>
<th>Color Temp</th>
</tr>
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<tbody>
<tr>
<td>PARI-2R</td>
<td>7</td>
<td>LED</td>
<td>E-electronic</td>
<td>SO-satin opal</td>
<td>NA-brushed</td>
<td>CC-canopy/cord*</td>
<td>120</td>
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<td>SA-satin amber</td>
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<td>bronze</td>
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</table>

Example: PARI-2R-7-LED-E-SO-NA-CC-120-3000

*Canopy/cord to match the body finish of the fixture

Cat #:  

Amerlux reserves the right to change details that do not affect overall function and performance.

Amerlux, Inc. • 20 Daniel Road, Fort Mill, NC 29715 • p: 973.882.5010 f: 973.882.2605 • www.amerlux.com

LIF-0591 rev 6/11
SEQUENCE™ PLATES

Typical Applications
- 2-story corridor
- Auditorium
- Church
- Civic
- Airport
- Healthcare
- Education
- Large venue
- Hospitality

Features
- 5 year product warranty
- Matte white acrylic cylinder body
- Oven cured no VOC acrylic powder coat for painted finishes; oven cured low VOC clear coat on metal finishes
- Plates formed from 1/4" colored acrylic or 1/8" finished aluminum
- Consistent brightness uniformly gradient minimizes shadowing and lamp image
- T-5 fluorescent or high performance T-8 fluorescent lamps
- Low energy, long life LED lamping
- Oram Octron® XPS® Ecologic® T-8 lamp/ballast combination (.71 ballast factor) provides up to 42,000 hours of lamp life (rated at 12 hours start)
- Optional recessed downlight with PAR lamps for beam spread selection
- Oram PowerDrive® 8111 downlight lamping option
- Integral ballast standard for CPS238, CPS239, CPS240
- Power cord (white) is included with cable mount models

UL Listed - cUL Listed Approved for indoor damp locations

LED Features
- Static color LED bodylight or color changing LED RGB
- Modular design allowing replacement of the LED linear source and driver
- Constant current LED technology to protect LEDs from experiencing "over current" conditions that can cause overheating and premature failure
- Thermally managed within manufacturer specifications to promote long LED life
- No ultraviolet or infrared, eliminating potential damage to art, fabric and materials
- Mercury free LED source reduces impact to waste stream

Solid Color LED Features
- Available in amber, blue, green, white and red
- Integral high power factor electronic driver (CPS238, CPS239, CPS240)
- Optional 0-10V LED bodylight dimming
- Remote driver mountable up to 20' maximum (CPS232, CPS233, CPS234)

Color Changing LED (RGB) Features
- DMX controller is available, see www.visalighting.com for details
- DMX compliant driver is standard with LEDRGB; Integral for CPS238, CPS239, CPS240, remote for CPS232, CPS233, CPS234 (20' maximum distance)
- DMX driver is field addressable through use of onboard switches
- DMX control cable is separate from power cable to meet code requirements
(CPS238, CPS239, CPS240)

Suggested Variations
- Teelit (cable mount only)
- Vary height of cylinders
- Alternative downlight bezel and end cap color
- Alternative plate shapes or sizes up to 36" square (plate models)
- Additional plates or plate colors
- Customized pre-programmed DMX controller effects
- See www.visalighting.com for additional variation suggestions

---

PLATE OPTIONS and sizes (inches)

<table>
<thead>
<tr>
<th>1 plate</th>
<th>3 plates</th>
<th>5 plates</th>
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<tbody>
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</tbody>
</table>

Companions

Sequence Plates
Pendant P 22
Sequence Plates
Pendant P 24
Sequence Plates
Pendant P 26

VISA LIGHTING
An Oldenburg Group Company
800-788-VISA  www.visalighting.com
Application: The DRACO® BS710 LED lowbay luminaire has combined performance and efficiency. The four piece integrated extruded aluminum ballast housing is designed for suspension cable or rigid pendant mounting. 12" or 16" reectors are used. Several reector types are available. The bottom glass trim ring features an inner opaque ring for increased diffusion. The DRACO® BS710 LED is ideal for retail, open ceiling areas, loft style offices and cafes.

HOUSING: Extruded aluminum construction with gray RAL 7040 powder coated finish as standard. Custom finishes are also available including different powder coated colors and anodizing.

REFRACTOR: 12" acrylic translucent prismatic design available in clear (ACT), red (ART), blue (ABT), green (AGT) and amber (AAI). The 16" acrylic translucent prismatic design is available in clear (ACT) and aluminum with a gray powder coated finish (AL).

LED MODULE: Beghell technology LED module. Standard 3200K, 4500K or 6500K versions. Custom color temperatures and performance available upon request. RGB color mixing available. Single color LED offered in red, red/orange, amber, green, cyan, blue or royal blue.

CONTROL: DRACO® RGB units are compatible with DMX-512 protocol / color controller.

POWER: DRACO® is supplied with 35'-15A cable - 3 conductor SPT white power cord. Power line/feeder attached to housing for all mounting types. Power cord may be cut.

POWER SUPPLY: Internal per unit.

CUSTOM: The glass trim ring is 9/16" tempered etched glass diffusing ring suspended by four (4) high polished, formed aluminum support arms.

WATTAGE: 24W per fixture

NOTE: Power consumption may vary based on LED specifications. Please consult factory for proper power supply configuration.

Bagley reserves the right to change, without notice, specifications or materials that in its opinion will not alter the function or performance of the product. Technical specifications that appear on www.beghelitcusa.com supersede all other versions existing in print or electronic form.
The Eon 303-S1 is a compact, low-profile, dimmable LED sign lighting luminaire. It attaches to a wall-mounted straight arm and delivers full vertical adjustments (180 degrees) for easy aiming. Optional 24-, 30- or 36-in. arms are available in lieu of the standard 12-in. arm. The 303i4 mounts directly to any wall surface over a standard 4-in. j-box and comes standard with a universal input LED driver (120-277V, 50/60 Hz). Circle 223.

Lumière
www.cooperindustries.com

Locate at Lightfair
Booth Number 2524
DESCRIPTION
The patent pending Lumark Crosstour™ LED Wall Pack Series of luminaires provides an architectural style with super bright, energy efficient LEDs. The low-profile, rugged die-cast aluminum construction, universal back box, stainless steel hardware along with a sealed and gasketed optical compartment make the Crosstour impervious to contaminants. The Crosstour wall luminaire is ideal for wall/surface, inverted mount for façade/canopy illumination, postbollard and low level pathway illumination including stairs. Typical applications include building entrances, multi-use facilities, apartment buildings, institutions, schools, stairways and loading docks.

SPECIFICATION FEATURES

Construction
Slim, low profile LED design with rugged one-piece, die-cast aluminum hinged removable door and back box. Matching housing styles incorporate both a small and large design. The small housing is available in 10W and 20W. The large housing is available in the 30W model. Patent pending secure lock hinge feature allows for safe and easy tool-less electrical connections with the supplied lever-lock connectors. Back box includes three (3) half-inch, NPT threaded conduit entry points. The universal back box supports both the small and large forms and mounts to standard 3-1/2" to 4" round and octagonal, 4" square, single gang and masonry junction boxes. Key hole gasket allows for adaptation to junction box or wall. External fin design extracts heat from the fixture surface. One-piece silicone gasket seals door and back box. Not recommended for car wash applications.

Optical
Silicone sealed optical LED chamber incorporates a custom engineered mirrored anodized reflector providing high-efficiency illumination. Optical assembly includes impact-resistant tempered glass and meets JESNA requirements for full cutoff compliance. Solid state LED Crosstour luminaires are thermally optimized with five (5) lumen packages in cool 5000K or neutral warm 3500K LED color temperature (CCT).

Electrical
LED driver is mounted to the die-cast housing for optimal heat sinking. LED thermal management system incorporates both conduction and natural convection to transfer heat rapidly away from the LED source. 10W models operate in -40°C to 40°C [0°F to 104°F]. 20W and 30W models operate in -30°C to 40°C [-22°F to 104°F]. Crosstour luminaires maintain greater than 70% of initial light output after 50,000 hours of operation. Three (3) half-inch NPT threaded conduit entry points allow for thru-brach wiring. Back box is an authorized electrical wiring compartment. Integral LED electronic driver incorporates surge protection. 10W, 120V 50/60 Hz., 20W and 30W, 120-277V 50/60Hz.

Finish
Crosstour is protected with a Super TGC carbon bronze or summit white polyester powder coat paint. Super TGC powder coat paint finishes withstand extreme climate conditions while providing optimal color and gloss retention of the finished life.

Warranty
Crosstour features a five-year limited warranty.

DIMENSIONS

CROSSTOUR LED
WALL / SURFACE MOUNT
POST / BOLLARD MOUNT
LOW LEVEL MOUNT
INVERTED MOUNT

CERTIFICATION DATA
UL656, Wet Location Listed
IP66 Ingress Protection Rated
ADA Compliant
LM79, LM80 Compliant
RoHS Compliant
ARRA Compliant
DLC Qualified Models
Lighting Facts® Approved
Title 24 Compliant
NOM Compliant Models

TECHNICAL DATA
40°C Maximum Ambient Temperature
External Supply Wiring 90°C Minimum

EPA
Effective Projected Area: [Sq. Ft.]
XTOR1A/XTOR2A = 0.34
XTOR2A = 0.45

SHIPPING DATA:
Approximate Net Weight:
3.7 - 6.25 lbs. [1.7 - 2.4 kgs.]

ADD112911 pc
2012-01-10 08:42:31
ORDERING INFORMATION

SAMPLE NUMBER: XTOR2A-N-WT-PC1

<table>
<thead>
<tr>
<th>Series</th>
<th>XTOR1A=Small Door, 10W</th>
<th>XTOR2A=Small Door, 20W</th>
<th>XTOR3A=Large Door, 30W</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>LED Kelvin Color</th>
<th>N = Neutral Warm White, 3500K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bright White (Standard) 6500K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing Color</th>
<th>Carbon Bronze (Standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT</td>
<td>Summit White</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Options (specify voltage)</th>
<th>PC1=Photocell 120 V</th>
<th>PC2=Photocell 220/277 V</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Accessories</th>
<th>W/G/XTOR=Wireguard (fits both)</th>
</tr>
</thead>
</table>

Note:
1. 10W only XTORIA not available in 3500K.
2. Design Lighting Consortium** qualified (down mount only).
3. Protective housing must be ordered separately.
4. PC1 and PC2 photocells are factory installed. PC2 not available on XTORIA models.
5. Order W/G/XTOR wire guard separately.

STOCK ORDERING INFORMATION

<table>
<thead>
<tr>
<th>10W Series</th>
<th>20W Series</th>
<th>30W Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>XTORIA = 10W, 5000K, Carbon Bronze</td>
<td>XTORIA = 20W, 5000K, Carbon Bronze</td>
<td>XTORIA = 30W, 5000K, Carbon Bronze</td>
</tr>
<tr>
<td>XTORIA-WT = 10W, 5000K, Summit White</td>
<td>XTORIA-WT = 20W, 5000K, Carbon Bronze</td>
<td>XTORIA-WT = 30W, Summit White</td>
</tr>
<tr>
<td>XTORIA-PC1 = 10W, 5000K, 120V PC, Carbon Bronze</td>
<td>XTORIA-PC1 = 20W, 120V PC, Carbon Bronze</td>
<td>XTORIA-PC1 = 30W, 120V PC, Carbon Bronze</td>
</tr>
</tbody>
</table>

5-DAY QUICK SHIP ORDERING INFORMATION

<table>
<thead>
<tr>
<th>10W Series</th>
<th>20W Series</th>
<th>30W Series</th>
</tr>
</thead>
</table>

LUMENS - CRI / CCT TABLE

<table>
<thead>
<tr>
<th>LED Information</th>
<th>XTORIA</th>
<th>XTORIA</th>
<th>XTORIA-N</th>
<th>XTORIA-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivered Lumen</td>
<td>719</td>
<td>1361</td>
<td>947</td>
<td>2245</td>
</tr>
<tr>
<td>CCT (Kelvin)</td>
<td>5000</td>
<td>5000</td>
<td>3500</td>
<td>5000</td>
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<tr>
<td>Color Rendering Index (CRI)</td>
<td>87</td>
<td>86</td>
<td>68</td>
<td>84</td>
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CURRENT DRAW

<table>
<thead>
<tr>
<th></th>
<th>XTORIA</th>
<th>XTORIA</th>
<th>XTORIA</th>
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<tr>
<td>120V</td>
<td>0.2A</td>
<td>0.2A</td>
<td>0.2A</td>
</tr>
<tr>
<td>240V</td>
<td>0.1A</td>
<td>0.1A</td>
<td>0.1A</td>
</tr>
<tr>
<td>277V</td>
<td>0.15A</td>
<td>0.15A</td>
<td>0.15A</td>
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</table>
### POWER AND LUMENS BY BAR COUNT

<table>
<thead>
<tr>
<th># of Bars</th>
<th>System Watts</th>
<th>Type BL2 Lumens</th>
<th>Type BL3 Lumens</th>
<th>Type BL4 Lumens</th>
<th>Ambient Temperature</th>
<th>Lumen Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bar</td>
<td>26</td>
<td>1,623</td>
<td>1,823</td>
<td>1,918</td>
<td>10°C</td>
<td>1.04</td>
</tr>
<tr>
<td>2 Bars</td>
<td>53</td>
<td>3,246</td>
<td>3,647</td>
<td>3,835</td>
<td>15°C</td>
<td>1.03</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25°C</td>
<td>1.00</td>
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<td>Options</td>
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<td></td>
<td></td>
<td>40°C</td>
<td>0.86</td>
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<td>ULG</td>
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<td></td>
<td></td>
<td></td>
<td>315</td>
</tr>
</tbody>
</table>

NOTE: Lumen values based upon 4000K CCT, 360mA drive current. 25°C ambient operating temperature.

### ORDERING INFORMATION

**Sample Number:** ENV-002-LED-E-1-BL3-GM

**Product Family:** ENV Envi Round Reveal

**Lamp Type**
- LED: Solid State Light Emitting Diodes (SSL)

**Distribution**
- BL2: Type II w/Back Light Control
- BL3: Type III w/Back Light Control
- BL4: Type IV w/Back Light Control
- G27W: Wall Gruzer Wide
- S11: 100 Degree Spill Light Eliminator Left
- S1R: 100 Degree Spill Light Eliminator Right

**Finish**
- BK: Black
- AP: Almond
- BR: Bronze
- WH: White
- DP: Dark Platinum
- GM: Graphite Metallic

**Options**
- ULG: Uplight Glow
- PC: Button Type Photocell (Available in 120V, 208V, 277V)
- WG: Wire Guard
- LS: Two Circuits
- TP: Tamper Resistant Hardware
- LCF: Lumen Cover Plate
- BMP: Battery Pack with Back Box (Specify 120 or 277)
- CWB: Cold Weather Battery Pack with Back Box (Specify 120 or 277)

**Accessories**
- VA3001-XX: Three-Way Convert Adapter Box
- VP4172: Wire Guard
- VA6172: Tamper Resistant Driver Box
- MA1253: 10V Circuit Module Replacement

**Notes:**
1. Standard 4000 K CCT and greater than 70 CRI. LightBar is for downlight use only.
2. 21 LED LightBar powered at 360mA, 7 LED LightBar powered at 1A.
3. Custom and RAL color matching available upon request. Consult your customer service representative for further information.
4. Add suffix in the order shown.
5. Lumen output varies by bar count, consult factory. Not available with 24V or 48V. Available with 120V only.
6. Consult customer service for both times and lumen multiplier.
7. Available with B22 or C92, only (1) LightBar on street side will be wired to sensor. Time Delay factory setting 15 minutes. When ordered with Option PC, both light bars will be connected in parallel as primary switching means. Standard sensor lens covers 8-foot mount height, 360-degree coverage, maximum 80-foot diameter. Not available in all configurations or with B22 or CWB options.
8. Specify 120 or 277V. LED standard integral battery pack is rated for minimum operating temperature 32°F (0°C). Operates (1) lightbar for 30 minutes. Not available in all configurations or with ULG option. Consult factory.
9. Specify 120 or 277V. LED cold weather integral battery pack is rated for minimum operating temperature -4°F (-20°C). Operates (1) lightbar for 90 minutes. Not available in all configurations or with ULG option.
10. Order separately, replace XX with color suffix.

**Additional Information:**
- Cooper Lighting
- www.cooperlighting.com
- Customer First Center 1121 Highway 74 South Peachtree City, GA 30269 770.486.4800 FAX 770.486.4801
- AVU32078b 2011-07-11 10:01:17
- 2012-03-26 15:53:48

NOTE: Specifications and dimensions subject to change without notice.
SECTION 266000 – LABORATORY ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The general conditions, Division 1, and Division 26 electrical requirements are part of this section and the contract for this work and apply to this section as fully as if repeated herein.

B. Reference to other sections: The applicable requirements from all other Division 26 sections shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections. For Laboratory areas only (excluding lab lighting), this section shall take precedence.

C. Provide complete electrical systems from the laboratory branch circuit panelboards to all devices and equipment as described in these specifications and shown on the Laboratory Electrical drawings. Electrical installations shall include all required hardware, fittings, boxes, mounting provisions and miscellaneous equipment to provide complete and operable systems in accordance with the standard practices of the trade. Materials utilized shall be as defined in other sections of Division 26 of these specifications and modified only as described herein.

1.2 EXPLANATION OF DRAWINGS

A. The Laboratory Electrical (LE) construction documents are intended to be diagrammatic and reflect the scope, quality, and character of the work to be performed; all miscellaneous materials and work required for a complete and operational system, though not specifically mentioned, shall be furnished and installed by the Contractor.

B. The Contractor shall confirm sizes, dimensions, weights and locations of all devices, light fixtures, and equipment prior to installation. Dimensioned architectural drawings shall take precedence over diagrammatic layouts shown on these contract documents.

C. The Contractor shall be responsible for reporting any discrepancies, errors, or omissions regarding the Laboratory Electrical drawings noted prior to bid.

D. It is the intent of the drawings to indicate schematic routing and placement of devices, fixtures, equipment and conduit. Exact locations shall be dimensioned on other trade documents (architectural, laboratory furnishings,
1.3 QUALITY ASSURANCE AND STANDARDS

A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.

B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications, and supplements, of the following codes and standards or other regulations which may apply:

1. American Disabilities Act (ADA)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Institute of Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronics Engineers (IEEE)
6. Local Code Enforcement Agency Requirements
7. National Electrical Code (NEC)
8. National Electrical Contractor’s Association (NECA)
9. National Electrical Manufacturer's Association (NEMA)
10. National Electrical Testing Association (NETA)
11. National Fire Protection Association (NFPA)
12. Underwriters’ Laboratories, Inc. (UL)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, Architect, and Owner's Representative by the Contractor.

C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.

D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.

E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The
actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the Contractor.

1.4 SUBMITTALS

A. Shop drawings for materials, equipment, devices, fixtures, and systems shall be submitted by the Contractor for review in compliance with the requirements of Division 1 and Division 26.

B. The Contractor shall bear the responsibility for any materials installed which were not submitted for review or not installed in compliance with the review comments and the contract documents.

C. Verbal modification of submittal documents or changes to the requirements of the contract documents shall not be acceptable. All submittal material must be documented in a written format.

D. All submittal packages must be submitted at one time and in accordance with the specification section appropriate for the material. All packages must be identical and clearly labeled indicating the specification section, project name, submittal date, Contractor's name, Engineer's name, preparer's name and submission version (first submission, resubmittal #1, etc.)

E. Product catalog cutsheets and descriptive literature shall be cross-referenced to the specification section by paragraph.

F. All submittal packages shall be permanently bound in brochure or booklet format. A minimum of six submittal booklets shall be provided by the Contractor; additional copies may be required if so noted.

G. Materials which bear a certification or approval of a testing agency, performance criteria, society, agency, of other organization shall be submitted with all labels identified.

H. The submittal shall be complete and with catalog data and information properly marked to show, among other things, materials, capacity and performance data to meet the specified requirements.

I. Incomplete submittals will be rejected at the discretion of the reviewing Engineer.

J. Review of the submittal is for general conformance with the contract documents. The Contractor is responsible for confirmation and coordination of dimensions, quantities, sizes, fabrication, installation methods, and for coordination of work of other trades with the electrical work.
K. Submittal brochures shall be complete and descriptive of the type, make, manufacturer, application, quantity, performance, capacity, ratings, options, dimensions, clearances, weights, nameplate data, special installation requirements, mounting method, NEMA type, NEMA class, environmental restrictions, layout requirements or other information as may be necessary for review of the material.

L. The Contractor shall be responsible for all aspects of substitutions of material including any additional cost or delay incurred as a result of the substitution. The Contractor shall coordinate all substitutions with other trades, verify code compliance, verify clearances, photometric performance, appearance, suitability, constructability, and availability of the material prior to submitting the substitution for review. The Contractor shall bear the responsibility of any increased costs to other trades which are directly related to the substitution.

M. Submittals shall include the following:

1. Raceways
2. Wire and Cable
3. Boxes
4. Wiring Devices
5. Disconnect Switches

N. Submit detailed dimensioned drawings for all multi-outlet surface raceways.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be new, of prime quality, listed as suitable for the application, and bear factory-applied U.L. labels.

B. Materials shall be currently in production and shall be supported by spare parts, repair service, maintenance, and factory technical support

2.2 RACEWAYS

A. Electrical Metallic Tubing (EMT)

1. Conduit shall be cold rolled zinc coated steel and manufactured per UL and ANSI requirements.
2. Fittings for EMT shall be watertight steel or malleable gripping ring compression type.
3. Pressure cast material for nuts of compression ring type fittings and setscrew connections are not acceptable.
4. Minimum raceway size shall be ¾”.

B. Flexible Metallic Conduit

1. Flexible conduit shall bear the UL label and be zinc-coated steel.
2. Fittings for flexible metallic conduit shall be steel or malleable iron. Fittings shall clamp to conduit securely.
3. Screw in type, sheet metal or set-screw type fittings are not acceptable.
4. Minimum raceway size shall be ¾”.

C. Liquid Tight Flexible Conduit

1. Conduit shall be manufactured in accordance with UL and ANSI requirements. Conduit shall be approved for grounding and compatible with approved fittings. Flexible steel conduit shall be hot dipped galvanized with extruded PVC covering manufactured per UL requirements.
2. Fittings shall be liquid tight type with body and gland nut of steel or malleable iron with provisions for grounding flexible conduit to fittings.
3. Minimum raceway size shall be ¾”.

D. Polyvinyl Chloride (PVC) Conduit

1. PVC shall be constructed of a virgin homopolymer PVC compound and be manufactured according to NEMA and UL specifications. PVC conduit shall be Schedule 40 or 80.
2. Minimum raceway size shall be ¾”.

E. Multi-outlet Surface Raceways

1. Multi-outlet surface raceways shall be furnished complete with bases, covers, end plates, connectors, wiring devices, receptacles, connectors, and labels as indicated on the drawings and in these specifications. The multi-outlet surface raceways may be factory or field assembled.
2. Mounting of multi-outlet surface raceways shall be according to the manufacturer’s recommendations and detailed drawings. Specific fitting of the multi-outlet surface raceways to casework, benches, or walls shall be the responsibility of the Contractor. Coordinate elevations with Laboratory Furnishings drawings and details.
3. Refer to the Laboratory Furnishings drawings and specifications for details in regard to the location, length, and quantity of multi-outlet surface raceways.
4. Multi-outlet surface raceways shall fit the intended space with no more than 1/8 inch clearance between each end of the raceway and the adjacent wall, bench, support riser, end of counter, or other laboratory finish as appropriate.
5. Final multi-outlet surface raceway cuts shall be plumb and straight and shall be finished to eliminate burrs, nicks, or sharp edges on both raceways and covers. Multi-outlet surface raceway field cuts which are not equal to the quality and appearance of the factory cuts will be rejected at the discretion of the Laboratory Engineer or Architect.
6. Provide end plates with conduit knock-outs for the conduit sizes indicated or as required by code.
7. All receptacles in multi-outlet surface raceways shall be wired for the entire length of the raceway section with properly tagged pigtail.
8. The multi-outlet surface raceways shall be U.L. listed assemblies.
9. Multi-outlet surface raceway bases, covers, and end plates shall be constructed of extruded aluminum with 0.094" minimum thickness walls and clear anodized finish. The multi-outlet surface raceway extrusion shall be rectangular in cross section and have no protrusions.
   a. Dual channel raceways shall be two compartment, factory pre-wired Wiremold AL4520 series, Monosystems SWA 4800 series, or equal. A continuous, permanently installed metallic barrier shall separate the compartments.
   b. Single channel raceways shall be one compartment, pre-wired Wiremold ALA3800 series, Monosystems SWA 3200 series, or equal.
10. Multi-outlet surface raceway covers shall be cut in 12-inch sections with one "filler" section of less than 12 inches at only one end of each run of raceway as required. Receptacle or telecommunications port locations shall only be provided on a 12-inch cover section.
11. Do not scale or dimension Laboratory Electrical drawings to determine raceway lengths. Laboratory Furnishings drawings should be used for this purpose.
12. Provide labeling with panel and circuit number at each receptacle installed in the raceway. Labels may be either engraved phenolic affixed with epoxy, or engraved directly on raceway cover plate. Phenolic labels shall be black with white lettering for normal power receptacles and red with white lettering for standby or emergency power receptacles. Engraved cover plate labels shall have black lettering for normal power receptacles or red lettering for standby or emergency power receptacles.

2.3 WIRE AND CABLE

A. Conductors shall be copper; conductors size #10AWG and smaller shall be solid, conductors size #8AWG and larger shall be stranded. Conductors shall be minimum size #12AWG for power and lighting circuits; control circuits shall use a minimum conductor size of #14AWG.
B. Insulation shall be type THW or THHN/THWN for all branch circuits up to and including size #2AWG. Insulation for conductors over size #2AWG shall be XHHW.

C. Jackets shall be nylon or PVC material.

D. All cables shall be UL listed for the application.

E. All conductors shall be installed in conduit in the field, unless specifically noted otherwise in these documents. Type AC and type NM cable are not acceptable; type MC cable may be used where specifically noted for purposes of flexibility, maintenance, or ease of installation but shall not be used without explicit permission and direction of the Engineer.

F. Multi-conductor flexible cords shall be types SO, SJO, STO, or SJTO.

G. Connectors shall be UL listed and suitable for the conductor material being connected and rated appropriately. Connectors shall be solderless helical metal spring pressure type or solderless finger metal spring barb type for conductors #10AWG and smaller. Connectors shall be compression type for conductors #8AWG and larger.

2.4 BOXES

A. Boxes shall be flat rolled steel sized as required by code and as suitable for the application. Boxes shall have mounting holes and knock-outs in sides and back. Grounding shall be accommodated by means of threaded holes.

B. Provide accessories, extension rings, gaskets, supports, trim rings, hangers, straps, and other material as necessary for a complete code complying installation.

C. Boxes installed outdoors shall be weather-tight, dust-tight, and corrosion resistant. Provide gaskets and conduit hubs.

D. Provide Type FS boxes for surface mounted applications.

E. Provide additional support for boxes as necessary when mounting fixtures or devices from boxes.

F. Provide ganged boxes for multiple switches and devices; provide barriers for boxes served by separate voltages.

2.5 WIRING DEVICES

A. Receptacles
1. Wiring devices shall be UL listed and suitable for the application.
2. Devices shall be color coded per the system to which they are connected: normal power shall be white; standby or emergency power shall be red; dedicated outlets shall be grey; unless otherwise noted on the construction documents.
3. Receptacles shall be heavy duty, screw type, side wired, 120V, 20A, duplex type, unless noted otherwise on the construction documents. Verify NEMA configuration with construction documents.
4. Weathertight receptacles shall be gasketed in cast metal boxes with cast metal coverplates with spring-loaded hinged covers over each opening.
5. Ground fault interrupting receptacles shall be duplex type and capable of detecting a leaking current of 5mA.

B. Toggle Switches

1. Toggle wall switches shall be quiet AC type, rated 120/277V, 20A and UL listed for the application.
2. Switches shall be single pole, double throw with white finish unless noted otherwise.

C. Coverplates

1. Single, combination coverplates shall be used at all ganged device locations.
2. Provide stainless steel coverplates with matching screws in laboratory, process, manufacturing, and clean room areas or as noted on the construction documents.
3. Provide labeling with panel and circuit number at each receptacle coverplate. Labels may be either engraved phenolic affixed with epoxy, or direct factory engraving on the coverplate. Phenolic labels shall be block with white lettering for normal power receptacles and red with white lettering for standby or emergency power receptacles. Engraved cover plate labels shall have black lettering for normal power receptacles or red lettering for standby or emergency power receptacles.

2.6 POWER AND TELECOMMUNICATIONS PEDESTALS

A. Manufacturer

1. Design is based on Hubbell Wiring Devices specialized services pedestals with 1" hub, two-gang catalog number SA6686 and four-gang catalog number SA6688.
2. If alternate product is to be submitted, all material and functional requirements of the specified product must be demonstrated and documented to be equal.
B. Pedestals shall have aluminum housing with integral pedestal base, containing devices as shown on drawings. Housing finish shall be brushed.

C. Faceplates

1. Pedestal receptacle faceplates shall be stainless steel, and shall accommodate the device types and quantities indicated on the drawings. Faceplates shall be have engraved labeling with requirements as noted for raceway and coverplate labels.

2. Pedestal telecommunication faceplates shall be stainless steel, and shall be provided with cutouts specifically designed to accommodate the type of tel/data devices to be installed by the telecommunications/data system installer. Coordinate prior to ordering faceplates.

2.7 DISCONNECT SWITCHES

A. Disconnects shall NEMA 1, indoor type, or rated for the locations in which they are installed as noted on the construction documents.

B. Disconnects shall be UL listed and suitable for the application.

C. Disconnects in exterior, wet, cold, warm, or hot environments shall be raintight, have raintight hubs, and be rated NEMA 3R.

D. Disconnects shall be heavy duty type, rated 600V with current capacity as noted on the construction documents. Verify NEMA configuration with construction documents.

E. Disconnects shall have hinged, lockable, dead-front doors with permanently marked ON/OFF indicators. Enclosures shall be baked enamel factory painted steel with conduit knockouts.

F. Disconnects shall be operated by a handle accessible from the exterior of the enclosure. Handles shall have provision to be padlocked in the OFF position.

G. All current carrying parts shall be high conductivity copper designed to carry rated load without damage from heat and plated to resist corrosion.

H. Switch mechanism shall be a quick-make, quick-break type such that the operation of the contact is restrained by the handle during the closing or opening operation.

I. Switches shall have a minimum fault current rating of 200,000A RMS.

J. All switches shall be fused unless specifically noted otherwise.
K. The disconnect door cover shall have an interlocking mechanism to prevent opening the cover when the switch is in the ON position.

L. Fuses serving motor loads shall be Class L and Class RK1, 250V and 600V, time delay, dual element unless noted otherwise on the construction documents.

M. Fuses serving non-motor loads shall be Class L and Class RK1, 250V and 600V, fast acting, dual element unless noted otherwise on the construction documents.

N. Provide built-in fuse pullers.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. All laboratory electrical work shall conform to National Electrical Contractors Association standards of installation and the requirements of the manufacturer, Division 1, Division 26, and the Owner’s Representative.

B. The Contractor shall field-verify all dimensions and coordinate dimensions with equipment sizes and locations.

C. The Contractor shall coordinate and install all penetrations, openings, slots, chases, or sleeves as necessary for the routing and installation of laboratory electrical equipment. The Contractor shall provide approved fire sealant to maintain fire ratings at all penetrations.

D. The Contractor shall coordinate and cooperate with all other trades for a successful completion of the laboratory electrical work.

E. The Contractor shall install access panels in walls or ceilings in coordination with the Architect for all laboratory electrical equipment, which require access.

F. All laboratory electrical equipment shall be installed plumb, parallel, or orthogonal to structure and in a neat orderly fashion. All material shall be accessible for maintenance, inspection, servicing or replacement.

G. Verify final locations for laboratory electrical devices and equipment during the rough-in phase with dimensioned architectural drawings, fabrication drawings, or other space planning requirements included in the contract documents.

H. The Contractor shall provide adequate and qualified supervision for the work performed; no work shall be performed without the supervision of a representative of the Contractor.
3.2 GROUNDING AND BONDING

A. Special Cabinets

1. At all flammable materials storage cabinets, solvent storage cabinets, corrosive storage cabinets and gas safety cabinets, provide a (minimum) #12 AWG copper, insulated green grounding conductor from the equipment grounding conductor of the nearest available 120 volt circuit outlet box.

2. Extend cabinet bonding conductor from the nearest circuit outlet box via ½" conduit concealed in wall and stubbed out behind the respective cabinet. Conduit shall be converted to flexible metal conduit where exposed, and shall terminate with a UL listed bushing. Where indicated on the drawings, provide a flush wall box with cover plate (with grommeted hole, ½" diameter) and extend bonding conductor from wall box to equipment terminal.

3. The bonding conductor shall be secured to the bonding terminal of the cabinet. If the cabinet is not equipped with a bonding terminal, provide a UL listed screw terminal and permanently secure it to the metallic cabinet with a screw, lockwasher and bolt. Self-tapping sheet metal screws will not be accepted as the means of attachment.

4. Refer to the Lab Furnishings (LF) specifications and drawings for cabinet specs, details, quantities and locations. Bonding shall be provided at each cabinet whether or not specifically indicated at each cabinet location.

B. Grounding Bus at Storage Rooms

1. Where indicated on the drawings, provide copper bus bar assemblies, wall mounted on insulator bushings, secured to the building framing structures.

2. For each area containing a ground bus bar system, provide a dedicated conduit homerun to the respective branch circuit panel serving the area. Install an insulated copper grounding conductor (green color).

3. Provide listed fittings, nuts, bolts, connectors and miscellaneous hardware for a complete ground bus system.

3.3 COMMISSIONING

A. The Contractor shall initiate start up of all laboratory electrical equipment including operation of all devices, switches, overcurrent protection, disconnect switches, etc. to verify normal operation of all moving parts and electrical performance.

B. The Contractor shall test, adjust, align, label, clean and complete all systems prior to acceptance by the Owner's Representative.
C. The Contractor shall demonstrate that all systems operate within the manufacturer’s recommended performance characteristics, the laboratory electrical construction documents, system requirements, and Owner requirements.

D. The Contractor shall test each laboratory electrical system per the manufacturer’s requirements and shall perform the following system tests:

1. Inspect cables for physical damage and proper connection.
2. Torque test cable connection and tighten in accordance with termination manufacturers recommendations.
3. Infrared scan all connections under loaded conditions and provide color printed images.
4. Insulation resistance test of each cable.
5. Inspect ground system connections.
6. Voltage drop tests on the main grounding electrode of system.
7. Determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral points.
8. Check rated voltage and phase balance at all equipment, motors and selected devices at full load conditions. Measure no load voltage conditions at each location.
9. Furnish all material, equipment, instruments and labor as required to complete testing.
10. Provide all test results properly bound in a three-ring binder.

3.4 CLEANING

A. Contractor shall clean all equipment, conduit interiors, fixtures, devices, etc. of all extraneous paint, drywall mud, overspray, dust, dirt, debris, trash, grease or markings. All cleaning shall be performed by the Contractor in accordance with the appropriate manufacturer’s recommendations.

3.5 RACEWAYS

A. EMT shall be run indoors concealed in drywall type construction, above suspended ceilings, or in utility chases at casework or lab benches. In unfinished indoor areas, EMT shall be run exposed no less than 8'0" above finished floor.

B. EMT shall not be installed underground or embedded in concrete.

C. Flexible conduit shall not exceed 6'0" in length.

D. Flexible conduit used for final connection to laboratory equipment shall not exceed 2'0" in length.
E. The conduit grounding system shall be continuous as recommended by the manufacturer and UL approved.

F. Liquidtight flexible conduit shall be used for final connection to machines, motors, transformers and equipment that requires vibration isolation.

G. Liquidtight flexible conduit shall be used for final connection to equipment in wet or damp locations or where exposed to grease, water, dust, dirt, pathogens, vapors, or chemicals.

3.6 WIRE AND CABLE

A. All wiring methods shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.

B. Conductors shall be installed in clean raceways using nylon cord, polypropylene cord, hemp rope, or other material, which will not damage the conductors or conduit. Do not use metal fish tape. Use lubricant when necessary for pulling.

C. Conductors shall be pulled into conduit simultaneously so as to not damage conductors during pulling.

D. Conductors installed at outlets and switches shall have a minimum of 6" pigtail left in the box for future connections. All conductors not connected to devices shall be terminated with splice caps and tape.

E. Conductors shall be terminated such that no copper material is exposed. Conductors shall be trained and labeled at terminations in a neat and workmanlike manner.

F. All terminations shall be mechanically sound, featuring helical twisting of the terminating conductors prior to the application of an electrical connector. The electrical connector shall not be used for the mechanical connection of the conductors.

G. All terminations shall comply with the manufacturer’s installation and torquing requirements.

H. Splices on conductors #10AWG and smaller shall be made with splice caps twisted onto the conductors. Tape all splices.

I. Splices on conductors #8AWG and larger shall be made with pressure connectors and terminal lugs. Where exposed to water, damp air, or moisture, splices shall be watertight.
J. Splices shall not be made in feeders; splices to branch circuits shall not be made within panelboards or similar enclosures.

K. When combining homeruns, the Contractor shall derate all conductors per code requirements including reducing the ampacity, using high temperature insulation where necessary. Conduit sizes shall be adjusted by the Contractor as suitable for the conductor revisions.

L. The Contractor shall provide a code-sized insulated ground conductor, in addition to the feeder conductors indicated on the drawings, where non-metallic conduit is used.

M. Conductors shall be color-coded as follows or as matches the building standard:

<table>
<thead>
<tr>
<th>208Y/120V</th>
<th>Phase</th>
<th>480Y/277V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>Red</td>
<td>B</td>
<td>Orange</td>
</tr>
<tr>
<td>Blue</td>
<td>C</td>
<td>Yellow</td>
</tr>
<tr>
<td>White</td>
<td>Neutral</td>
<td>Gray</td>
</tr>
<tr>
<td>Green</td>
<td>Ground</td>
<td>Green</td>
</tr>
</tbody>
</table>

N. Where tape or labels are used for color-coding, apply material at each end of the conductor, splices, boxes, and all terminations.

3.7 BOXES

A. All box installation methods shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.

B. Install all boxes plumb, square, and securely fastened to structure.

C. Boxes shall be placed such that they are readily accessible.

D. Cover or plug all unused openings in boxes where knockout blanks have been removed.

E. Install boxes such that they are flush with the finished surface of the wall or surface within which they are mounted.

F. Install all boxes at mounting heights per architectural, electrical code, and ADA requirements.

G. Boxes shall not be mounted back to back in walls.
H. Boxes in sealed environments shall be sealed with an approved sealant suitable for the application.

I. Boxes penetrating fire rated walls or surfaces shall be sealed with a Fire Marshal approved fire sealant to maintain the fire rating of the wall or surface.

J. Boxes located above inaccessible ceilings shall be made accessible by means of access doors or hatches in the ceiling.

K. Install all boxes per manufacturer’s recommendations and requirements.

L. Provide for ground continuity at all boxes.

3.8 WIRING DEVICES

A. Installation methods for wiring devices shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.

B. Install all devices in accordance with the manufacturer’s recommendations and requirements.

C. Coordinate device mounting height, location and type with architectural and interior drawings. Coordinate with other trades to identify conflicts with device locations and notify the Engineer of any conflicts.

D. Install devices only in clean boxes.

E. Install all trim rings and coverplates in coordination with other trades and their installation schedules.

F. Tighten and inspect all connections prior to covering devices and reconnect or repair wiring as necessary.

G. Test all devices for voltage level, continuity, ground fault, and short circuits.

H. Install all devices plumb and square to structure and adjacent surfaces.

I. Connect and inspect all ground bonds prior to covering device.

J. Demonstrate the proper operation of all ground fault interrupting devices.

3.9 DISCONNECT SWITCHES

A. Installation methods for disconnects shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.
B. Install all disconnects in accordance with the manufacturer's recommendations and requirements.

C. Coordinate disconnect mounting height, location and type with architectural and interior drawings. Coordinate with other trades to identify conflicts with device locations and notify the Engineer of any conflicts. Mount switches 42" above finished floor unless noted otherwise.

D. Provide suitable galvanized metal strut framework where no wall or structure is available for the mounting of disconnects.

E. Provide flexible conduit connections for disconnects mounted to strut framework, motors, or vibrating equipment.

F. Tighten and inspect all connections and reconnect or repair wiring as necessary.

G. Test all disconnects for voltage level, continuity, ground fault, and short circuits. Check switch mechanism operation under no load conditions prior to operating under load.

H. Install all disconnects plumb and square to structure and adjacent surfaces.

I. Provide and install all fuses sized per the equipment manufacturer's recommendation.

END OF SECTION 266000
SECTION 271100 – TELEPHONE SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Work included in this Section: Materials, equipment, fabrication, installation and tests for the following:

1. Telephone conduits, boxes and outlets.
2. Horizontal cables for telephone signals.

1.2 SUBMITTALS

A. Crossconnect patch panels and termination blocks at IDF racks.
B. Outlets and connectors for station cables.
C. Workstation cables.

PART 2 – MATERIALS

2.4 TELEPHONE OUTLETS (single station, non-combination outlets)

A. Provide single-gang outlets. Where instruments are to be wall-mounted, provide mounting studs on the faceplate. Faceplates are to be ivory or white, to match existing. Combination outlets (with data connectors) are specified in Section 16730: Structured Data Cabling Plants.

2.1 HORIZONTAL CABLES

A. Provide workstation cables as specified on the drawings.
B. All horizontal cable shall be plenum rated and shall be installed without bridges, splices or taps.

2.2 CROSS-CONNECTS AND TERMINATIONS

A. Provide patch panels for all telephone cable pairs at the telecom terminal boards. Patch panels shall be Panduit CPPLA48WBLY or approved equal. Provide CAT 5E jack for each outlet indicated on drawings.
PART 3 – EXECUTION

2.1 GENERAL

A. Provide all terminations required for a full and functioning system.

B. Provide identification of cables and pairs at all termination points in accordance with the requirements of the EIA/TIA national standards. The cable management and identification protocol for this section shall be coordinated and compatible with that of the data cabling systems described in Section 271500: Structural Data Cabling Plants.

C. Provide written results of the tests of the cable pairs after installation with a record of pass/fail for each pair.

D. Provide the Owner with three copies of the cable management and record plan.

**End of Section**
SECTION 271500 – STRUCTURED DATA CABLING PLANTS

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Work included in this Section: Materials, equipment, fabrication, installation and tests for the following:

1. Data raceways, boxes and outlets.
2. Horizontal cabling.
3. Terminations and cross connects at patch panels for data system cabling.
4. Equipment racks and/or frames.
5. Cable testing.
6. Cable tray.

1.2 CODES AND STANDARDS

A. PCC's telecommunications infrastructure standards shall generally follow the applicable standards and technical service bulletins published by the Electronic Industry Association/Telecommunications Industry Association (EIA/TIA). The specific EIA/TIA standards are indicated in sections within this document. While the EIA/TIA standards are considered the primary standards, standards from other organizations such as Underwriter's Laboratory and the American National Standards Institute may also apply.

B. All pertaining statutes, ordinances, rules, codes, regulations, standards, and the lawful orders of all public authorities having jurisdiction over the construction of telecommunications cable systems shall be followed in the design and installation of new cable systems. These include, without limitation, applicable building codes, handicapped regulations, municipal codes, fire codes, State Statutes and the regulations of the Occupational Safety and Health Administration (OSHA) unless superseded by State Statute or local law.

C. All work shall conform to all local codes and ordinances, as applicable. ANSI/TIA/EIA-568-A and ANSI/TIA/EIA-569-A shall be adhered to during all installation activities. Methodologies outlined in the latest edition of the BICSI Telecommunications Distribution Methods Manual shall also be used during all installation activities. Should conflicts exist with the foregoing, the authority having jurisdiction for enforcement will have responsibility for making interpretation.

1.3 SUBMITTALS
A. Cable tray system.

B. Equipment frames.

C. Termination, cross connect and cable management components to be used at racks and/or frames.

D. Cables.

E. Station outlets and connectors.

1.4 QUALIFICATIONS

Construction projects require the use of a Registered Communications Distribution Designer (RCDD\textsuperscript{®}) with a current Building Industry Consulting Service International (BICSI) registration, either on staff or on acting as a consultant to the contractor or sub-contractor, who will be ultimately responsible for the design, installation and Warranty of this project. The RCDD\textsuperscript{®} must have sufficient experience in this type project as to be able to lend adequate technical support to the field installers/technicians during installation, during the warranty period, and during any extended warranty periods or maintenance contracts. The RCDD\textsuperscript{®} must be present at the beginning and end of each phase and physically conduct project walkthroughs at these times. Registered Communications Distribution Designer (RCDD) with a current Building Industry Consulting Service International (BICSI) registration.

The selected cable contractor shall be fully capable and experienced in the installation of telecommunications cable plant. To ensure the system has continued support, PCC will contract only with vendors having a successful history of sales, installation, service, and support. During the evaluation process, PCC may, with full cooperation of the vendor, visit vendors' places of business, observe operations, and inspect records. The vendor must have a minimum of three (3) years of experience.

A resume of the responsible RCDD\textsuperscript{®} must be attached to vendor response for evaluation by PCC. Should the RCDD\textsuperscript{®} assigned to this project change during the installation; the new RCDD\textsuperscript{®} assigned must also submit a resume for review by PCC.

If, in the opinion of PCC, the RCDD\textsuperscript{®} does not possess adequate qualifications to support the project, PCC reserves the right to require the contractor or sub-contractor to assign a RCDD\textsuperscript{®} who, in PCC's opinion, possesses the necessary skills and experience required of this project.
The vendor must also be an approved Panduit Partner with the ability to receive a Panduit Warranty. A copy of their Panduit Certification must be submitted to the general contractor or sub-contractor.

PART 2 – MATERIALS

2.1 Telecommunication Closet / Equipment Rooms

A. Wire management shall include one (2) 2-position wire management panel for each 48 ports and not less than two (4) panels per rack. Wire management panels shall be Panduit wire manager part# NCMH2 or equal. Vertical wire management shall be dual channel #PRV8 with 2 doors each part #PRD8 or equal, placed between all racks. In a single rack application, two side vertical wire management is required.

B. Patch panels are to be Panduit part # CPPLA48WBLY. The outlets shall be terminated on the patch panels in the rack in order from lowest to highest workstation number, left to right, top to bottom as follows:

The workstation red outlet (#1) shall terminate in the patch panel starting at the top of the rack in the position right of the leftmost hole.
The workstation blue outlet (#2) shall terminate in the patch panel’s next hole.
The workstation yellow outlet shall terminate on a separate patch panel.

D. Spare patch panel outlets shall be installed to provide for a minimum of fifteen (15) percent growth.

F. Provide video system signal taps that are two (2), four (4) or eight (8) port design as required, that are powder-coated for corrosion protection and that are fitted with moisture and RF gaskets to prevent moisture ingress and radio frequency leakage. Taps shall be Scientific-Atlanta #SAT2F-XX, #SAT4F-XX or #SAT8F-XX (or approved equal) as required, where “XX” equals the specified value of the tap required.

G. Provide video system amplifiers, Blonder Tongue #BIDA 750 or approved equal, with a nominal gain of 45 dB as required to maintain signal levels.

2.2 Inside Plant Cabling and Requirements - Horizontal

A. Install cables with two (2) feet (609 mm) of slack at each outlet or at the entrance of the conduit.

B. Remove all existing cabling which is not reused from patch panel to removed outlet.
C. Keep cables eighteen (18) inches (457 mm) away from EMF-producing fixtures, transformers, etc. Where the distance cannot be maintained, install cables in metallic conduit. Support free-run cables at distances not exceeding five (5) feet (1.5 m).

D. Use tubular cable runway or eighteen (18) inch (457 mm) wide cable tray, routed above corridor ceilings, supported by wall brackets or hanger rods.

E. Provide one (1) 1-inch empty conduit stub from information outlets up to an accessible above-ceiling location. Outlet boxes in hard-walled office areas and junction boxes serving modular furniture systems shall be four (4) inches x four (4) inches and as deep as possible with double-gang rings.

F. Provide 4-pair extended frequency Category 5E cables to each data and voice jack. Quantities of jacks and cables shall be per plan.

G. Provide voice and data cables with 24 AWG solid copper insulated conductors formed into individually twisted pairs and enclosed by a plenum jacket. The cable shall be intended for use in gigabit ethernet applications and include the factory test report. The cable must maintain an impedance of 100 ohms across the entire frequency spectrum. Horizontal cable shall be certified to meet or exceed the electrical performance specifications being established for Category 5E as specified in EIA/TIA Technical Systems Bulletin TSB-36.

Category 5E cable installation and termination practices shall be in compliance with EIA/TIA Technical Systems Bulletin TSB-40 and TSB-95.

I. Horizontal cable will be plenum rated and must be classified as meeting the low flame spread and smoke producing characteristics of the National Electrical Code, Section 800-3(d)(b), as determined by the Underwriter's Laboratories.

J. Install horizontal cable without bridges, splices, or taps.

K. All newly installed telecommunications conduits shall be used to support and protect communications cabling only. Under no circumstances shall line voltage electrical cabling be located within any conduit used to route communications cabling.

L. No section of conduit shall contain more than three (3) 90 degree bends between pull points or junction/pull boxes.

M. Video drop cables from telecommunications closets to individual outlets in rooms shall be RG-6 with 18 AWG solid copper clad steel conductor, 0.170 inch foam
FEP dielectric, aluminum foil and 90% aluminum braid outer conductors with 21.0 Ω/Km nominal DC resistance, insulated with polyvinylidene fluoride (plenum rated) jacket as required. Nominal capacitance shall be 50±3.0 pF/km, nominal impedance shall be 75 Ω and nominal velocity of propagation shall be 82%. Cable shall be installed in continuous sections without splices. Special care shall be taken to prevent any kinks from occurring that would render the affected section useless. Connectors for drop cables shall be Gilbert #GABNC6AHS322L or approved equal.

2.3 Information Outlets

A. All information outlets will be of a modular design that will allow for the easy transition to other connector types if needed in the future. Provide 4-pair extended frequency Category 5E cable to each data and voice jack.

B. Voice jack in the information outlets will be EIA/TIA standards call for all eight (8) conductors in the four (4) pair cables to be terminated on a single eight (8) position/eight (8) conductor jack in the information outlet.

Voice Jack Configuration Summary:

Voice jacks in the information outlets shall be equipped with EIA/TIA Category 5E jacks configured identically to the data outlet. All eight (8) conductors in the four (4) pair data cable will be terminated on the first voice jack in accordance with the EIA/TIA standard using the 568B pinning sequence. The jacks are to be yellow in color and number with the same number as the other end patch panel number.

C. Data jacks in the information outlets shall be equipped with EIA/TIA Category 5E jacks configured identically to the information outlet. All eight (8) conductors in the four (4) pair data cable will be terminated on the first data jack in accordance with the EIA/TIA standard using the 568B pinning sequence. An additional four (4) pair cable shall be installed and terminated on the second data jack. All eight (8) conductors of the second data cable will be terminated on the second data jack using the EIA 568B pinning sequence.

Data Jack Configuration Summary:

Eight-conductor (RJ-45) Category 5E non-keyed jacks with EIA/TIA 568B pinning sequence. Four (4) pair UTP workstation cable shall supplied to each jack.

D. The wiring sequence in the jacks shall not be altered or reconfigured except to match the standards detailed above. Under no circumstances should it be necessary to rewire a jack to accommodate a specific manufacturer's equipment. If
any equipment requires a non-standard wiring sequence, the adaptation shall be
made with customized drop and patch cords or modular to modular adapters.

E. The outlet labeled #1 is red, #2 is blue, #3 is red, #4 is blue, #5 is red, #6 is blue,
#7 is red, #8 is blue.

F. Information outlets in new construction or renovations require a four (4) inch
square deep box.

G. Video outlets shall be ModTap single-gang bezel with one (1) #17-51-V-0
connector or approved equal. The faceplate should match the color of the other
information outlets in the room.

2.4 Basic Pathway Materials and Requirements

A. Conduits - Above Grade

1. Minimum conduit size shall be 1-inch. Conduits shall be routed parallel or
perpendicular to the building lines. No diagonal runs will be permitted.

2. Conduits two (2) inches (50 mm) and smaller shall be steel EMT. The
EMT shall be galvanized on the outside and coated on the inside with a smooth,
hard finish of lacquer, varnish or enamel and shall comply with UL Standard
UL797 and ANSI C80-1. EMT couplings and box connectors for EMT shall be of
the steel compression gland type.

3. Conduits 2 ½ inches (64 mm) and larger shall be rigid galvanized steel
(RGS). RGS conduit shall be hot-dipped galvanized steel with zinc coating or
corrosion resistant lacquer on the inside, and shall comply with UL Standard UL6
and ANSI C80-1. Fittings shall be threaded, water and concrete-tight.

4. All conduits subject to mechanical injury or exposed to the elements shall
be rigid galvanized steel.

5. Conduit from a workstation that does not run home to the
telecommunications closet but rather is specified as a stub out above a lay-in tile
ceiling shall include a gentle sweep toward the proposed TC, a connector and
bushing.

6. Where conduits are not contiguous from workstation to closet, cables must
be supported in an approved method (J-hooks or cable tray system) every five
(5) feet (1.5m).
7. Raceways and conduits passing through fire barriers shall be fire stopped in accordance with all NFPA codes. Fire stopping rating shall match the rating of the wall being penetrated, but at a minimum be rated for one (1) hour.

B. Junction and Pull boxes

1. Boxes shall be of the size required by the National Electrical Code or larger in size. Except as noted on the Drawings, or as hereinafter specified, boxes shall be fabricated of galvanized code gauge steel and each shall be of a type approved for its particular location and purpose.

2. Junction boxes shall be four (4) inch square deep. Junction boxes shall have proper cover plates to match the surrounding environment. Junction boxes shall not open into finished areas unless specifically permitted by the Project Manager. If determined necessary for cable installation, additional pull boxes or junction boxes may be installed in unfinished areas or in concealed but accessible locations.

3. Where pull boxes larger than outlet boxes are required, galvanized code gauge sheet steel boxes may be used with covers attached by brass machine screws. Boxes exposed to the weather shall be approved for the purpose and conduit entrances on the side or top shall be made by means of Square D Company, or equal, interchangeable hub with gasket and adapter nut. Pull boxes exposed to the weather shall be gasketed and weatherproof.

PART 3 – EXECUTION

3.1 Category 5 Testing and Labeling

a. Test equipment shall be suitable for certifying all EIA/TIA 568A Addendum 5 specifications. Performance requirements for testers will meet the level II-E accuracy. Contractor shall provide proof of current factory calibration of all test equipment.

b. Contractor shall provide a complete test plan, to the Project Manager, seven (7) days prior to the proposed test date, specifying capabilities and function to be tested. Tests shall be in accordance with TSB67 level II-E accuracy. All tests shall be forwarded to the Project Manager upon completion.
c. Contractor shall test and certify all new and retained existing station cable for all EIA/TIA 568A Addendum 5 Additional Transmission Performance Guidelines.

d. Contractor shall provide test reports in both booklet form and electronic flat ASCII file format.

e. Contractor shall provide a reproducible right reading sepia and one electronically formatted in the current release of Auto-Cad copy of floor plan as-built of communications, cableways, data and special circuit plans (on a separate layer compatible with PCC Facilities Planning backgrounds) to the Project Manager.

f. Contractor shall certify and warrant the complete system for operation at current EIA/TIA 568A 100 MHz specifications for a period of not less than ten (10) years.

g. Horizontal cable runs shall be identified at the workstation end of the cable according to the following scheme:

   CAMPUS - BUILDING - TELECOMMUNICATION CLOSET - PATCH PANEL JACKET

Example: DC-CC-IDF2-B-44 is at the Downtown campus in the CC building, IDF #2, patch panel 'B', in jacket 44.

3.2 Video Cabling Testing

a. Contractor will provide a complete test plan, to the Project Manager, seven (7) days prior to the proposed test date, specifying capabilities and function to be tested. All tests shall be forwarded to the Project Manager upon completion.

b. Contractor shall provide test reports, in both booklet form and electronic flat ASCII file format.

c. Contractor shall provide a reproducible right reading sepia and one electronically formatted in the current release of Auto-Cad copy of floor plan as-built of communications, cableways, data and special circuit plans (on a separate layer compatible with PCC Facilities Planning backgrounds) to the Project Manager.

d. Contractor will provide a system that will deliver a minimum signal level of +5dBmV for each television station outlet from 50mhz to 600mhz with a maximum slope of +/- 6dB.
After completion of the system installation and prior to connection to the source, the system shall be subjected to a standard sweep test. Deficiencies that are found should be corrected and the system re-tested prior to acceptance. Final operational acceptance testing will also include a demonstration in the presence of the project manager.

**End of Section**
SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

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. Electronic safety and security equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
5. Common electronic safety and security installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.
3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch
(25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### 3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 280500
SECTION 283100 - FIRE DETECTION AND ALARM

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. This Section includes fire alarm systems.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.
B. LED: Light-emitting diode.
C. NICET: National Institute for Certification in Engineering Technologies.
D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.
   1. Interface with existing fire alarm system.
B. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.
   1. Interface with existing fire alarm system.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.
B. Premises protection includes building construction and occupancy type.
C. Fire alarm signal initiation shall be by one or more of the following devices:

2. Heat detectors.
3. Smoke detectors.
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire standpipe system.

D. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
8. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
9. Record events in the system memory.
10. Record events by the system printer.

E. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.

F. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
G. System Trouble and Supervisory Signal Actions: Ring trouble bell and announce at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

   a. Trained and certified by manufacturer in fire alarm system design.
   b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

3. Device Address List: Coordinate with final system programming.

4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.

5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.


7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

9. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

10. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Qualification Data: For Installer.
D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 01 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.

2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

   a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.

   b. Electronic media may be provided to Architect, and authorities having jurisdiction.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Work of this Section be performed by a UL-listed company.

C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level II, III.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Owner's written permission.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment:
   a. Edwards Systems Technology Inc.
   c. Fire Control Instruments, Inc.; a GE-Honeywell Company.
   d. Fire-Lite Alarms; a GE-Honeywell Company.
   e. Gamewell Company (The).
   f. NOTIFIER; a GE-Honeywell Company.

2. Wire and Cable:
   a. Comtran Corporation.
   b. Helix/HITemp Cables, Inc.; a Draka USA Company.
   c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
   d. West Penn Wire/CDT; a division of Cable Design Technologies.

3. Audible and Visual Signals:
   a. Amseco; a division of Kobishi America, Inc.
   b. Commercial Products Group.
   c. Gentex Corporation.
   d. System Sensor; a GE-Honeywell Company.

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864 listed.
2. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Signaling Line Circuits: NFPA 72, Class A, Style 2, 5, 6, 7.
2. Signaling Line Circuits: NFPA 72, Class B, Style 0.5, 1, 3, 3.5, 4, 4.5.

   a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.

3. Notification-Appliance Circuits: NFPA 72, Class A, Style Z.
5. Actuation of alarm notification appliances, annunciation, and actuation of suppression systems shall occur within 20 seconds after the activation of an initiating device.
6. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel FACP indication and system reset if the alarm is not verified.
E. Notification Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41, 60 beats per minute, march-time pattern, 120 beats per minute, march-time pattern.

F. Elevator Controls: Heat detector operation shuts down elevator power by operating a shunt trip in a circuit breaker feeding the elevator.

G. Elevator Controls: Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shuts down elevators associated with the location without time delay.

1. A field-mounted relay actuated by the fire detector or the FACP closes the shunt trip circuit and operates building notification appliances and annunciator.

H. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

I. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

J. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.
L. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.

M. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.
1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

N. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including the same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

O. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

P. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
2. Battery and Charger Capacity: Comply with NFPA 72.

Q. Surge Protection:
1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

R. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include
interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, breaking-glass or plastic-rod, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:
   a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
   b. Piezoelectric sounder rated at 88 dBA at 10 feet (3 m) according to UL 464.
   c. Heat sensor, combination rate-of-rise and fixed temperature.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
   a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F (57 or 68 deg C).
   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
   1. Sensor: LED or infrared light source with matching silicon-cell receiver.
   2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Ionization Smoke Detector:
   1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
   2. Detector Sensitivity: Between 0.5 and 1.7 percent/foot (0.0016 and 0.0056 percent/mm) smoke obscuration when tested according to UL 268A.

D. Duct Smoke Detectors:
   1. Photoelectric Smoke Detectors:
      a. Sensor: LED or infrared light source with matching silicon-cell receiver.
      b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
   2. Ionization Smoke Detectors:
      a. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
      b. Detector Sensitivity: Between 0.5 and 1.7 percent/foot (0.0016 and 0.0056 percent/mm) smoke obscuration when tested according to UL 268A.
   3. UL 268A listed, operating at 24-V dc, nominal.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

7. Integral Visual-Indicating Light: LED type. Indicating detector has operated, and power-on status. Provide remote status and alarm indicator and test station where indicated.

8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

9. Each sensor shall have multiple levels of detection sensitivity.

10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.


2.5 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate-of-rise of temperature that exceeds 15 deg F (8 deg C) per minute, unless otherwise indicated.


2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).


2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
D. Continuous Linear Heat-Detector System: Consists of detector cable and
control unit.

1. Detector Cable: Rated detection temperature 155 deg F (68 deg C).
   Listed for "regular" service and a standard environment. Cable includes
two steel actuator wires twisted together with spring pressure, wrapped
with protective tape, and finished with PVC outer sheath. Each actuator
wire is insulated with heat-sensitive material that reacts with heat to allow
the cable twist pressure to short circuit wires at the location of elevated
temperature.
2. Control Unit: Two-zone or multizone unit as indicated. Provides same
   system power supply, supervision, and alarm features as specified for the
   central FACP.
3. Signals to the Central FACP: Any type of local system trouble is reported
to the central FACP as a composite "trouble" signal. Alarms on each
detection zone are individually reported to the central FACP as separately
identified zones.
4. Integral Addressable Module: Arranged to communicate detector status
   (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for
   system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a
   single-mounting assembly.

B. Bells: Electric-vibrating, 24-V dc, under-dome type; with provision for housing
   the operating mechanism behind the bell. Bells shall produce a sound-pressure
   level of 94 dBA, measured 10 feet (3 m) from the bell. 10-inch (254-mm) size,
   unless otherwise indicated. Bells are weatherproof where indicated.

C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the
   operating mechanism behind a grille. Horns shall produce a sound-pressure
   level of 90 dBA, measured 10 feet (3 m) from the horn.

F. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or
   nominal white polycarbonate lens mounted on an aluminum faceplate. The
   word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output: 110 candela.
2. **Strobe Leads:** Factory connected to screw terminals.

G. **Voice/Tone Speakers:**

1. UL 1480 listed.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Mounting: Flush, semirecessed, or surface mounted; bidirectional as indicated.
5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.7 **SPRINKLER SYSTEM REMOTE INDICATORS**

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 **MAGNETIC DOOR HOLDERS**

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.9 **REMOTE ANNUNCIATOR**

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 SYSTEM PRINTER

A. Listed and labeled as an integral part of the fire alarm system.

2.12 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.


1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet (9 m), the rating of the detector.
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

E. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

L. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph (160-km/h) wind load with a 1.3 gust factor without damage.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.
D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.
3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
   a. Include the existing system in tests and inspections.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
   a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.
B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 283100
SECTION 321000 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Geotechnical Engineering Report prepared by Terracon dated January 18, 2012, Project No. 63115087, are included following this specification for reference of the Contractor.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, and exterior plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling for utility trenches.

B. Related Sections include the following:

1. Sections 321216 and 321313, Asphalt and Concrete Paving, respectively.

1.3 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect and Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's and Owner's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. On-Site Soils: On-site soils may be used as fill material for the following:

- General site grading
- Foundation areas
- Interior floor slabs
- Foundation backfill
- Exterior slabs

All on-site materials used as fill shall inorganic, free of vegetation, debris and fragments larger than 6" in size. In addition the soil should have maximum expansive potential of less than 2.0 percent as measured on a sample compacted to approximately 95% of the ASTM D 698 maximum dry density at about 3% below optimum water content, and submerged/inundated while confined under a 100 psf surcharge.

C. Imported Fill Material may be used as fill as above. It shall be inorganic soils free of vegetation, debris, and fragments larger than 6". Pea gravel or other similar non-cementitious, poorly graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.
Gradation: Percent Fines by Weight (ASTM C136)
6" 100
3" 70-100
No. 4 sieve 50-100
No. 200 sieve 60 (max.)

Maximum expansive potential (%)* 1.5
Liquid limit 40 (max)
Plasticity index 20 (max)

Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

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 earthwork operations.

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 EXPLOSIVES

A. Explosives: Do not use explosives.
3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.5 EXCAVATION FOR STRUCTURES

A. Wall and Column Footing Areas: Remove existing soils as required to a minimum depth of 2 feet below the bottom of the footing. Removal shall extend a minimum of 2 feet beyond the footing edges. Replace with engineered fill material. See Geotech Engineering Report for complete requirements.

B. Moisten or dry as required, and compact all subgrade soils to a minimum depth of 8 inches below interior slabs.

C. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to a minimum depth of 8 inches. Moisten or dry as required and compact prior to placement of fill and pavement materials to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
3.8 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

   1. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 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.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

   1. Construction below finish grade including, where applicable, waterproofing.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing all trash and debris.

B. Place backfill on subgrades free of mud, frost, snow, or ice.
3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03300 - Cast-in-Place."

D. Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.12 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. Landscape Areas, including both planting and seeding areas: Place and compact to 90% compaction salvaged top soil. Refer to Civil Plans for final finish grades.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use satisfactory soil material or engineered fill.
5. Under footings and foundations, bear on engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.
3.13 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.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in horizontal layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches 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 density according to ASTM D 698:

Percent compaction for on-site subgrade soils, subbase fill, and imported fill:

Below footings/foundations 95*
Below slabs-on-grade 95
Aggregate base (below slabs) 95

Below pavement 95

Aggregate base below pavement
Parking areas 100

Miscellaneous backfill 93
(not intended for lateral or vertical support of structural elements)

All at -3% to +3% moisture content for compaction.
*Use 100 where fill below structural elements exceed 5 feet in thickness.

2. Sprinkle water on surface of subgrade or layers of soil material where soil is too dry to permit compaction to required density. Onsite and imported soils shall be compacted within a water content range of 3 percent below to 3 percent above optimum. Remove and replace, or scarify and air dry soil material that is too wet to permit compaction to required density.

3. Pavement Subbase Course: Place subbase material in layers of indicated thickness, over subgrade surface to support walks and pavement. Compact each lift to 95 percent maximum density, in accordance with AASHTO T-99.

   a) Thickness of Pavement Subbase Course and Pavement Sections: As shown on Civil Drawings.

4. Grading: grade areas where indicated, including adjacent transition areas, with uniform levels or slopes between finish elevations. Shape surfaces of areas to within 10 feet above or below required subgrade elevation and compact as specified.

D. FIELD QUALITY CONTROL

1. Quality Control Testing During Construction:

   a) Allow testing service to test and approve subgrades and fill layers before further construction work is performed.

   b) Perform field density tests in accordance with AASHTO T-99.

2. Footing Subgrade: For each strata of soil on which footings will be placed, perform at least one field density test to verify design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to the Architect.

3. Paved Areas: Make at least one field density test of subgrade for every 2000 sq. ft. of paved area, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 2000 sq. ft. of overlaying paved area, but in no case less than 3 tests.
4. Building Areas: Perform observation and testing services necessary to confirm that earthwork has been performed in accordance with the Soils Report.

5. Foundation Wall Backfill: Perform at least two field density tests at locations and elevations as directed by the Geotechnical Engineer.

6. If in opinion of Architect based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

E. MAINTENANCE

1. Protection of Graded Areas:
   a) Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
   b) Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

2. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface of finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

F. DISPOSAL OF EXCESS AND WASTE MATERIALS

1. Removal from Owner's Property: Remove waste materials (including excess excavated material), trash and debris, and dispose of it off Owner's property in accordance with Waste Management Plan.
Geotechnical Engineering Report

Pima Community College Northwest Campus Building Expansion
7600 North Shannon Road
Pima County, Arizona
January 18, 2012
Terracon Project No. 63115087

Prepared for:
Pima Community College
Tucson, Arizona

Prepared by:
Terracon Consultants, Inc.
Tucson, Arizona

Expires 03/31/2012
January 18, 2012

Pima Community College  
Maintenance and Security Building  
6680 South Country Club Road  
Tucson, Arizona 85709-1810

Attn: Emie Federico  
Facilities Project Manager  
P: [520] 206-2681  
F: [520] 206-2665  
E: efederico@pima.edu

Re: Geotechnical Engineering Report  
Pima Community College Northwest Campus Building Expansion  
7600 North Shannon Road  
Pima County, Arizona  
Terracon Project No. 63115087

Dear Mr. Federico:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number P63110394 dated November 10, 2011. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Oleg B. Lysyj, P.E.  
Geotechnical Services Manager  
oblisyj@terracon.com

Brent M. Borchers, P.E.  
Office Manager  
bmborchers@terracon.com

Copies to: Addressee (1 via email, 1 via mail)
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- Exhibit A-2: Field Exploration Description
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- Exhibit A-10: General Notes
- Exhibit A-11: Unified Soil Classification

#### APPENDIX B – LABORATORY TESTING
- Exhibit B-1: Laboratory Testing
- Exhibit B-2 to B-11: Laboratory Testing Results

#### APPENDIX C – RECORDS OF COMPACTION TESTING
- Exhibit C-1 to C-4: Field Density Test Reports

Expires 03/31/2012
EXECUTIVE SUMMARY

A geotechnical investigation has been performed for the proposed building expansion for Pima Community College at the Northwest Campus at 7600 North Shannon Road in Pima County, Arizona. Terracon performed four borings, designated B-1 through B-4, to depths of approximately 21.5 to 31.5 feet below the existing ground surface.

Based on the information obtained from our subsurface exploration the site can be developed for the proposed project. The following geotechnical considerations were identified:

- The proposed building expansion is in an area where our borings indicated between five and nine feet of existing fill. We found no records of compaction testing for this area, and our laboratory data indicates the fills have compacted densities of less than 95 percent of Standard Proctor Density in most areas tested. We recommend the fills be removed in this area and replaced as engineered fill, and the foundations bear on engineered fill. The on-site soils in this area are suitable to be re-used as engineered fill. Foundations may also bear on the native soil below the fill. Recommendations for the placement of engineered fill are located in the Earthwork section of this report.

- The proposed lower shade structure may be supported on shallow footings bearing on the native soil.

- The proposed upper shade structure to be located in the area between Buildings A,B,C, and L, is in an area with as much as 7.5 feet of existing fill. We have records of compaction testing for the existing fill in this area performed by Pattison Evanoff Engineering during the time of original construction. The compaction tests indicate densities of 95 percent or higher relative to Standard Proctor Density. Therefore, we consider this fill as engineered and shallow footings for this shade structure may bear on this existing engineered fill.

- The 2006 International Building Code, Table 1613.5.2 IBC seismic site classification for this site is D.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that the Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled GENERAL COMMENTS should be read for an understanding of the report limitations.
1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed building expansion for Pima Community College at the Northwest Campus at 7600 North Shannon Road in Pima County, Arizona. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- earthwork
- seismic considerations
- lateral earth pressure
- groundwater conditions
- foundation design and construction
- floor slab design and construction

Our geotechnical engineering scope of work for this project included the advancement of four test borings to depths ranging from approximately 21.5 to 31.5 feet below existing site grades.

Logs of the borings along with a Site Plan and Boring Locations Diagram (Exhibit A-1), are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT INFORMATION

2.1 Project Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures</td>
<td>The project will include a three-story building addition with a footprint of approximately 16,000 square feet. There will also be two new shade structures.</td>
</tr>
<tr>
<td>Building construction</td>
<td>Assumed frame or masonry with concrete slab-on-grade floors.</td>
</tr>
</tbody>
</table>
### 2.2 Site Location and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>This project will be located on the Pima Community College Northwest Campus at 7600 North Shannon Road in Pima County, Arizona.</td>
</tr>
<tr>
<td>Existing improvements</td>
<td>Existing community college campus</td>
</tr>
<tr>
<td>Current ground cover</td>
<td>Expansion at the southern end of the school is within a flat and graded area with no structures or landscaping with an approximately 20-foot-high fill slope, sloping down at the west end. The proposed lower shade structure is currently a landscaped and side walk area directly west of Building B. The propped upper shade structure is in the common area between Buildings A, B, C, and L and is currently surfaced with portland cement concrete and supports tables and benches.</td>
</tr>
<tr>
<td>Existing topography</td>
<td>Relatively level project site in the areas where the proposed structures will be located. The campus was originally constructed on terrain sloping down to the west and is currently terraced with multiple levels and retaining walls.</td>
</tr>
</tbody>
</table>

### 3.0 SUBSURFACE CONDITIONS

#### 3.1 Typical Subsurface Profile

Specific conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can
be found on the boring logs included in Appendix A of this report. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Approximately Depth to Bottom of Stratum (feet)</th>
<th>Material Encountered</th>
<th>Consistency/Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratum 1 in building expansion area (Borings B-2,3, and 4)</td>
<td>5 to 9</td>
<td>Existing fill consisting of silty sand and sandy lean clay</td>
<td>Stiff/Very Dense</td>
</tr>
<tr>
<td>Stratum 2 in building expansion area (Borings B-2,3, and 4)</td>
<td>31.5 (max depth of exploration)</td>
<td>Silty sand</td>
<td>Loose to Dense</td>
</tr>
<tr>
<td>Stratum 1 at lower shade structure (Boring B-1)</td>
<td>21.5</td>
<td>Silty Sand</td>
<td>Loose to Medium Dense</td>
</tr>
<tr>
<td>Stratum 1 at upper shade structure (no boring due to limited access)</td>
<td>7.5 (max depth from records of compaction testing)</td>
<td>Engineered Fill</td>
<td>---</td>
</tr>
</tbody>
</table>

The sandy lean clay soils have plasticities in the low to medium range. The silty sand soils are nonplastic.

Laboratory tests were conducted on selected soil samples and the test results are presented in Appendix B. Laboratory test results indicate that the native (non-fill) subsoils at shallow depth exhibit low to moderate compression at in-situ moisture contents. The native (non-fill) soils show a low tendency for hydro-compaction when elevated in moisture content. Hydro-compactive soils, sometimes referred to as collapsible soils, are capable of supporting typical building loads at natural moisture contents, these same materials however, undergo volume decrease (settlement/consolidation) when subjected to increases in moisture content under constant load.

Our laboratory data indicates the fills in the proposed building expansion have compacted densities of less than 95 percent of Standard Proctor Density at moisture contents significantly below optimum, in most of the areas tested.
When water is added to samples of laboratory compacted near-surface soils, the materials exhibit low expansion potential under light loading conditions such as those imposed by floor slabs.

3.2 Groundwater

Groundwater was not observed in any test boring at the time of field exploration. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Groundwater conditions can change with varying seasonal and weather conditions, and other factors.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The proposed building expansion is in an area where our borings indicated between five and nine feet of existing fill. We found no records of compaction testing for this area, and our laboratory data indicates the fills have compacted densities of less than 95 percent of Standard Proctor Density at moisture contents significantly below optimum in most areas tested. We recommend the fills be removed in this area and replaced as engineered fill, and the foundations bear on engineered fill. The on-site soils in this area are suitable to be re-used as engineered fill. The foundations may also bear on the native soils below the fill.

Shallow foundations for the shade structures may bear on undisturbed native soils as in the case of the lower shade structure, or existing documented engineered fill as in the case of the upper shade structure.

On-site soils should be suitable for use as engineered fill beneath the foundation systems and floor slabs. The recommendations contained in this report are based upon the results of field and laboratory testing (presented in Appendices A and B), engineering analyses, and our current understanding of the proposed project.

4.2 Earthwork

The following recommendations include site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth supported elements including foundations and slabs are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation,
foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

4.2.1 Site Preparation

Strip and remove existing vegetation, debris, landscaping and hardscaping, and other deleterious materials from proposed building and shade structure areas. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

Stripped materials consisting of vegetation and organic materials should be wasted from the site, or used to revegetate landscaped areas or exposed slopes after completion of grading operations. If it is necessary to dispose of organic materials on site, they should be placed in non-structural areas, and in fill sections not exceeding 5 feet in height.

The site should be initially graded to create a relatively level surface to receive fill, and provide for a relatively uniform thickness of fill beneath proposed building structures.

If fill is placed in areas of the site where existing slopes are steeper than 5:1 (horizontal:vertical), the area should be benched to reduce the potential for slippage between existing slopes and fills. Benches should be wide enough to accommodate compaction and earth moving equipment, and to allow placement of horizontal lifts of fill.

Our explorations indicate the building site has approximately five to nine feet of undocumented fill material across the site. The fill soils consist of silt sand and sandy lean clay. We recommend that all fill soils be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction. Although evidence of other underground facilities such as septic tanks, cesspools, basements, and utilities was not observed during the site reconnaissance, such features could be encountered during construction. If any unexpected underground facilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

4.2.2 Excavation

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

On-site soils may pump or become unworkable at high water contents. Workability may be improved by scarifying and drying. Overexcavation of wet zones and replacement with granular materials may be necessary. Lightweight excavation equipment may be required to reduce subgrade pumping.
The use of biaxial geogrid may be considered to stabilize the soils and to reduce the amount of overexcavation that may otherwise be required. Use of lime, fly ash, kiln dust or cement could also be considered as a stabilization technique. Laboratory evaluation is recommended to determine the effect of chemical stabilization on subgrade soils prior to construction.

4.2.3 Subgrade Preparation

The proposed building expansion is in an area where our borings indicated between five and nine feet of existing fill. We recommend the fills be removed in this area and replaced as engineered fill, and the foundations bear on engineered fill. The on-site soils in this area are suitable to be re-used as engineered fill.

Shallow foundations for the shade structures may bear on undisturbed native soils as in the case of the lower shade structure, or existing documented engineered fill as in the case of the upper shade structure.

On-site soils should be suitable for use as engineered fill beneath the foundation systems and floor slabs. Subgrade soils beneath exterior slabs should be scarified, moisture conditioned, and compacted to a minimum depth of 10 inches. The moisture content and compaction of subgrade soils should be maintained until slab or pavement construction.

4.2.4 On Site Soils Used as Fill Material

On-site soils may be used as fill material for the following:

- general site grading
- foundation areas
- interior floor slabs

- foundation backfill
- exterior floor slabs

All on-site materials used as fill, should be inorganic, free of vegetation, debris, and fragments larger than 6 inches in size. In addition, the soil should have a maximum expansive potential of less than 2.0-percent as measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content, and submerged/inundated while confined under a 100 psf surcharge.

4.2.5 Imported Fill Material

Approved imported materials may be used as fill material for the following:

- general site grading
- foundation areas
- interior floor slabs

- foundation backfill
- exterior floor slabs
Imported fill materials should be inorganic soils free of vegetation, debris, and fragments larger than 6 inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

Imported soils for use as fill material within proposed building and structure areas should conform to low volume change materials as indicated in the following specifications:

<table>
<thead>
<tr>
<th>Gradation</th>
<th>Percent Finer by Weight (ASTM C 136)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3&quot;</td>
<td>70-100</td>
</tr>
<tr>
<td>No. 4 Sieve</td>
<td>50-100</td>
</tr>
<tr>
<td>No. 200 Sieve</td>
<td>60 (max)</td>
</tr>
</tbody>
</table>

- Liquid Limit: 40 (max)
- Plasticity Index: 20 (max)
- Maximum expansive potential (%)*: 1.5

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged/inundated.

### 4.2.6 Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

<table>
<thead>
<tr>
<th>Material Type and Location</th>
<th>Minimum Compaction Requirement (%)</th>
<th>Range of Moisture Contents for Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-site soils, or approved imported fill soils:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beneath foundations:</td>
<td>95</td>
<td>-3%</td>
</tr>
<tr>
<td>Beneath slabs:</td>
<td>95</td>
<td>-3%</td>
</tr>
<tr>
<td>Aggregate base (beneath slabs):</td>
<td>95</td>
<td>-3%</td>
</tr>
<tr>
<td>Miscellaneous backfill:</td>
<td>95</td>
<td>-3%</td>
</tr>
</tbody>
</table>

Responsive • Resourceful • Reliable
4.2.7 Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Planters and other surface features which could retain water in areas adjacent to the building or pavements should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 5 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration. We recommend a minimum horizontal setback distance of 10 feet from the perimeter of any building and the high-water elevation of the nearest storm-water retention basin.

Roof drainage should discharge into splash blocks or extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Sprinkler systems and landscaped irrigation should not be installed within 5 feet of foundation walls.

4.2.8 Exterior Slab Design and Construction

Compacted subgrade composed of on-site clay soils could expand with increasing moisture content; causing exterior concrete slabs to heave and result in cracking or vertical offsets. The potential for damage would be greatest where exterior slabs are constructed adjacent to the building or other structural elements. To reduce the potential for damage caused by movement, we recommend:

- exterior slabs be supported directly on subgrade fill (not ABC) with no, or very low expansion potential;
- strict moisture-density control during placement of subgrade fills;
- maintain proper subgrade moisture until placement of slabs;
- placement of effective control joints on relatively close centers and isolation joints between slabs and other structural elements;
- provision for adequate drainage in areas adjoining the slabs;
- use of designs which allow vertical movement between the exterior slabs and adjoining structural elements.
4.2.9 Slopes

For permanent slopes in compacted fill areas, recommended maximum configurations for on-site materials are as follows:

<table>
<thead>
<tr>
<th>Inclination (horizontal:vertical)</th>
<th>Slope Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:1 to less steep than 2:1</td>
<td>Re-vegetate</td>
</tr>
<tr>
<td>2:1 to less steep than 1.5:1</td>
<td>Rip-rap over filter fabric</td>
</tr>
<tr>
<td>1.5:1 to 1:1</td>
<td>Grouted rip-rap or 6-inch thick grout with integrated toe-down at base of slope having a minimum depth of 1/5 the total slope height</td>
</tr>
<tr>
<td>Steeper than 1:1</td>
<td>Stability analysis or structural retaining wall required</td>
</tr>
</tbody>
</table>

We expect slopes with this configuration to be resistant to erosion and stable against circular failure. The face of all slopes should be compacted to the minimum specification for fill embankments. Alternately, fill slopes can be over-built with compacted material and trimmed to final configurations.

4.2.10 Corrosion Potential

Results of soluble sulfate testing indicate that ASTM Type I/II Portland cement is suitable for all concrete on and below grade. Foundation concrete should be designed for low sulfate exposure in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

Refer to Summary of Laboratory Results contained in Appendix B for the complete results of the various corrosivity testing conducted on the site soils in conjunction with this geotechnical exploration.

4.2.11 Construction Considerations

Individual contractors are responsible for designing and constructing stable, temporary excavations. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.
4.3 Foundations

Foundation excavations and bearing soils should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required. Design recommendations for foundations for the proposed structures and related structural elements are presented in the following paragraphs.

4.3.1 Shallow Foundation Design Recommendations

<table>
<thead>
<tr>
<th>Description</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures</td>
<td>Three-story building addition and two new shade structures</td>
</tr>
<tr>
<td>Bearing Material</td>
<td>Building Addition: Engineered fill as prepared in the earthwork section of this report, or on native soils below the existing undocumented fill. All existing fills should be removed.</td>
</tr>
<tr>
<td>Allowable Bearing Pressure</td>
<td>Lower Shade Structure: Undisturbed native soil</td>
</tr>
<tr>
<td></td>
<td>Upper Shade Structure: Existing documented engineered fill</td>
</tr>
<tr>
<td>Minimum Dimensions</td>
<td>2000 psf at 18-inch embedment</td>
</tr>
<tr>
<td></td>
<td>2500 psf at 24-inch embedment</td>
</tr>
<tr>
<td></td>
<td>3000 psf at 30-inch embedment</td>
</tr>
<tr>
<td></td>
<td>3500 psf at 36-inch embedment</td>
</tr>
<tr>
<td>Minimum Embedment Depth Below Finished Grade</td>
<td>Columns: 24 inches</td>
</tr>
<tr>
<td></td>
<td>Walls: 16 inches</td>
</tr>
<tr>
<td>Total Estimated Settlement</td>
<td>18 inches</td>
</tr>
<tr>
<td>Estimated Differential Settlement</td>
<td>1/2-inch in 40 feet under walls</td>
</tr>
<tr>
<td></td>
<td>3/4-inch between columns</td>
</tr>
</tbody>
</table>

Finished grade is defined as the lowest adjacent grade within 5 feet of the foundation for perimeter (or exterior) footings, and finished floor level for interior footings.

The allowable foundation bearing pressures may include dead loads plus design live-load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead-load computations.
Total and differential settlements should not exceed predicted values, provided that:

- foundations are constructed as recommended, and
- essentially no changes occur in water contents of foundation soils.

Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction.

Footings, foundations, and masonry walls should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings, or other discontinuities, in masonry walls is recommended.

### 4.3.2 Shallow Foundation Design for Uplift Recommendations

Reinforced concrete footings or dead-man foundations, cast against undisturbed subsoils, are recommended for resistance to uplift. Footings may be designed using the cone method. The equation for determining the ultimate uplift capacity as a function of footing dimension, foundation depth, and soil weight is:

\[
T_u = 0.4 \times \gamma \times D^2 \times (B + L) + W
\]

Where:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_u )</td>
<td>Ultimate uplift capacity</td>
<td>lbs</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>Unit weight of soil(^1)</td>
<td>pcf</td>
</tr>
<tr>
<td>( D )</td>
<td>Depth to base of footing/dead-man foundation below final grade</td>
<td>ft</td>
</tr>
<tr>
<td>( B )</td>
<td>Width of footing/dead-man foundation</td>
<td>ft</td>
</tr>
<tr>
<td>( L )</td>
<td>Length of footing/dead-man foundation</td>
<td>ft</td>
</tr>
<tr>
<td>( W )</td>
<td>Weight of footing/dead-man + weight of soil directly over the top of the footing/block</td>
<td>lbs</td>
</tr>
</tbody>
</table>

Notes: \(^1\)A unit weight (\( \gamma \)) of 120 pcf is recommended for soil (either undisturbed or compacted backfill) at this site.

The design uplift resistance should be calculated by dividing the ultimate resistance obtained from the equation above by an appropriate factor of safety. A factor of safety of at least 2 is recommended for live uplift loads in the analysis.

Footings, foundations, and masonry walls should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings, or other discontinuities, in masonry walls is recommended.
4.3.3 Construction Considerations

The proposed building expansion is in an area where our borings indicated between five and nine feet of undocumented existing fill. We recommend the fills be removed in this area and replaced as engineered fill, and the foundations bear on engineered fill, or on native soils below the undocumented existing fill. The on-site soils in this area are suitable to be re-used as engineered fill.

4.4 Seismic Considerations

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 International Building Code Site Classification (IBC)</td>
<td>D^2</td>
</tr>
<tr>
<td>Site Latitude</td>
<td>N 32° 17.5937'</td>
</tr>
<tr>
<td>Site Longitude</td>
<td>W 111° 39.8753'</td>
</tr>
<tr>
<td>S_s Spectral Acceleration for a Short Period</td>
<td>0.30g</td>
</tr>
<tr>
<td>S_s Spectral Acceleration for a 1-Second Period</td>
<td>0.08g</td>
</tr>
<tr>
<td>F_a Site Coefficient for a Short Period</td>
<td>1.56</td>
</tr>
<tr>
<td>F_a Site Coefficient for a 1-Second Period</td>
<td>2.4</td>
</tr>
</tbody>
</table>

1 Note: In general accordance with the 2006 International Building Code, Table 1613.5.2. IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.

2 Note: The 2006 International Building Code (IBC) requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100 foot soil profile determination. Borings extended to a maximum depth of 31.5 feet, and this seismic site class definition considers that very dense soil continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

4.5 Floor Slab

4.5.1 Design Recommendations

<table>
<thead>
<tr>
<th>Description</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior floor system</td>
<td>Slab-on-grade concrete.</td>
</tr>
<tr>
<td>Floor slab support</td>
<td>The on-site soils generally have low expansive potential under light loading conditions such as those imposed by floor slabs. Floor slabs and subbase may bear directly on prepared subgrade soils.</td>
</tr>
<tr>
<td>Subbase</td>
<td>4-inches of ABC materials</td>
</tr>
<tr>
<td>Modulus of subgrade reaction</td>
<td>200 pounds per square inch per inch (psi/lin)</td>
</tr>
</tbody>
</table>
In areas of exposed concrete, control joints should be saw cut into the slab after concrete placement in accordance with ACI Design Manual, Section 302.1R-37 8.3.12 (tooled control joints are not recommended). Additionally, dowels should be placed at the location of proposed construction joints. To control the width of cracking (should it occur) continuous slab reinforcement should be considered in exposed concrete slabs.

Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement. Interior trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in the Earthwork section of this report. Other design and construction considerations, as outlined in the ACI Design Manual, Section 302.1R are recommended.

4.5.2 Construction Considerations

Some differential movement of a slab-on-grade floor system is possible should the subgrade soils become elevated in moisture content. Such movements are anticipated to be within general tolerance for normal slab-on-grade construction. To reduce potential slab movements, the subgrade soils should be prepared as outlined in the Earthwork section of this report.

4.6 Lateral Earth Pressures

The lateral earth pressure recommendations herein are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of geogrid-reinforced-backfill walls. Recommendations covering these types of wall systems are beyond the scope of services for this assignment; however, we would be pleased to develop recommendations for the design of such wall systems upon request.

For soils above any free water surface, recommended equivalent fluid pressures for unrestrained foundation elements are:

<table>
<thead>
<tr>
<th>Item</th>
<th>Value$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Case</td>
<td>32 psf/ft</td>
</tr>
<tr>
<td>Passive Case</td>
<td>400 psf/ft</td>
</tr>
<tr>
<td>At-Rest Case</td>
<td>55 psf/ft</td>
</tr>
<tr>
<td>Coefficient of Base Friction</td>
<td>0.45$^2$</td>
</tr>
</tbody>
</table>

$^1$Note: The values are based on the on-site soils used as backfill.

$^2$Note: The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.
The lateral earth pressures herein do not include any factor of safety and are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if such conditions are to be included in the design.

Fill against foundation and retaining walls should be compacted to densities specified in the Earthwork section of this report. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.
APPENDIX A

FIELD EXPLORATION
Field Exploration Description

A total of four test borings were drilled at the site on December 19, 2011. The borings were drilled to depths ranging from approximately 21.5 to 31.5 feet below the ground surface at the approximate locations shown on the attached Site Plan and Boring Locations Diagram, Exhibit A-1. The test borings were located as follows:

<table>
<thead>
<tr>
<th>Borings</th>
<th>Location</th>
<th>Depth (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower shade structure</td>
<td>21.5</td>
</tr>
<tr>
<td>2 thru 4</td>
<td>Planned building expansion</td>
<td>31.5</td>
</tr>
</tbody>
</table>

The test borings were advanced with a truck-mounted CME-75 drill rig utilizing 8-inch diameter hollow-stem augers.

The borings were located in the field by using the proposed site plan, an aerial photograph of the site, and measuring from existing property lines. The accuracy of boring locations should only be assumed to the level implied by the method used.

Continuous lithologic logs of each boring were recorded by the field geologist during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon or ring-barrel samplers. Bulk samples of subsurface materials were also obtained.

In the split-spoon sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel-sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound C.M.E. auto-hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). A similar sampling procedure is used to advance a 3-inch O.D. split-barrel, ring-lined, sampler a total of 12 inches. This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils.

Groundwater conditions were evaluated in each boring at the time of site exploration.
**LOG OF BORING NO. B-1**

**CLIENT**
Pima Community College

**SITE**
7600 North Shannon Road
Pima County, Arizona

**PROJECT**
PCC Northwest Campus Expansion

---

**DESCRIPTION**

**Silty Sand:** light brown, loose to medium dense, damp, non-plastic.

<table>
<thead>
<tr>
<th>DEPTH, ft.</th>
<th>USC'S SYMBOL</th>
<th>INTERVAL</th>
<th>TEST RESULTS (BLOWS/FT)</th>
<th>WATER CONTENT, %</th>
<th>DRY DENSITY, Mg/L</th>
<th>LIQUID LIMIT</th>
<th>PLASTICITY INDEX</th>
<th>#200</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>SM</td>
<td>BS</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>4.0</td>
<td>SM</td>
<td>RS</td>
<td>15</td>
<td>5</td>
<td>112</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>SM</td>
<td>RS</td>
<td>12</td>
<td>5</td>
<td>105</td>
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</tr>
<tr>
<td>8.0</td>
<td>SM</td>
<td>SS</td>
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<td>SM</td>
<td>SS</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>16.0</td>
<td>SM</td>
<td>SS</td>
<td>15</td>
<td></td>
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<td>18.0</td>
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<td>SS</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>20.0</td>
<td>SM</td>
<td>SS</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bottom of BORING.**

---

**WATER LEVEL OBSERVATIONS, ft**

<table>
<thead>
<tr>
<th>WL</th>
<th>None WD</th>
</tr>
</thead>
</table>

**BORING STARTED**
12-19-11

**BORING COMPLETED**
12-19-11

**RIG**
CME-75

**FOREMAN**
OBL

**Terracon**

**APPROVED**
OBL

**JOB #**
63115087
LOG OF BORING NO. B-2

CLIENT
Pima Community College

SITE
7600 North Shannon Road
Pima County, Arizona

PROJECT
PCC Northwest Campus Expansion

<table>
<thead>
<tr>
<th>DEPTH, ft</th>
<th>USCS SYMBOL</th>
<th>INTERVAL</th>
<th>TYPE</th>
<th>PENETRATION TEST RESULTS (BLOWS/FT)</th>
<th>WATER CONTENT, %</th>
<th>DRY DENSITY, lb/ft³</th>
<th>LIQUID LIMIT</th>
<th>PLASTICITY INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CL</td>
<td>BS</td>
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<td></td>
<td>26</td>
<td></td>
<td>8</td>
<td>51</td>
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<td>4</td>
<td>CL</td>
<td>RS</td>
<td>33</td>
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<td>106</td>
<td></td>
<td></td>
</tr>
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<td>RS</td>
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</tr>
<tr>
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<td>SS</td>
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<tr>
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<td>42</td>
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</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FILL - SANDY LEAN CLAY:** light brown, stiff, slightly damp, low plasticity.

**SILTY SAND:** light brown, medium dense to dense, slightly damp, non-plastic.

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

Terracon

WATER LEVEL OBSERVATIONS, ft
WL: None WD
WL: Backfilled Upon Completion

BORING STARTED 12-19-11
BORING COMPLETED 12-19-11
RIG: CME-75 FOREMAN: OBL
APPROVED: OBL JOB #: 63115087
**LOG OF BORING NO. B-2**

**CLIENT**
Pima Community College

**SITE**
7600 North Shannon Road
Pima County, Arizona

**PROJECT**
PCC Northwest Campus Expansion

<table>
<thead>
<tr>
<th>GRAPHIC LOG</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>SILTY SAND:</strong> light brown, medium dense to dense, slightly damp, non-plastic.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH, ft.</th>
<th>USCS SYMBOL</th>
<th>PENETRATION TEST RESULTS (BLOWS/FT.)</th>
<th>PENETRATION TEST RESULTS (BLOWS/FT.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>SS</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>SM</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

**Bottom of BORING.**

**WATER LEVEL OBSERVATIONS, ft.**
- WL  V  None WD  V
- WL  V
- WL  V  Backfilled Upon Completion

**BOARING STARTED** 12-19-11
**BOARING COMPLETED** 12-19-11
**RIG** CME-75  **FOREMAN** OBL
**APPROVED** OBL  **JOB #** 63115087
FILL - SILTY SAND: light brown, very dense, damp, non-plastic.

SILTY SAND: light brown, loose to medium dense, slightly damp, non-plastic.

The stratification lines represent the approximate boundary lines between soil and rock types; in situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**

<table>
<thead>
<tr>
<th>WL</th>
<th>None WD</th>
<th>V</th>
</tr>
</thead>
</table>

**BORING STARTED** 12-19-11

**BORING COMPLETED** 12-19-11

**RIG** CME-75 **FOREMAN** OBL

**APPROVED** OBL **JOB #** 63115087
**LOG OF BORING NO. B-3**

**CLIENT**  
Pima Community College

**SITE**  
7600 North Shannon Road  
Pima County, Arizona

**PROJECT**  
PCC Northwest Campus Expansion

<table>
<thead>
<tr>
<th>GRAPHIC LOG</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Silty Sand:</strong> light brown, loose to medium dense, slightly damp, non-plastic.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH, ft.</th>
<th>USCS SYMBOL</th>
<th>INTERVAL</th>
<th>TYPE</th>
<th>PENETRATION RESULTS (BLOWS/FT)</th>
<th>WATER CONTENT, %</th>
<th>DRY DENSITY,pcf</th>
<th>LIQUID LIMIT</th>
<th>PLASTICITY INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>SM</td>
<td></td>
<td>SS</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>SM</td>
<td></td>
<td>SS</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>SM</td>
<td></td>
<td>SS</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Bottom of Boring.** |

---

The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**

<table>
<thead>
<tr>
<th>WL</th>
<th>None WD</th>
<th>Y</th>
</tr>
</thead>
</table>

**VWL** Backfilled Upon Completion

---

**BORING STARTED**  
12-19-11

**BORING COMPLETED**  
12-19-11

**RIG**  
CME-75

**FOREMAN**  
OBL

**APPROVED**  
OBL  
JOB #  
63115087
<table>
<thead>
<tr>
<th>DEPTH, ft</th>
<th>USCS SYMBOL</th>
<th>INTERVAL</th>
<th>TYPE</th>
<th>PENETRATION TEST RESULTS</th>
<th>WATER CONTENT, %</th>
<th>DRY DENSITY, pcg</th>
<th>LIQUID LIMIT</th>
<th>PLASTICITY INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CL</td>
<td>BS</td>
<td></td>
<td></td>
<td>28</td>
<td></td>
<td>10</td>
<td>69</td>
</tr>
<tr>
<td>4</td>
<td>CL</td>
<td>RS</td>
<td>37</td>
<td></td>
<td>1</td>
<td></td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>CL</td>
<td>RS</td>
<td>41</td>
<td></td>
<td>3</td>
<td></td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SM</td>
<td>RS</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>SM</td>
<td>SS</td>
<td>36</td>
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<td></td>
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<td>22</td>
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<td>SS</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**
- WL: None
- WD: Y

**Boring Information**
- BORING STARTED: 12-19-11
- BORING COMPLETED: 12-19-11
- RIG: CME-75
- FOREMAN: OBL
- APPROVED: OBL
- JOB #: 63115087

**Terrain Description**
- **Fill - Sandy Lean Clay**: brown, stiff, slightly damp, low to medium plasticity.
- **Silty Sand**: light brown, medium dense to dense, slightly damp, non-plastic.
## LOG OF BORING NO. B-4

### CLIENT
Pima Community College

### SITE
7600 North Shannon Road  
Pima County, Arizona

### PROJECT
PCC Northwest Campus Expansion

### GRAPHIC LOG

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DEPTH, ft</th>
<th>USCS SYMBOL</th>
<th>INTERVAL</th>
<th>PENETRATION RESULTS (BLOWS/FT)</th>
<th>WATER CONTENT, %</th>
<th>DRY DENSITY,pcf</th>
<th>LIQUID LIMIT</th>
<th>ELASTICITY INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILTY SAND, light brown, medium dense to dense, slightly damp, non-plastic.</td>
<td>24</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>SS</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>SM</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>31.5</td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom of BORING.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

### WATER LEVEL OBSERVATIONS, ft

<table>
<thead>
<tr>
<th>WL</th>
<th>None WD</th>
<th>Backfilled Upon Completion</th>
</tr>
</thead>
</table>

### BORING

<table>
<thead>
<tr>
<th>BORING STARTED</th>
<th>12-19-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>BORING COMPLETED</td>
<td>12-19-11</td>
</tr>
<tr>
<td>RIG</td>
<td>CME-75</td>
</tr>
<tr>
<td>FOREMAN</td>
<td>OBL</td>
</tr>
<tr>
<td>APPROVED</td>
<td>OBL</td>
</tr>
</tbody>
</table>
**GENERAL NOTES**

**DRILLING & SAMPLING SYMBOLS:**
- SS: Split Spoon - 1-1/8" I.D., 2" O.D., unless otherwise noted
- ST: Thin-Walled Tube - 2" O.D., 3" O.D. unless otherwise noted
- RS: Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted
- DB: Diamond Bit Coring - 4", N, B
- BS: Bulk Sample or Auger Sample
- HS: Hollow Stem Auger
- PA: Power Auger
- HA: Hand Auger
- RB: Rock Bit
- WB: Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value". For 3" O.D. ring samplers (RS) the penetration value is reported as the number of blows required to advance the sampler 12 inches using a 140-pound hammer falling 30 inches, reported as "blows per foot," and is not considered equivalent to the "Standard Penetration" or "N-value".

**WATER LEVEL MEASUREMENT SYMBOLS:**
- WL: Water Level
- WS: While Sampling
- WC: Wet Cave In
- WC: While Drilling
- DCI: Dry Cave In
- BCR: Before Casing Removal
- AB: After Boring
- ACR: After Casing Removal
- N/E: Not Encountered

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

**DESCRIPTIVE SOIL CLASSIFICATION:** Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

### CONSISTENCY OF FINE-GRAINED SOILS

<table>
<thead>
<tr>
<th>Unconfined Compressive Strength, Qu, psi</th>
<th>Standard Penetration or N-value (SS) Blows/Ft.</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 500</td>
<td>0 - 1</td>
<td>Very Soft</td>
</tr>
<tr>
<td>500 - 1,000</td>
<td>2 - 3</td>
<td>Soft</td>
</tr>
<tr>
<td>1,000 - 2,000</td>
<td>4 - 6</td>
<td>Medium Stiff</td>
</tr>
<tr>
<td>2,000 - 4,000</td>
<td>7 - 12</td>
<td>Stiff</td>
</tr>
<tr>
<td>4,000 - 8,000</td>
<td>13 - 26</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>8,000+</td>
<td>27+</td>
<td>Hard</td>
</tr>
</tbody>
</table>

**RELATIVE DENSITY OF COARSE-GRAINED SOILS**

<table>
<thead>
<tr>
<th>Standard Penetration or N-value (SS) Blows/Ft.</th>
<th>Ring Sampler (RS) Blows/Ft.</th>
<th>Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 3</td>
<td>0 - 8</td>
<td>Very Loose</td>
</tr>
<tr>
<td>4 - 9</td>
<td>7 - 16</td>
<td>Loose</td>
</tr>
<tr>
<td>10 - 29</td>
<td>19 - 58</td>
<td>Medium Dense</td>
</tr>
<tr>
<td>30 - 49</td>
<td>59 - 98</td>
<td>Dense</td>
</tr>
<tr>
<td>50+</td>
<td>99+</td>
<td>Very Dense</td>
</tr>
</tbody>
</table>

**RELATIVE PROPORTIONS OF SAND AND GRAVEL**

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>With</td>
<td>15 - 29</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 29</td>
</tr>
</tbody>
</table>

**GRAIN SIZE TERMINOLOGY**

<table>
<thead>
<tr>
<th>Major Component of Sample</th>
<th>Particle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Over 12 in. (300mm)</td>
</tr>
<tr>
<td>Cobbles</td>
<td>12 in. to 3 in. (300mm to 75 mm)</td>
</tr>
<tr>
<td>Gravel</td>
<td>3 in. to #4 sieve (75mm to 4.75 mm)</td>
</tr>
<tr>
<td>Sand</td>
<td>#4 to #200 sieve (4.75mm to 0.075mm)</td>
</tr>
<tr>
<td>Silt or Clay</td>
<td>Passing #200 Sieve (0.075mm)</td>
</tr>
</tbody>
</table>

**RELATIVE PROPORTIONS OF FINES**

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 5</td>
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<tr>
<td>With</td>
<td>5 - 12</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 12</td>
</tr>
</tbody>
</table>

**PLASTICITY DESCRIPTION**

<table>
<thead>
<tr>
<th>Term</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-plastic</td>
<td>0</td>
</tr>
<tr>
<td>Low</td>
<td>1 - 10</td>
</tr>
<tr>
<td>Medium</td>
<td>11 - 30</td>
</tr>
<tr>
<td>High</td>
<td>&gt; 30</td>
</tr>
</tbody>
</table>
### UNIFIED SOIL CLASSIFICATION SYSTEM

**Criteria for Assigning Group Symbols and Names Using Laboratory Tests**

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>Group Symbol</th>
<th>Group Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Grained Soils</td>
<td>GW</td>
<td>Well-graded gravel</td>
</tr>
<tr>
<td>More than 50% retained on No. 200 sieve</td>
<td>GP Poorly graded gravel</td>
<td></td>
</tr>
<tr>
<td>Clean Gravels</td>
<td>Cu &gt; 4 and 1 ≤ Co ≤ 3°</td>
<td></td>
</tr>
<tr>
<td>Less than 5% fines</td>
<td>Cu ≤ 4 and/or 1 &gt; Co &gt; 3°</td>
<td></td>
</tr>
<tr>
<td>Gravels with Fines</td>
<td>Fines classify as ML or MH</td>
<td></td>
</tr>
<tr>
<td>More than 12% fines</td>
<td>Fines classify as CL or CH</td>
<td></td>
</tr>
<tr>
<td>Sands</td>
<td>GC Clayey gravel</td>
<td></td>
</tr>
<tr>
<td>50% or more of coarse fraction passes No. 4 sieve</td>
<td>GM Silty gravel</td>
<td></td>
</tr>
<tr>
<td>Clean Sands</td>
<td>Cu &gt; 6 and 1 &lt; Co ≤ 3°</td>
<td></td>
</tr>
<tr>
<td>Less than 5% fines</td>
<td>Cu ≤ 6 and/or 1 &gt; Co &gt; 3°</td>
<td></td>
</tr>
<tr>
<td>Sands with Fines</td>
<td>Fines classify as ML or MH</td>
<td></td>
</tr>
<tr>
<td>More than 12% fines</td>
<td>Fines classify as CL or CH</td>
<td></td>
</tr>
<tr>
<td>Fine-Grained Soils</td>
<td>SM Silty sand</td>
<td></td>
</tr>
<tr>
<td>50% or more passes the No. 200 sieve</td>
<td>SC Clayey sand</td>
<td></td>
</tr>
<tr>
<td>Silts and Clays</td>
<td>CL Lean clay</td>
<td></td>
</tr>
<tr>
<td>Liquid limit less than 50</td>
<td>ML Silt</td>
<td></td>
</tr>
<tr>
<td>Inorganic</td>
<td>Pi &gt; 7 and plots on or above &quot;A&quot; line</td>
<td></td>
</tr>
<tr>
<td>Organic</td>
<td>Liquid limit - oven dried</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liquid limit - not dried</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 0.75 OL Organic clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organic silt</td>
<td></td>
</tr>
<tr>
<td>Silts and Clays</td>
<td>CH Fat clay</td>
<td></td>
</tr>
<tr>
<td>Liquid limit 50 or more</td>
<td>MH Elastic Silt</td>
<td></td>
</tr>
<tr>
<td>Inorganic</td>
<td>Pi plots on or above &quot;A&quot; line</td>
<td></td>
</tr>
<tr>
<td>Organic</td>
<td>Liquid limit - oven dried</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liquid limit - not dried</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 0.75 OH Organic clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organic silt</td>
<td></td>
</tr>
<tr>
<td>Highly organic soils</td>
<td>Primarily organic matter, dark in color, and organic odor</td>
<td></td>
</tr>
<tr>
<td>Peat</td>
<td>PT Peat</td>
<td></td>
</tr>
</tbody>
</table>

---

A *Based on the material passing the 3-in. (75-mm) sieve
B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC poorly graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
E Cu = D<sub>60</sub>/D<sub>0</sub> Cc = (D<sub>0</sub>)<sup>2</sup> D<sub>0</sub> x D<sub>e</sub>
F If soil contains ≥ 15% sand, add "with sand" to group name.
G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SC.
H If fines are organic, add "with organic fines" to group name.
I If soil contains > 15% gravel, add "with gravel" to group name.
J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
K If soil contains 15 to 25% plus No. 200, add "with sand or "with gravel," whichever is predominant.
L If soil contains 30% plus No. 200 predominantly sand, add "sandy" to group name.
M If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
N Pi ≥ 4 and plots on or above "A" line.
O Pi < 4 or plots below "A" line.
P Pi plots on or above "A" line.
Q Pi plots below "A" line.

---

**For classification of fine-grained soils and fine-grained fraction of coarse-grained soils**

- **Equation of "A" line**: Horizontal at Pi=4 to LL=25.5, then Pi=0.73 (LL-50).
- **Equation of "U" line**: Vertical at LL=4 to Pi=7, then Pi=0.9 (LL-6).

---

**Terracon**

Form 111-009
APPENDIX B
LABORATORY TESTING
Laboratory Testing

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix A. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- Consolidation
- Sieve Analysis
- Atterberg Limits
- One-Point Proctor
- Soluble Chlorides
- In-situ Water Content
- In-situ Dry Density
- Standard Proctor
- Remolded Expansion/Swell
- Soluble Sulfates
<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>%&lt;#200</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td>15</td>
<td>SILTY SAND (SM)</td>
</tr>
<tr>
<td>B-2</td>
<td>0.0f</td>
<td>28</td>
<td>18</td>
<td>8</td>
<td>SANDY LEAN CLAY (CL)</td>
</tr>
<tr>
<td>B-4</td>
<td>0.0f</td>
<td>28</td>
<td>18</td>
<td>10</td>
<td>SANDY LEAN CLAY (CL)</td>
</tr>
</tbody>
</table>
Specimen Identification | Classification       | $\gamma'_{d}$, psi | W/C, % |
--- | --- | --- | --- |
B-1 | 5.0ft Silt | Silty Sand (SM) | 105 | 5 |

Water added at 2,000 psf
Water added at 2,000 psf
Source of Material: B-3 0.0ft
Description of Material: Silty Sand (SM)
Test Method: ASTM D698 Method A

TEST RESULTS
Maximum Dry Unit Weight: 120.5 PCF
Optimum Water Content: 11.5 %

ATTERBERG LIMITS
LL
PL
PI

Curves of 100% Saturation for Specific Gravity Equal to:
- 2.80
- 2.70
- 2.60

MOISTURE-DENSITY RELATIONSHIP
Project: PCC Northwest Campus Expansion
Site: 7600 North Shannon Road  Pima County, Arizona
Job #: 63115087
Date: 1-8-12
<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (ft.)</th>
<th>USCS Soil Class.</th>
<th>In-Situ Properties</th>
<th>Classification</th>
<th>Expansion Testing</th>
<th>Corrosivity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry Density (pcf)</td>
<td>Water Content (%)</td>
<td>Passing #200</td>
<td>Atterberg Limits</td>
</tr>
<tr>
<td>B-1</td>
<td>0</td>
<td>SM</td>
<td></td>
<td>105</td>
<td>5</td>
<td>15</td>
<td>NP</td>
</tr>
<tr>
<td>B-1</td>
<td>2</td>
<td>SM</td>
<td></td>
<td>112</td>
<td>5</td>
<td>51</td>
<td>26</td>
</tr>
<tr>
<td>B-1</td>
<td>5</td>
<td>SM</td>
<td></td>
<td>106</td>
<td>5</td>
<td>112</td>
<td>4</td>
</tr>
<tr>
<td>B-2</td>
<td>0</td>
<td>CL</td>
<td></td>
<td>106</td>
<td>3</td>
<td>51</td>
<td>26</td>
</tr>
<tr>
<td>B-2</td>
<td>2</td>
<td>CL</td>
<td></td>
<td>112</td>
<td>4</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>B-2</td>
<td>5</td>
<td>CL</td>
<td></td>
<td>109</td>
<td>2</td>
<td>69</td>
<td>28</td>
</tr>
<tr>
<td>B-3</td>
<td>0</td>
<td>SM</td>
<td></td>
<td>100</td>
<td>2</td>
<td>69</td>
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<tr>
<td>B-4</td>
<td>2</td>
<td>CL</td>
<td></td>
<td>104</td>
<td>1</td>
<td>108</td>
<td>3</td>
</tr>
<tr>
<td>B-4</td>
<td>5</td>
<td>CL</td>
<td></td>
<td>108</td>
<td>3</td>
<td>108</td>
<td>3</td>
</tr>
</tbody>
</table>

**REMARKS**

1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4529-95.
5. Air-Dried Sample

**SUMMARY OF LABORATORY RESULTS**

Project: PCC Northwest Campus Expansion
Site: 7800 North Shannon Road, Pima County, Arizona
Job #: 63115087
Date: 1-8-12
<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (ft.)</th>
<th>USCS Soil Class.</th>
<th>In-Situ Properties</th>
<th>Classification</th>
<th>Moisture-Density Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dry Density (pcf)</td>
<td>Water Content (%)</td>
<td>Passing #200 Sieve (%)</td>
</tr>
<tr>
<td>B-3</td>
<td>0</td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-4</td>
<td>0</td>
<td>CL</td>
<td>69</td>
<td>28</td>
<td>18</td>
</tr>
</tbody>
</table>

**REMARKS**
1. Dry Density determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.

**SUMMARY OF LABORATORY RESULTS**

Project: PCC Northwest Campus Expansion
Site: 7600 North Shannon Road Pima County, Arizona
Job #: 63115087
Date: 1-17-12
APPENDIX C

COMPACTION TEST RECORDS
SOIL/AGGREGATE FIELD DENSITY TESTS - NUCLEAR METHOD

CLIENT: Pine Community College  PROJECT: PCC, North West Campus
JOB NO.: 92-214  LOCATION: S.R.C. of Shannon/Nagse
INVOICE #: 11962  SOURCE OF MATERIAL: Eng. Fill
DATE/TEST: 07/23/02  LOCATION MUNDATED BY: Contractor

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>STRENGTHS</th>
<th>LOCATION OF TEST HOLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YES</td>
<td>At point S642, 'D', D. Bldg.</td>
</tr>
<tr>
<td>2</td>
<td>YES</td>
<td>Bldg. C, N.</td>
</tr>
<tr>
<td>3</td>
<td>NO</td>
<td>Between 'C' and 'D' Bldg. Common area</td>
</tr>
<tr>
<td>4</td>
<td>YES</td>
<td>Between Bldg. A and B, E. side of bldg.</td>
</tr>
<tr>
<td>5</td>
<td>YES</td>
<td>Bldg. #1</td>
</tr>
<tr>
<td>6</td>
<td>NO</td>
<td>Bldg. C, backfill footing, 15' N. of S.R.C. of Bldg.</td>
</tr>
<tr>
<td>7</td>
<td>NO</td>
<td>Bldg. D, footing backfill, 20' N. of Bldg.</td>
</tr>
<tr>
<td>8</td>
<td>YES</td>
<td>Bldg. E</td>
</tr>
<tr>
<td>9</td>
<td>YES</td>
<td>Bldg. F</td>
</tr>
<tr>
<td>10</td>
<td>YES</td>
<td>Bldg. G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>DISTANCE FROM OCTOM (FT.)</th>
<th>LABORATORY RESULTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-2.5</td>
<td>12.5 118.9 12.5 118.9 7.2 137.2 99</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>2</td>
<td>-4.5</td>
<td>12.5 118.9 12.5 118.9 8.0 120.1 103</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>3</td>
<td>-2.0</td>
<td>12.5 118.9 12.5 118.9 4.2 112.7 95</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>4</td>
<td>-4.0</td>
<td>12.5 118.9 12.5 118.9 4.6 114.7 96</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>5</td>
<td>-7.0</td>
<td>12.5 118.9 12.5 118.9 9.2 115.8 108</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>6</td>
<td>-6.0</td>
<td>15.7 114.2 15.7 114.2 7.0 106.2 93</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>7</td>
<td>-9.0</td>
<td>15.7 114.2 15.7 114.2 4.9 104.3 92</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>8</td>
<td>-9.0</td>
<td>15.7 114.2 15.7 114.2 7.2 110.3 96</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>9</td>
<td>-6.0</td>
<td>15.7 114.2 15.7 114.2 10.2 115.9 100+</td>
<td>2, 3, 4, 6, 10</td>
</tr>
<tr>
<td>10</td>
<td>-5.0</td>
<td>15.7 114.2 15.7 114.2 6.1 133.8 100</td>
<td>2, 3, 4, 6, 10</td>
</tr>
</tbody>
</table>

**CONCIDENTS:**
- 5. BREAM FOOTING
- 6. ROCKET FOOTING
- 12. 95% MIN. REQ'D
- 23. ROCK CORRECTION PER: ABNT-NF T-224
- 34. TESTED: ASTM D2932/D-3027
- 35. SPICE UHMSHUN

**ABBREVIATIONS (FOR DATION):**
- F.G. = FINISHED GRADE
- P.F.E. = FINISHED FLOOR ELEV.
- B.P.G. = FINISHED PRE GRADE
- B.O.P. = BOTTOM OF FOOTING
- F.R.C. = FINISHED DASH COURSE
- T.O.P. = TOP OF PIPE
- T.M.R. = TOP OF MASONRY
- OTHER:

Copies: (2) Client (1) Sundt (1) Borderland (1) John Kilseth Assoc. (1) MGLA
SOIL/AGGREGATE FIELD DENSITY TESTS - NUCLEAR METHOD

CLIENT: Pima Community College
JOB NO.: 01-230
INVOICE #: 14125
DATE/TEST: 07/19/92

PROJECT: PCC, North West Campus
LOCATION: S.E.C. of Shannon/Mages
SOURCE OF MATERIAL: Eng Fill
LOCATION DESIGNATED BY: Contractor
TESTED BY: NWC
MATERIAL TYPE: Soil

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>SPEC?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YES</td>
</tr>
<tr>
<td>2</td>
<td>YES</td>
</tr>
<tr>
<td>3</td>
<td>YES</td>
</tr>
<tr>
<td>4</td>
<td>YES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCATION OF TEST HOLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. side of bathroom (Ldg. A-North)</td>
</tr>
<tr>
<td>Elevator over-ex. building B-South</td>
</tr>
<tr>
<td>Common area between building C and D-North</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th><em>DISTANCE</em> FROM DATUM (FT.)</th>
<th><em>LABORATORY RESULTS</em></th>
<th><em>ADJUSTED FOR ROCK</em></th>
<th><em>IN-PLACE DATA</em></th>
<th><em>RELATIVE</em></th>
<th><em>SEE COMMENT BELOW</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.5</td>
<td>12.5</td>
<td>138.7</td>
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<td>15.7</td>
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<td>6.7</td>
</tr>
<tr>
<td>3</td>
<td>3.5</td>
<td>15.7</td>
<td>114.2</td>
<td>15.7</td>
<td>114.2</td>
<td>6.7</td>
</tr>
<tr>
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<td>4.0</td>
<td>15.7</td>
<td>114.3</td>
<td>15.7</td>
<td>114.2</td>
<td>7.4</td>
</tr>
</tbody>
</table>

*COMMENTS:*
1. SLOPES
2. SURFACE FILL
3. SUBBASE FILL
4. BASE COURSE
5. PAVEMENT AREA

*ABBREVIATIONS (FOR DATUM):*
F.G. = FINISHED GRADE
F.P.G. = FINISHED PAVEMENT GRADE
F.B.C. = FINISHED BASE COURSE
F.F.E. = FINISHED FLOOR ELEV.
B.O.E. = BOTTOM OF ELEVATION
T.O.F. = TOP OF FILL
T.M.R. = TOP OF MANHOLE

Copies: (2) Client  (1) Sundc  (1) Borderland  (1) John Kulseth Assoc.  (1) NWEA

PATTISON > EVANOFF > ENGINEERING, L.L.C.
SOIL/AGGREGATE FIELD DENSITY TESTS - NUCLEAR METHOD

CLIENT: Pine Community College
JOB NO.: 01-239
INVOICE #: 14926
DATE/ TEST: 07/15/02

PROJECT: FCC, North West Campus
LOCATION: S.E.C. of Shannon/Mages
SOURCE OF MATERIAL: Eng. Fill
LOCATION DESIGNATED BY: Contractor
TESTED BY: RM
MATERIAL TYPE: Soil

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>SPECIES</th>
<th>LOCATION OF TEST HOLE</th>
<th>(SEE ABBREVIATIONS BELOW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YES</td>
<td>Elag. A-North, E. side</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>YES</td>
<td>Over-X: A-5 column (Elag. A-North)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>YES</td>
<td>Backfill footing Elag. A-North, 20% of N.E.C. of bathroom</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>YES</td>
<td>Between Elag. B &amp; C. E. side</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>&quot;RESISTANCE&quot;</th>
<th>&quot;LABORATORY RESULT*&quot;</th>
<th>&quot;ADJUSTED FOR ROCK*&quot;</th>
<th>&quot;IN-PLACE DATA*&quot;</th>
<th>&quot;RELATIVE&quot;</th>
<th>*SEE COMMENTS BELOW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FROM DATEM</td>
<td>% MOIST</td>
<td>DENSITY</td>
<td>% MOIST</td>
<td>DENSITY</td>
<td>% MOIST</td>
</tr>
<tr>
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<td>114.7</td>
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<td>114.7</td>
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<td>116.7</td>
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<td>114.2</td>
<td>15.7</td>
<td>114.2</td>
<td>6.2</td>
</tr>
</tbody>
</table>

*ABBREVIATIONS (for DATEM):
P.G. = FINISHED GRADE
F.P.F. = FINISHED FLOOR ELEV.
F.P.G. = FINISHED P.A.D. GRADE
T.O.P. = TOP OF PIPE
F.B.C. = FINISHED BASE COURSE
B.O.P. = BOTTOM OF FOOTING
F.P.G. = FINISHED PREFERRED GRADE
T.R.N. = TOP OF HANNO

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### SOIL/AGGREGATE FIELD DENSITY TESTS - NUCLEAR METHOD

**CLIENT:** Pima Community College  
**JOB NO.:** 01-230  
**INVOICE #:** 24974  
**DATE/TEST:** 07/17/92  
**SOURCE OF MATERIAL:** Reg. Fill  
**LOCATION DESIGNATED BY:** Contractor  
**MATERIAL TYPE:** Soil  

**TEST WITHIN**  

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>SPECS?</th>
<th>LOCATION OF TEST HOLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YES</td>
<td>At point 1853+23, bldg. S. S.</td>
</tr>
<tr>
<td>2</td>
<td>YES</td>
<td>Walkway between bathrooms nd building, A-North</td>
</tr>
<tr>
<td>3</td>
<td>YES</td>
<td>Common area, E. side, between B&amp;C</td>
</tr>
<tr>
<td>4</td>
<td>YES</td>
<td>Bldg. A-North, E. side</td>
</tr>
<tr>
<td>5</td>
<td>YES</td>
<td>N. side of bathroom, building A-North</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th><em>DISTANCE</em> FROM DATUM (FT.)</th>
<th><em>LABORATORY RESULT</em></th>
<th><em>ADJUSTED FOR ROCK</em></th>
<th><em>IN-PLACE DATA</em></th>
<th><em>RELATIVE</em></th>
<th><em>SEE COMMENTS BELOW</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OPTIMUM MOIST DENSITY</td>
<td>MAX DRY DENSITY PCF</td>
<td>OPTIMUM MOIST DENSITY</td>
<td>MAX DRY DENSITY PCF</td>
<td>WETT DRY BNS Compact'</td>
</tr>
<tr>
<td>1</td>
<td>-1.0</td>
<td>12.5</td>
<td>118.7</td>
<td>12.5</td>
<td>118.7</td>
<td>0.8</td>
</tr>
<tr>
<td>2</td>
<td>-4.0</td>
<td>12.5</td>
<td>114.2</td>
<td>15.7</td>
<td>114.7</td>
<td>5.4</td>
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<tr>
<td>3</td>
<td>-5.5</td>
<td>12.5</td>
<td>118.7</td>
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<td>118.7</td>
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<td>118.7</td>
<td>12.5</td>
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</tr>
<tr>
<td>5</td>
<td>-6.0</td>
<td>12.5</td>
<td>118.7</td>
<td>12.5</td>
<td>118.7</td>
<td>6.2</td>
</tr>
</tbody>
</table>

**COMMENTS:**  

1. **SUBGRADE**  
2. **SUBBASE FILL**  
3. **BASE COURSE**  
4. **REBASE**  
5. **PAVEMENT AREA**

**ABBREVIATIONS (FOR DATUM):**  

- F.D. = FINISHED GRADE  
- F.P.C. = FINISHED BASE COURSE
- F.P.E. = FINISHED FLOOR ELEV.
- B.O.F. = BOTTOM OF FOUNDATION
- F.P.O. = FINISHED PAVEMENT GRADE
- T.O.P. = TOP OF PIPE
- T.W.H. = TOP OF MANHOLE

**COPIES:** (2) Client  
(1) Sundt  
(1) Borderland  
(1) John Klueth Assoc.  
(1) MLA
SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for termite control: Soil treatment for structural concrete on grade.

1.3 DEFINITIONS

A. EPA: Environmental Protection Agency.

B. PCO: Pest control operator.

1.4 SUBMITTALS

A. Product Data: Treatments and application instructions, including EPA-Registered Label.

B. Product Certificates: Signed by manufacturers of termite control products certifying that treatments furnished comply with requirements.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

D. Soil Treatment Application Report: After application of termicide is completed, submit report for Owner's record information, including the following as applicable:

   1. Date and time of application.
   2. Brand name and manufacturer of termicide.
   3. Quantity of undiluted termicide used.
   4. Dilutions, methods, volumes, and rates of application used.
5. Areas of application.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A PCO who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment similar to that indicated for this Project and whose work has a record of successful in-service performance.

B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with EPA regulations and authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with EPA-Registered Label requirements and requirements of authorities having jurisdiction.

1.7 COORDINATION

A. Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction.

1.8 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights. Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation. Use only soil treatment solutions that are not harmful to plants. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA-Registered Label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended by termicide manufacturer.

C. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.
3.3 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.4 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termitecidual barrier or treated zone is established around and under building construction. Distribute the treatment evenly.

1. Slabs-on-Grade: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.

2. Foundations: Adjacent soil including soil along entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers and piers; and along entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.

3. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116
SECTION 321216 - HOT-MIXED ASPHALT PAVING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. All site work shown on the Civil Plans shall be in accordance with PC/COT Standard Specifications and Details.

1.2 SUMMARY

A. This Section includes provisions for hot-mixed asphalt paving or chip-sealing over prepared subbase.
   1. Work also includes concrete wheel stops and striping as indicated.
B. Prepared subbase is specified in Section 312000 – Earthwork. Proof rolling of prepared subbase is included in this Section.

1.3 SUBMITTALS:

A. Mix Design Proposal

   1. The Contractor shall submit a mix design stamped/certified by and prepared under the direct supervision of a professional civil engineer of a certified testing laboratory experienced in the development of mix designs and mix design testing.

   2. The mix design proposal shall contain as a minimum:

      a. The name and address of the testing organization and the person responsible for the mix design testing.

      b. The specific location(s) of the source(s) of mineral aggregate.

      c. The supplier, refinery, and type of asphalt cement, and the source and type of mineral admixture, if appropriate, and the percentage
of each to be used.

d. The mineral aggregate gradation in each stockpile.

e. Mix design gradation.

f. The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss of abrasion, crushed faces, immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources.

1.4 SITE CONDITIONS

A. Weather Limitations: Apply tack coats when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.

B. Place hot-mixed asphalt surface course when atmospheric temperature is above 40 deg F and when base is dry. Base course may be placed when air temperature is above 40 deg F and rising.

C. Surveying: All measurement necessary to lay out the work and all construction staking which includes, but is not limited to, establishing property subgrade for earthwork, grade for the finish surfaces of A.C. pavement shall be done by the Contractor at his/her expense.

PART - PRODUCTS

2.1 MATERIALS: The Contractor shall be solely responsible for assuring that the mineral aggregate meets all requirements and, when processed, is fully capable of providing asphaltic concrete which meets all the requirements of these Specifications.

A. Asphalt Cement

1. Paving asphalt shall be grade PG 64-16. Asphalt cement content percentage by weight shall be between 5.0% and 6.0%. The exact
amount of bituminous material shall be determined, by testing, in accordance with the mix design’s adherence to the requirements of these Specifications.

2. The asphalt-cement shall be in accordance with Standard Specification 711 prepared by the refining of petroleum, and no material matter other than that naturally contained in the asphalt shall be present. It shall be uniform in character, free from water, and shall not foam when heated to 350°F.

3. The asphalt refineries test report or an approved laboratory test report for each shipment of asphalt shall be submitted to the City for approval prior to use. This report shall show the results of all tests as required by these Specifications.

B. Mineral Aggregate

1. Course mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these Specifications.

2. Fine mineral aggregate or blend material shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these Specifications.

3. Mineral aggregate furnished for mix designs shall be representative of the source and sampled from the materials stockpiles to be utilized in asphaltic concrete production for this project. Deviation from the designated stockpiles shall result in further testing for its compliance to the approved mix design. All costs for this testing will be the responsibility of the Contractor. Mix designs shall be performed utilizing mineral aggregate which conforms to the grading limits in the Table below:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>97-100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>85-100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>70-90</td>
</tr>
</tbody>
</table>

MIX DESIGN GRADING LIMITS

HOT-MIXED ASPHALT PAVING
Mineral aggregate shall conform to the following requirements in the following table when tested in accordance with the applicable test methods:

### 4. Mineral Aggregate Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Bulk Specific Gravity</td>
<td>AASHTO T 85, Arizona Test Method 211</td>
<td>2.35 - 2.85</td>
</tr>
<tr>
<td>Combined Water Absorption</td>
<td>AASHTO T 85, Arizona Test Method 211</td>
<td>0 - 2.5</td>
</tr>
<tr>
<td>Sand Equivalent Crushed Faces</td>
<td>AASHTO T 176, Arizona Test Method 212</td>
<td>Minimum 45%</td>
</tr>
<tr>
<td>Abrasion</td>
<td>AASHTO T 96</td>
<td>Minimum 30%</td>
</tr>
</tbody>
</table>

Tests on aggregates outlined in the Table above shall be performed on materials furnished for mix design purposes and composited to the mix design gradation.

### 5. Mineral Admixture

1. If the mix design includes a mineral admixture, the amount used shall be 1.0 to 2.0 percent, by weight, of the mineral aggregate, with the exact amount to be specified in the mix design proposal. Mineral admixture shall be either Portland Cement, blended hydraulic cement, or lime conforming to the requirements of the following Table:

#### 2. Mineral Admixture

<table>
<thead>
<tr>
<th>Material</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement, Type I or II</td>
<td>ASTM C 150</td>
</tr>
<tr>
<td>Blended Hydraulic Cement, Type IP</td>
<td>ASTM C 595</td>
</tr>
<tr>
<td>Lime, Type N or S</td>
<td>ASTM C 207</td>
</tr>
</tbody>
</table>

### 3. Mix Design

HOT-MIXED ASPHALT PAVING
Mix designs for asphaltic concrete shall meet the criteria in the Table below when tested in accordance with the applicable test methods.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Requirements</th>
<th>Arizona Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voids in Mineral Aggregate, Percent, Range</td>
<td>15-18</td>
<td>815</td>
</tr>
<tr>
<td>Effective Voids, Percent, Range</td>
<td>4-6</td>
<td>815</td>
</tr>
<tr>
<td>Index of Retained Strength Percent, Minimum</td>
<td>75</td>
<td>802</td>
</tr>
<tr>
<td>Wet Strength, psi, Minimum</td>
<td>150</td>
<td>802</td>
</tr>
<tr>
<td>Stability, Pounds, Minimum</td>
<td>2000</td>
<td>815</td>
</tr>
<tr>
<td>Flow, 0.01 Inches, Range</td>
<td>8-16</td>
<td>815</td>
</tr>
</tbody>
</table>

F. Lane Marking Paint: Alkyd-resin type, ready-mixed complying with AASHTO M 248, Type I. Colors as required by local standards.

G. Herbicide Treatment: Commercial chemical for weed control, registered and approved by Environmental Protection Agency. Provide granular, liquid, or wettable powder form.

H. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate. Dowels shall be galvanized steel, 3/4-inch diameter, 10-inch minimum length. Provide asphalt mastic for bedding wheel stops.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. General: Remove loose material from compacted subbase surface immediately before applying herbicide treatment.
B. Proof-roll prepared subbase surface to check for unstable areas and areas requiring additional compaction.

C. Notify Contractor of unsatisfactory conditions. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.

D. REMOVAL OF PAVEMENT: All sawcutting and removal of bituminous pavement shall be in accordance with the materials and workmanship requirements of PC/COT Specifications.

1. Self propelled drop hammer will not be allowed as a substitute for sawcutting.

E. Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subbase.

3.2 ASPHALT PLACEMENT: Placement of asphaltic concrete shall be as described herein. All Portland Cement Concrete shall be placed prior to asphaltic concrete.

A. Transporting Mixture

1. Trucks used in hauling the mixture shall have tight, clear, smooth compartment, lightly oiled to prevent the mixture from adhering to the body. If required by the Project Inspector, the load shall be covered with a tarpaulin to prevent loss of heat. Mixtures which have cooled in transport shall be rejected. Hauling over freshly laid asphaltic concrete pavement will not be permitted.

B. Equipment

1. General - All equipment and tools used on the work shall be subject to approval of the Owner's Representative, and shall be maintained in good condition and proper working order. Mixtures shall not be placed when atmospheric temperature is below 50°F, or unless otherwise directed by the Owner's Representative, on wet or frozen surfaces or if the weather is rainy or if rain is imminent. The temperature of the asphaltic concrete, immediately behind the laydown machine shall be a minimum of 250°F but shall not exceed 350°F. Unless otherwise directed by the Owner's Representative, the mixture shall be placed in uniform strips approximately 8-10 feet
in width for the full width to be paved. The material shall be spread in a layer of such thickness that, when compacted, the pavement will be of the required thickness and smoothness.

2. When spreading cannot be done by machines, it shall be done with shovels and rakes.

3. Placing and finishing by Means of a Self-Propelled Paving Machine: Except when placing asphaltic concrete under certain conditions or at certain locations where the Owner's Representative deems the use of automatic controls impracticable, all courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatic control system.

a. The self-propelled paving machine shall be equipped with an automatic control system which will control the elevation of the screed at each end and which is automatically actuated by a system of sensor-operated devices which sense and follow reference lines or surfaces on one or on both sides of the machine as required.

b. Failure of the automatic control system to function properly may be cause for the suspension of the asphaltic concrete operations until such time as the automatic control system has been made operative and is functioning properly.

c. The screed shall be maintained at the proper elevation at each end by controlling the elevation of one end directly and the other end indirectly through controlling the transverse slope and alternately, when directed, by controlling the elevation of each end independently.

d. The automatic control system shall be capable of working with the following items which shall be furnished with the machine and used when laying the asphaltic concrete roadway:

Ski-type device at least 30 feet in length.
Short ski or shoe.

e. The asphaltic concrete shall be deposited directly into the paving machine from the hauling vehicle, spread and compacted in a dense layer with a smooth surface. The
screed assembly shall be heated when required to facilitate finishing the surface.

f. Before final acceptance, all paved surfaces shall be water tested for drainage in the presence of the Owner's Representative. Any areas not draining properly shall be corrected to the Owner's Representative's satisfaction at the Contractor's expense.

4. Compacting and Rolling: Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic tired and/or tandem powered vibrating steel wheel and shall be approved by the Owner's Representative.

a. Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

b. Steel wheel compactors shall weigh not less than eight tons.

c. Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds.

d. Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

5. Rolling Method Procedure

a. Compaction control shall be the responsibility of the contractor. Contractor shall establish a rolling pattern at sequence of coverages using specified types of compactors
to achieve a minimum 100% compaction for aggregate base course and 95% compaction for asphaltic material. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved. The finish pass shall be by static steel wheel.

b. Initial and intermediate compaction shall be accomplished before the temperature of the pavement surface falls below 200°F.

c. Steel wheel compactors shall not be used in the vibrating mode for courses of one-inch (1") or less in nominal thickness nor when the temperature of the asphaltic concrete falls below 180° F.

6. Joints - All joints shall be finished to the same denseness and smoothness as other sections of the pavement. Joints between old and new work or between successive days' work shall be made so as to ensure a continuous bond between old and new sections of the pavement. All contact surfaces of previously constructed pavement shall be painted with a thin, uniform coat of a bituminous material just before the fresh mixture is placed.

a. Transverse - The roller shall not pass over the unprotected end of freshly laid mixture except when the work is to be discontinued. The edge of the previously laid course shall be cut the full depth of the course to present an even, vertical edge.

b. Longitudinal - When the edges of the longitudinal joints are irregular, poorly compacted, or otherwise unsatisfactory, the edges shall be cut back to present a straight, even edge for the full thickness of the course.

7. Edges of Pavement - The edges of the pavement shall be trimmed neatly to line while the course is being finished.

8. Joining New Pavement to Existing Structures - Edges of compacted or concrete pavement, against which new material is to be laid, shall first be given a coat of emulsion SS-1H cut back 50% with water prior to placing the new mixture. In no event shall more tack coat be applied in one day than will be covered by
bituminous mix materials during that same day. Tack coat against existing structures or pavement is considered incidental to this item, and no additional payment will be made for this item. All existing asphalt to be joined by new asphalt shall be saw cut.

9. Protection of Pavement - The pavement shall not be used for vehicular traffic of any kind until the pavement has cooled sufficiently after final rolling and the Owner's Representative has so ordered.

3.3 SMOOTHNESS TESTS - The finished surface shall be smooth and to specified grade. It shall have the thickness specified and shall not vary more than ¼-inch from the specified thickness. Any spots deficient in thickness shall be cut out and replaced with fresh mixture which shall be properly bonded to the existing pavement. The finished surface shall not have depressions in excess of 1/8-inch when measured with a 10-foot straight-edge. Any variation shall be corrected by adding or removing material as required. After the final rolling, the surface shall be tested again and any irregularities in excess of the specified tolerances shall be corrected by removing the defective work and replacing with new material. The Contractor shall furnish, at his own expense, at least one 10-foot straight-edge, true to line for its entire length.

Thickness - The thickness shall be as designated on the plans.

3.4 TRAFFIC AND LANE MARKINGS

A. Allow asphalt to cure for at least 30 days prior beginning striping work.

B. Cleaning: Sweep and clean surface to eliminate loose material and dust.

C. Striping: Do not apply traffic and lane marking paint until layout and placement have been verified with Architect. Apply paint with mechanical equipment to produce uniform straight edges in configurations shown. Apply at manufacturer's recommended rates to provide minimum 12 to 15 mils dry thickness.

D. Wheel Stops: Install at indicated locations using ground spikes; set in full bed of mastic.

3.6 FIELD QUALITY CONTROL

A. General: Testing in-place hot-mixed asphalt courses for compliance with requirements for thickness and surface smoothness will be done by Owner's
testing laboratory. Repair or remove and replace unacceptable paving as directed by Architect.

B. Thickness: In-place compacted thickness tested in accordance with ASTM D3549 will not be acceptable if exceeding following allowable variations:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus or minus 1/4 inch.

END OF SECTION 321216
SECTION 321313 - PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All site work shown on the Civil and Architectural Site Plans shall be in accordance with Pima County/City of Tucson Standard Specifications for Public Improvements except as modified on the above mentioned plans.

1.2 SUMMARY

A. This Section includes exterior portland cement concrete paving for the following:

1. Curbs and gutters.
2. Walkways, ramps, patios, and other exterior non-structural concrete paving, most broom finish, one small section exposed aggregate.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 312000 - Earthwork for subgrade preparation and grading.
2. Section 033000 - Cast-In-Place Concrete for criteria applying to work of this section and for general building applications of concrete.

1.3 QUALITY ASSURANCE

A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.

1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
2. ACI 318, "Building Code Requirements for Reinforced Concrete."
4. Uniform Standard Specifications for Public Works Construction, 2004, Pima County and City of Tucson, excluding sections on payment and measurement, unless otherwise shown on plans.
B. All work under this section shall be in accordance with the materials and workmanship requirements of SECTION 908, entitled CONCRETE CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS, of the latest edition of the Pima County/City of Tucson Standard Specifications for Public Improvements, as well as Standard Details Section 200.

C. PROJECT CONDITIONS: Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a 100-foot or less radius and to produce configurations as shown on site paving.

B. Form Release Agent: Provide commercial formulation form-release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type II.


C. Water: Potable.

2.3 ADMIXTURES: Provide for concrete paving as specified in Section 03300.

2.4 CURING MATERIALS

A. Liquid Membrane-Forming Curing Compound: ASTM C 309, Type I, Class A or B, wax free.
2.5 RELATED MATERIALS

A. Bonding Agent: Acrylic or styrene butadiene.

B. Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.

2.6 CONCRETE MIX

A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.

1. Do not use the Owner's field quality-control testing agency as the independent testing agency.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:

2. Slump: Comply with Section 03300.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

B. Remove loose material from compacted subbase surface immediately before placing concrete.
3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

1. Provide block-outs or additional forming as needed to produce colored concrete pattern areas as shown on the drawings.

B. Check completed formwork and screeds for grade and alignment to following tolerances:

1. Top of Forms: Not more than 1/8 inch in 10 feet.
2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 JOINTS

A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.

1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise.

B. Contraction Joints: Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings. Construct contraction joints for a depth equal to at least 1/4 of the concrete thickness, as follows:
1. Toolled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.

2. Inserts: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.

C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than 1/2 hour, unless paving terminates at isolation joints.

1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete.

2. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.

3. Provide tie bars at sides of paving strips where indicated.

4. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

D. Isolation Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, building foundations, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless indicated otherwise. Locate contraction joints at 20 feet on center, or as shown on drawings.

2. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.

3. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.

4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

C. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete. Add color admixture to concrete at plant in strict accordance with manufacturer’s instructions.

D. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

1. When concrete placing is interrupted for more than 1/2 hour, place a construction joint.

E. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

F. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.

G. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.

1. Radius Edges: Provide minimum 3/8" radius edges for all flatwork.

H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire
fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect.

I. Curbs and Gutters: Comply with local Standards and details on drawings.

J. CONCRETE FINISHING

1. Float Finish: For concrete to receive specified finishes, begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightsedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.

2. Broom Finish: Provide at typical new paving to match existing.

3. Exposed Aggregate Finish: Provide at rear courtyard. WHAT KIND OF AGGREGATE - EXPOSURE?

K. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to a smooth radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
D. Curing Methods: Cure concrete by curing compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoil areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.7 FIELD QUALITY CONTROL TESTING: Test concrete in accordance with Section 033000.

A. Remove and replace any concrete sections (from joint to joint or other logical stopping point) that has been damaged during construction processes prior to Substantial Completion.

END OF SECTION 321313
SECTION 328400 – LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including all General and Supplementary Conditions and Supplements and Amendments to the General Conditions of the Contract apply to work specified in this section.

1.2 DESCRIPTION OF WORK

A. The work covered by this section includes, but is not limited to the:
   1. Excavation, backfill and compaction of trenches.
   2. Connection and modification to existing irrigation mainlines.
   3. Installation of new mainline and lateral line pipe.
   4. Pressure testing of mainlines.
   5. Installation of isolation valves and remote control valves.
   6. Modification of the existing automatic controller, control wiring, and related equipment.
   7. Installation of new irrigation control wiring and related equipment.
   8. Installation of drip emitters.
   9. Operational testing of the system components to insure proper system operation.
   10. Initial maintenance of the irrigation system.

B. The extent of the irrigation work is shown on the drawings and details.

1.3 RELATED WORK

A. Related work includes, but is not limited to:
   1. The planting of trees and shrubs.
   2. The construction / installation of hardscape and other site improvements.

1.4 COORDINATION

A. The Contractor shall coordinate all irrigation system work with the Architect. Work that is completed or in-progress shall be protected during the installation of the irrigation system. The Contractor shall notify the

LANDSCAPE IRRIGATION 328400-1
Architect of field conditions, which prevent installation of the irrigation system as shown.

1.5 REQUIRED LICENSURE

A. All work shall be performed by a Contractor licensed by the State of Arizona Registrar of Contractors. The commercial license classification held by the Contractor shall be appropriate for the work to be performed.

1.6 COMPLIANCE WITH APPLICABLE REGULATIONS

A. The Contractor shall comply with all local, state, and federal regulations regarding materials, methods of work, and disposal of excess and waste materials. The Contractor shall provide notices required by governmental authorities, request required inspections, obtain required permits, and pay for all associated fees.

1.7 SUBMITTAL REQUIREMENTS

A. Material and Equipment Information: The Contractor shall submit to the Architect, three (3) sets of catalog cuts for all irrigation system materials and equipment proposed for use on the project. The information submitted shall clearly indicate the type, model, and size of the equipment proposed and shall be sufficient for the Architect to determine if the proposed equipment meets the project specifications. No materials or equipment shall be ordered or incorporated into the work until the material or equipment has been approved for use on the project. The submittal shall include information related to the following items.

1. Mainline Pipe
2. Lateral Line Pipe
3. Fittings for Mainline Pipe
4. Fittings for Lateral Line Pipe
5. Solvent Weld Primer for PVC Pipe
6. Solvent Weld Cement for PVC Pipe
7. Ball Isolation Valves
8. Remote Control Valves
9. Pressure Regulating Valves
10. Access Boxes for Remote Control Valves
11. Access Boxes for Gate / Ball Valves
12. Irrigation Pull Box
13. Existing Controller
14. Two-Wire Control Cable
15. Communication Wire
16. Waterproof Wire Splices
17. Drip Emitters (Multi-outlet and single outlet)
18. In-Line Screen Filters
19. Emitter Distribution Tubing
20. Access Boxes for Emitters
21. Emitter Line Flush Caps
22. Access Boxes for Flush Caps
23. Mainline Marking Tape

B. As-Built Record Drawings: The Contractor shall submit to the Architect prior to Substantial Completion of the Work, As-Built Record drawings for the irrigation system installed. The drawings shall indicate the location of all; mainlines, master valves, flow sensors, gate valves, remote control valves, quick coupling valves, and sleeves and pipelines under roadways or other paved surfaces. Locations shall be identified by two or more dimensions from fixed objects such as curbs or structures. The As-Built Drawings shall be prepared with ink on mylar. The preparation of mylar reproductions of the drawings and the preparation of the drawings shall be at the Contractor's expense.

1.8 IRRIGATION SYSTEM DRAWINGS:

A. The irrigation drawings are diagrammatic and are intended to show the approximate location of outlets, equipment and piping. Certain runs of piping may be shown distorted for clarity. Minor adjustment to the layout of the system will be necessary. Significant adjustments to the layout, including all changes that effect the configuration of the system or length of piping runs, shall be approved by the Architect.

1.9 PERFORMANCE REQUIREMENTS

A. General Performance Requirements: The Contractor shall be responsible for providing a complete and fully functioning irrigation system to support all landscape plantings installed on the project site. All changes to the layout and dimensions of the irrigation system shall be as approved by the Owner's Representative. Adjustments to the irrigation system, if needed, shall be made by the Contractor, as directed by the Owner's Representative.

B. Control System Requirements: The Contractor shall be responsible for the installation of complete and fully functioning irrigation control system utilizing existing and new equipment. The Contractor shall provide and install all specified equipment and all other incidental items as needed for the proper operation of the system. The Contractor shall coordinate his work with the Owner and with the control system manufacturer to ensure that all system features are fully operational.
1.10 Continuous Operation of Existing Irrigation System:

A. Operation of Existing Irrigation System: To the greatest extent possible, the existing irrigation system within the project work area and within other portions of the campus shall be maintained in an operable condition during project construction. Temporary shut-downs of portions of the existing system will only be allowed with permission from the Owner's Representative. The schedule and duration of shut-downs shall be as approved by the Owner's Representative.

PART 2 - MATERIALS

2.1 PIPE AND FITTINGS

A. PVC Mainline and Lateral Line Pipe: Mainline and lateral line pipe shall be PVC plastic pipe extruded from virgin parent materials. Pipe shall comply with ASTM standards D-1785-34 or D-2241-34 as applicable and shall be free from defects.

1. PVC Mainline and Lateral Line Pipe: Mainline and lateral line pipe shall be PVC plastic pipe extruded from virgin parent materials. Pipe shall comply with ASTM standards D-1785-34 or D-2241-34 as applicable and shall be free from defects.

2. Mainline Pipe (4" and larger) – Mainline pipe, pipe subject to constant pressure, shall be C-900 PVC pipe.

3. Mainline Pipe (Smaller than 4") – Mainline pipe, pipe subject to constant pressure, shall be Schedule 40 PVC pipe.

4. Lateral Line Pipe: Lateral line pipe not subject to constant pressure shall be Schedule 40 PVC pipe.

5. Sleeves for Pipe and Control Wire: Sleeves for irrigation pipe and control wire under the parking lot paving or walkway shall be C-900 PVC pipe for sleeves larger than 4" size and Schedule 40 PVC pipe for pipe 4" size and smaller.

B. PVC Pipe Fittings: PVC fittings shall be made from Type I, Grade I, PVC compounds conforming to ASTM D-1784, D-2672, and D-2241 as applicable.

1. PVC Fittings for Mainline Pipes (Size 4" and Larger): PVC fittings for mainline pipes 4" size and larger shall be cast-iron, deep bell pressure fittings.

2. PVC Fittings for Mainline Pipes (Smaller than 4" Size) and Lateral Lines: PVC fittings for mainlines and lateral lines shall be Schedule 40 PVC.
3. PVC Pipe Fittings: PVC fittings shall be made from Type I, Grade I, PVC compounds conforming to ASTM D-1784, D-2672, and D-2241 as applicable.

4. PVC Fittings for Remote Control Valve Assemblies: PVC fittings for remote control valve assemblies, and as detailed for other locations, shall be Schedule 80 PVC.

5. Threaded PVC Pipe and Nipples: All threaded PVC pipe and nipples shall be Schedule 80 PVC.

6. PVC Fittings for Remote Control Valve Assemblies: PVC fittings for remote control valve riser and assemblies, and as detailed for other locations, shall be Schedule 80 PVC.

C. PVC Solvent Cement and Primer: Solvent cement and primer for joining PVC pipe and fittings shall be as approved by the pipe and fitting manufacturers and shall comply with ASTM Standards D-2564 and F-656.
   1. Primer shall be as manufactured by IPS-Weld-On, Type P-70 or approved equal.
   2. Solvent cement shall be as manufactured by IPS-Weld-On, Type 711 or approved equal.

2.2 VALVES

A. Gate Valves – Larger than 4” Size: Gate valves larger than 4” size shall be of the epoxy coated cast iron type with flanged end, non-rising stem, resilient wedge, and handwheel operator. Gate valves shall be manufactured by Mueller, Model 2360 Series, or approved equal. Valve size shall be as noted on drawings or, if not noted, incoming pipe size.

B. Gate Valves – 2” Size to 4” Size: Ball valves shall be 200 psi. rated WOG bronze gate valves with female NTP threaded ends. Valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be equipped with a handwheel and non-rising stem. Valves shall be as manufactured by Watts, Model GV or approved equal.

C. Ball Valves – 1-1/2” Size and Smaller: Ball valves shall be 400 psi. rated WOG brass or bronze ball valves with threaded ends. Ball valves shall be equipped with resilient TFE seats and blow-out proof stems. Valve handle shall provide 1/4 turn on/off control. Valves shall be as manufactured by Watts, Model FBV, or approved equal.

D. Remote Control Valves: Remote control valves shall be of the globe type with heavy duty glass filled nylon body and bonnet, nylon reinforced rubber diaphragm, stainless steel flow control stem, self-cleaning scrubber, and 24 volt heavy-duty solenoid. Valves shall be as
manufactured by Rain Bird, Model PES Series, or approved equal. Valve size shall be as noted on the drawings.

E. In-Line Pressure Regulating Valves: In-Line pressure regulating valves shall be of the permanently assembled type with heavy-duty plastic body and NPT ends. The regulator shall have a pre-set outlet pressure of 40 psi. The regulator shall be as manufactured by Rain Bird, Model PSI-M40X-100, or approved equal.

2.3 EXISTING IRRIGATION CONTROLLER:

A. Existing Irrigation Controller: An existing Tucor TWC 100-C controller with Flowmaster LTB 100 Line Termination Box shall be utilized for this project and shall connect to the new remote control valves specified for this project using the following line decoders, two-wire control cable, and wire splices.

1. Line Decoders: Line decoders shall be Flowmaster Line Decoders LD-100 (for single valves), LD-200 (where two valves are located adjacent to each other) and LD-400 (where four valves are located adjacent to each other). The line decoders be as manufactured by Tucor, or approved equal.

2. Two-Wire Control Cable: Shall consist of bare copper conductors insulated with PVC and a high-density polyethylene, direct burial jacket. Wire size for control wires shall be #14 AWG or as noted on the drawings. Wire shall be Underwriters Laboratory (UL) approved for direct burial. Insulation on control cable shall be red. The regulator shall be as manufactured by Tucor, Model Tucor Control Cable, or approved equal.

3. Waterproof Wire Splices: Wire splices shall be of the two piece, sealant filled type which permit connection of 2 or 3 wires of 18 through 10 gauge size. Wire splices shall be Underwriter Laboratory (UL) listed. Splices shall be as manufactured by Spears, Model ds-400 prefilled connectors and Spears ds-300 sealer, or approved equal. Line splices are allowed only on runs of more than 500'.

B. Existing Controller Locations and Zones: The existing controller is located in a stainless steel pedestal enclosure in the northwest corner of the Receiving Yard. This controller serves the entire campus via the Tucor Two-Wire/Decoder based system.
2.4 DRIP EMITTERS:

A. Multi-Outlet Drip Emitters: Emitters shall be of the permanently assembled, pressure compensating, six-outlet type with ½" FPT inlets. The flow rate per outlet shall be nearly the same at inlet pressures of 15 to 50 psi. The multi-outlet emitters shall be as manufactured by Rain Bird, Model XBT-05-6 and Model XBT-10-6 or approved equals.

B. Single-Outlet Drip Emitters: Single-Outlet Emitters shall be of the permanently assembled type with heavy-duty plastic housing and ½"FTP inlet. Emitters shall have a flow rate of 1.0 gph. Emitters shall be as manufactured by Rain Bird, Model XBT-10, or approved equal. Single-outlet emitters shall be used only for the irrigation of individual shrubs in locations where it is not feasible to irrigate the subject shrub with a multi-outlet emitter.

C. Emitter Line Flush Caps: Flush caps shall consist of a Schedule 40 PVC male adapter with a Schedule 40 PCV threaded cap.

D. Emitter Distribution Tubing: Emitter distribution tubing shall be manufactured of vinyl with an O.D. of .22" and an I.D. of .16". Distribution tubing shall be as manufactured by Rain Bird, Model XQ, or approved equal.

2.5 ACCESS BOXES:

A. Valve Access Boxes: Valve access boxes for isolation valves and remote control valve assemblies shall be constructed of a combination of polyolefin and fibrous inorganic components. Valve box covers shall be permanently marked with the words "control valve" or "irrigation". Valve boxes covers (lids) shall be Purple.

B. Valve access box shall be as manufactured by Rainbird or approved equal. All boxes, exclusive of emitter line flush cap access boxes, shall be equipped with bolt-down lids. Color shall be Purple. Box sizes and configurations shall be as follows:

1. Remote Control Valve Assemblies ...............Jumbo – 12.1" x 19.8"
2. Ball / Isolation Valves................................Standard - 12" x 16"
3. Emitter Line Flush Cap Access Boxes.................8" Inch Round
2.6 Emitter Access Boxes:

A. Emitter Access Boxes: Emitter access boxes shall be constructed of UV resistant thermoplastic materials with a base diameter of approximately 9.8", a top diameter of approximately 6.4", and a snap-on lid. Box shall be slotted to accommodate pipe and distribution tubing. Access box shall be as manufactured by Rain-Bird, Model VB-7RNDT, or approved equal.

2.7 Irrigation Pull Boxes

A. Irrigation pull boxes shall be constructed of reinforced concrete with cast-iron lids. Boxes shall be as manufactured by Old Castle Precast, Model No. 2 or approved equal. Pull boxes shall be provided with extensions as required to provide access to the equipment installed to the specified depth(s).

2.8 Miscellaneous Irrigation System Equipment:

A. In-Line Filter: The in-line filters shall have a glass-filled nylon body with removable 200 mesh screen filter and integral flush valve. The filter shall be as manufactured by Rainbird, Model RBY-100-C-LSS with flush valve and 200 mesh stainless steel screen, or approved equal.

B. Detectable Marking Tape: Detectable marking tape to be installed above the mainlines shall be a five mil thick, five-ply composition, polyethylene tape. The tape shall have a 20 gauge solid aluminum foil core that is encapsulated within the polyethylene material. The tape shall be three inches (3") wide and shall have the words “CAUTION, RECLAIMED IRRIGATION LINE BELOW” printed at regular intervals. Tape color shall be purple. The detectable marking tape shall be as manufactured by T. Christy Enterprises Inc., Model TA-DT-3"-P-RW or approved equal.

PART 3 - EXECUTION

3.1 Blue Staking:

A. Blue Staking: The Contractor shall request that the project site be Blue Staked prior to the start of any excavation or trenching work. Blue Staking shall be kept current during the course of the project. The Contractor shall also request that all private utilities be marked prior to the start of any excavation and trenching work. All utilities damaged by the Contractor shall be repaired or replaced by the Contractor, as required by the Owner or appropriate utility company, at the Contractor's expense.
3.2 LAYOUT:

A. Layout of Irrigation System: Prior to the start of trenching and excavation work, the Contractor shall layout the irrigation system, staking out the location of mainline, master valves, flow sensors, remote control valves, and other equipment as shown on the drawings. All significant deviations from the layout shown on the drawings shall be approved by the The Architect.

B. Existing Mainline and Lateral Line Connections: The location of all points of connections to the existing irrigation mainlines, laterals, and control cable shall be coordinated with the PCC Grounds Maintenance Staff prior to construction.

3.3 TRENCHING:

A. Trenching: Trench excavations shall be straight and true with uniform bottom for bearing of pipe or conduit. Minimum depth of cover on pipe, sleeves, conduit, and wire shall be as follows:

1. Under Fire Lanes, Drives, and Parking Areas:
   a. PVC Sleeves for Mainlines ................................. 24 inches
   b. Mainline Pipe .................................................. 24 inches
   c. PVC Sleeves for Lateral Lines ............................. 24 inches
   d. Lateral Line Pipe .............................................. 24 inches

2. Under Pedestrian Pavements and within Landscaped Areas
   a. PVC Sleeves for Mainlines ................................. 18 inches
   b. Mainline Pipe .................................................. 18 inches
   c. PVC Sleeve for Lateral Lines .............................. 12 inches
   d. Lateral Line Pipe .............................................. 12 inches

3.4 PLACEMENT OF PIPE AND SLEEVES:

A. Sleeves: Sleeves shall be installed as detailed. Separate sleeve shall be provided for pipe and control wire. Sleeves shall extend 12" beyond edge of sidewalk and/or pavement. Sleeve size shall be as noted. If not noted, the sleeve shall be a minimum of two standard pipe sizes larger than the pipe enclosed.

B. Placement of PVC Pipe: Place select backfill material in bottom of trench as detailed before laying pipe. Do not install pipe in trench that is wet or when conditions are otherwise unsuitable for the work. Keep inside of pipe clean during installation. Snake pipe from side to side of trench to
allow 1 additional foot per 100 inches of pipe for expansion and contraction. Provide 2-inch minimum vertical and horizontal clearance between irrigation pipes. Provide 12-inch minimum clearance between irrigation pipes and pipe, conduit, or cable of other trades.

3.5 CONSTRUCTION OF PIPE JOINTS:

A. PVC Pipe: Make solvent weld joints using only procedures recommended by the pipe, fitting, and solvent weld cement manufacturers. Make all threaded connections using teflon tape on male threads.

3.6 FLUSHING AND PRESSURE TESTING OF MAINLINE:

A. Notification: The Contractor shall notify the Architect of his intent to perform pressure testing 72 hours prior to the scheduled test time. Except as otherwise approved, all tests shall be performed in the presence of the Architect. The entire mainline shall be tested at one time except for instances where project phasing requires testing of individual segments of the mainline system.

B. Tools and Equipment: The Contractor shall furnish all tools, materials, fittings, and equipment required for testing and shall make all temporary connections.

C. Trench and Backfill Conditions for Testing: The trench(es) shall not be backfilled until pressure testing of mainline has been successfully completed. Center loading of mainline pipe during testing is acceptable. All joints shall be exposed during testing operations.

D. Flushing: After all mainline piping and risers are connected in place and all related work is complete, open each control valve(s) and use a full head of water to flush the mainline system.

E. Testing: The mainline shall be tested at a pressure of not less than 100 psi for a period of 4 hours with all isolation valves open, and all pipe uncovered. For acceptance, the original test pressure shall be maintained for the duration of the test.

F. Repairs: All leaks or defects which develop under pressure testing shall be promptly repaired and the test repeated until satisfactory results have been achieved. Repairs shall be made using only materials and procedures specified herein.
3.7 TWO-WIRE CABLE INSTALLATION:

A. Control Wiring: Control wires shall be installed in PVC conduit. Pull boxes shall be provided along conduit runs at intervals not exceeding 200 feet and at all changes in direction greater than 30 degrees. A three-foot long (3') coil of wire shall be looped within the pull box.

B. Two-Wire Control Cable: Each end of the control or "hot" wire and the common or "ground" wire shall be brought to the remote control valve and a coil of wire shall be neatly looped in the access box as detailed. Splices shall be made using waterproof wire splices. Wire shall be spliced at remote control valve and controller locations only.

3.8 BACKFILLING:

A. Placement of Bedding Material: Place select backfill material around pipe to provide minimum cover shown on the details. Carefully tamp or water-in bedding material around pipe.

B. Placement of Backfill: Place excavated material as backfill in lifts of six inches, maximum. Carefully compact each lift as work progresses. Grade top of trenches to be level with adjacent finished grade. All trenches improperly backfilled or where settlement occurs shall be re-excavated and compacted as specified.

C. Removal of Excess Material: Excavated material that is removed from trenches and not used as backfill shall be carefully removed from the site and disposed of in an approved location at the Contractor's expense.

3.9 VALVES AND VALVE ACCESS BOXES:

A. Valves: Isolation valves and remote control valves shall be installed as detailed. Use teflon tape on all threaded connections.

B. Valve Access Boxes: Install valve access boxes such that top of box is parallel to and flush with the surrounding finished grade, or as detailed. Provide gravel sumps and brick footings as detailed. Where more than one access box is to be installed in a given location, group boxes together and keep boxes within a uniform alignment. Provide adequate clearance around enclosed valves to allow for valve operation and/or removal.
3.10 IRRIGATION PULL BOXES:

Irrigation Pull Boxes: Install irrigation pull boxes such that top of box is parallel to and flush with the surrounding finished grade, or as detailed. Provide gravel sumps and brick footings as detailed.

3.11 CONTROL SYSTEM:

A. Existing Irrigation Controller: The existing controller shall be relocated from its current location. The controller shall be installed as detailed, in the location approved by the Architect. Extend electrical power and telephone communication to new controller location as shown on the electrical plans and make connections. All work shall be in accordance with applicable code requirements.

B. Modifications to the existing controller and all related control system components shall be performed in accordance with the control system manufacturer's written instructions. The work shall be under the supervision or direction of a factory authorized technician. The Contractor shall be responsible for all installation and testing work as required for the operation of the system in accordance with the manufacturer's specifications.

3.12 DRIP EMITTERS:

A. Drip Emitters: Install drip emitters in access boxes and extend distribution tubing to locations around the irrigated plant as detailed.

3.13 MISCELLANEOUS IRRIGATION EQUIPMENT:

A. In-Line Filters: Install in-line filters as detailed. Position filter in access box so that the unit can be disassembled and the filter removed and/or replaced, without removal of the access box.

B. Detectable Marking Tape: Install detectable marking tape above all mainline pipe as detailed.

3.14 OPERATIONAL TESTING:

A. Operational Test: An operational test shall be performed by the Contractor after the irrigation system installation is complete. The test shall demonstrate that all controller and all new and existing control valves perform properly and shall demonstrate that all emitters are operating
correctly and are providing adequate irrigation water to landscape plantings. All tests shall be performed in the presence of the Architect. Irrigation system components found to be operating incorrectly or to be defective shall be replaced or repaired by the Contractor at no cost to the Owner.

3.15 REPAIR OF DAMAGE BY LEAKS:

A. Repair of Damage: The Contractor shall be responsible for damages to the slabs, curbs, roadways, walkways, piping systems, electrical systems, buildings and associated equipment and contents caused by leaks in the irrigation piping systems being installed or having been installed by him. The Contractor shall repair all damage so caused. All repair work shall be performed in a manner that is satisfactory to the Architect, and at no cost to the Owner.

3.16 CLEAN-UP:

A. Clean up: Perform cleaning operations during the installation of the work and upon completion of the project. Remove from the site all excess materials, debris, and equipment. Legally dispose of all excess and waste materials. Repair all damage resulting from irrigation system installation.

3.17 MAINTENANCE AND GUARANTEE:

A. Maintenance during Construction: The Contractor shall operate and maintain the irrigation system during project construction. Operation and maintenance procedures shall include, but not be limited to: programming of the controller(s), repair / adjustment of sprinklers, repair / replacement of emitters, and replacement of defective installations. Maintenance during construction shall continue until the issuance of a Certificate of Substantial Completion.

B. Inspection of Completed Irrigation Work: Upon substantial completion of the irrigation work, the Contractor shall notify the Architect who will schedule an inspection of the irrigation system improvements. During the inspection, items which are incomplete or which must be repaired or replaced will be identified. The Issuance of a Certificate of Substantial Completion will be contingent on the completion or correction of noted items.

C. Maintenance after Substantial Completion: After issuance of a Certificate of Substantial Completion, the Contractor shall continue to operate and maintain the irrigation system for a period of 30 consecutive calendar
days. Operation and maintenance procedures shall include, but not be limited to: programming of the controller(s), repair / replacement of emitters, and replacement of defective installations. Upon satisfactory completion of the initial Contractor maintenance period, the Owner will assume responsibility for irrigation system operation and maintenance.

1. Suspension of Initial Contractor Maintenance Period for Non-Compliance: Failure to properly operate and maintain the irrigation system as specified herein, as determined by the Architect, will result in the suspension of the number of days being credited towards the initial 30 day Contractor maintenance period. The suspension will remain in effect until such time as the remedial actions required by the Architect have been implemented by the Contractor.

3.18 GUARANTEE:

A. Guarantee: The Contractor shall guarantee the irrigation system to be free of defects in materials and workmanship for a period of one year from the date of Final Acceptance. All material and equipment that proves defective within that period shall be promptly repaired or replaced by the Contractor at no additional cost to the Owner. The guarantee period for any part so repaired or replaced shall be extended for a period of one year from the date of repair or replacement.

END OF SECTION 328400
SECTION 329000 – PLANTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract including all General and Supplementary Conditions and Supplements and Amendments to the General Conditions of the Contract apply to the work specified in this section.

1.2 SUMMARY

A. The work covered by this Section includes, but is not limited to, the:
   1. Fine grading of landscaped areas.
   2. Excavation of plant pits.
   3. Planting of trees, shrubs and cacti
   4. Installation of decomposed granite surfacing (Type I and II).
   5. Installation of decorative rip rap surfacing.
   6. Placement of landscape boulders.
   7. Hydroseeding of designated areas with native plant seed.
   8. Clean up of all soil, debris, and excess materials from the project site.
   9. Initial maintenance of the landscape improvements.

B. The extent of the landscape work is shown on the drawings and details.

1.3 RELATED WORK

A. Related work includes, but is not limited to:
   1. Installation of an automatic irrigation system and modification of the existing irrigation system.
   2. Earthwork and site grading.
   3. The construction of walkways and other paved surfaces.

1.4 COORDINATION:

A. The Contractor shall coordinate all planting and related landscape work with the Architect. Work that is completed or in-progress shall be protected during installation of landscape plantings. The Contractor shall notify the Architect of field conditions which prevent the installation of landscape improvements as shown.
1.5 REQUIRED LICENSURE:

A. All work shall be performed by a Contractor licensed by the State of Arizona Registrar of Contractors. The commercial license classification held by the Contractor shall be appropriate for the work to be performed.

1.6 COMPLIANCE WITH APPLICABLE REGULATIONS:

A. The Contractor shall comply with all local, state, and federal regulations regarding materials, methods of work, and disposal of excess and waste materials. The Contractor shall provide notices required by governmental authorities, request required inspections, obtain required permits, and pay for all associated fees.

1.7 SUBMITTAL REQUIREMENTS

A. General: The Contractor shall make the submittals identified below. Submittals shall be made and approved prior to the delivery of material to the site and its incorporation into the work.

B. Certificates of Compliance: Submit three copies of the following Certificates of Compliance to the Architect for review and approval

1. Mulch: The certificate, signed by the supplier, shall indicate that the material complies with the project specifications.
2. Fertilizer: Copies of the manufacturer’s statement of analysis.
4. Native Plant Seed: The certificate, signed by the supplier, shall indicate that the seed is of the species mix specified and that it complies with these specifications and applicable state statutes.

C. Samples: Submit the following samples to the Architect for review and approval.

1. Decomposed granite: One cubic foot of each gradation and color proposed for use on the project.
2. Rip Rap: One cubic foot of the gradation and color proposed for use on the project.
3. Boulders: One sample boulder of the smallest boulder size specified for the project. Sample to be representative shape shown in boulder detail on plans and of the color of the boulders proposed for use on the project.
4. Rock Mulch for Hydroseeded Areas: One cubic foot of each gradation and color proposed for use on the project.
PART 2 - MATERIALS

2.1 TOPSOIL:

A. Topsoil for Plant Pit Backfill: Topsoil for plant pit backfill shall be the existing native soil on the project site
   1. Removal of Extraneous Materials: Prior to the use of on-site native soil (topsoil) for the plant pit backfill, all large roots, brush, rocks with a dimension of three inches (3") or larger, clay lumps, caliche, debris, and other extraneous material shall be removed from the soil and disposed of off-site.

2.2 SOIL AMENDMENTS:

A. Mulch: Mulch shall be "Forest Magic" brand or other approved nitrogen stabilized (nitrolized) fine ground fir bark. Mulch shall consist of composted, ground, or shredded Fir or Ponderosa Pine Bark shavings with at least 85% able to pass through a 1/4 inch screen. The pH of the mulch shall not exceed 7.5. It shall be hygroscopic or shall contain a wetting agent and shall be Nitrogen stabilized with 0.5% Nitrogen content.

B. Soil Sulfur: Soil sulfur shall be agricultural sulfur for soil treatment. It shall be piled or granulated, containing 99.5% (minimum) sulfur and 0.5% (maximum) inert ingredients. Soil sulfur shall be Disper-Sol Elemental Sulfur or approved equal. It shall be delivered to the site in the original unopened containers bearing the manufacturer's guaranteed statement of analysis.

2.3 FERTILIZERS

A. General Requirements: All fertilizers used on the project shall be in pelleted form and of recent manufacture. Fertilizers shall be delivered to the site in the original unopened containers bearing the manufacturer's guaranteed statement of analysis.
   1. Fertilizer for Prepared Planting Soil Mix for Tree and Shrub Plantings: Fertilizer shall be Ammonium Phosphate (16-20-0) commercial fertilizer containing in available form a minimum of 16% Nitrogen and 20% Phosphoric Acid.

2.4 PREPARED PLANTING SOIL MIX FOR TREES, SHRUBS, AND ACCENTS:

A. Prepared Planting Soil Mix for Trees, Shrubs and Accents: Prepared planting soil mix shall consist of a uniform mixture, by volume and loose measure, of the following components per cubic yard: 20 cu. ft. on-site native soil (topsoil), 7 cu.
ft. organic soil conditioner, 2 lb. soil sulfur, and 1 lbs. fertilizer (16-20-0). The prepared planting soil shall be thoroughly blended prior to placement in plant pits.

B. Prepared Planting Soil Mix for Cacti: Prepared planting soil mix for cacti shall consist of on-site native soil with 0.25 lbs. of Soil Sulfur incorporated into the soil backfill at each plant (cactus).

2.5 MATERIALS FOR NATIVE PLANT SEEDING (HYDROSEEDING)

A. Native Plant Seed: Seed shall be State Certified seed of the latest season’s crop and shall be delivered to the site in the original, unopened, containers bearing the supplier’s guaranteed statement of analysis for: species mixture, purity, germination, weed content, and inert material content. The percentage of noxious weed seed allowable shall be as defined by current State of Arizona statutes related to agricultural seed. Seed that has become wet, moldy, or otherwise damaged during transit or storage will be rejected.

1. Seed Mix: The seed mix shall be as identified on the project plans.
2. Wood Fiber Mulch: Mulch shall be virgin or recycled wood cellulose fiber produced specifically for hydraulic application and shall not contain any germination or growth inhibiting substances. The mulch shall contain a temporary, non-toxic green dye to aid in the uniform application of the mulch slurry. When applied to the soil surface, the mulch shall form an absorbent cover that allows for the percolation of water into the underlying soil.
3. Rock Mulch: Rock mulch shall be as specified under Inorganic Surfacing Materials, Section 2.6, D.

2.6 INORGANIC SURFACING MATERIALS

A. Decomposed granite surfacing – Type I and II: Except as may be approved by the Owner’s Representative, all material used on the project shall be from the same source and shall match the approved sample. The decomposed granite types shall be as supplied by Kalamazoo Materials Inc, color “Apache Gold,” or approved equal. Sizes shall be as noted on plans.

B. Rock Rip-Rap: Rock rip-rap shall be native rock, free from caliche, organic matter, debris and other extraneous materials. Size shall be from four inches (4") to twelve inches (12") in diameter. Rip-rap shall be as supplied by Kalamazoo Materials Inc, color “Apache Gold,” or approved equal. Sizes shall be as noted on plans.

C. Boulders: Boulders shall be as supplied by Kalamazoo Materials Inc, color “Kino Blue,” or approved equal. Size shall be as noted in the plans and details.
D. Rock Mulch for Hydroseeded Areas: Except as may be approved by the Owner's Representative, all material used on the project shall be from the same source and shall match the approved sample. The rock mulch shall be as supplied by Kalamazoo Materials Inc, color "Apache Gold," or approved equal. Sizes shall be as noted on plans.

2.7 TREES, SHRUBS, AND ACCENT PLANTS:

A. Plant Form and Quality: All trees, shrubs, and accent plants shall be normally developed individuals of their species. The habit of branching, development of foliage, and outline shall conform to grades of sound, first quality nursery stock for the subject species. All plants shall be free of disease, insects, insect eggs and larvae, animals, or animal damage.

B. Plant Size: Plant size shall conform to the measurements specified on the plant list, and all provisions of "American Standard for Nursery Stock" by the American Association of Nurseriesmen, Inc. or the "Growers Committee Recommended Tree Specifications" by the Arizona Nursery Association, whichever is the more stringent specification. Minimum caliper and other dimensions shall be as noted on the drawings.

C. Plant Root Systems: Container grown plants shall be in containers for a sufficient length of time for the root system to hold the earth when taken from the container but not long enough to become rootbound or cause a "hardening off" of the root system. No plant shall be loose in the root ball.

2.8 STAKING MATERIALS

A. Tree Stakes: Tree stakes shall be three (3) inch (min.) diameter by eight (8) feet (min.) long peeled lodge pole pine stakes. Stakes shall be pressure treated with an EPA approved wood preservative and free of any weakening knots or other defects. Stakes longer than eight feet (8') shall be utilized, at no additional cost to the Owner, if required to properly support the trees installed on the project.

B. Guy Wire: Guy Wire shall be 12 gauge, annealed, galvanized wire.

C. Chaffing Guards: Chaffing guards shall be new, 3/4-inch diameter, reinforced rubber or vinyl hose. Guards shall be 12 inches in length, minimum, as required to protect tree from damage by guy wires.
2.9 HORTICULTURAL CHEMICALS:

A. Pre-emergent Herbicide: The pre-emergent herbicide shall be "Surflan" or approved equal.

B. Post-emergent Herbicide: The post emergent herbicide shall be "Round-up" or approved equal.

PART 3 - EXECUTION

3.1 BLUE STAKING:

A. Blue Staking: The Contractor shall have the work area Blue Staked prior to the start of any excavation work. Blue Staking shall be kept current during the course of the project. All utilities damaged by the Contractor shall be repaired or replaced by the Contractor, as required by the Owner or appropriate utility company, at the Contractor's expense.

3.2 PROTECTION OF PLANTS TO BE PRESERVED-IN-PLACE:

A. Plants within Limits of Grading: All plants within the limits of grading and designated as to remain-in-place shall be protected during project construction. The Contractor shall provide barricades around each plant or planting area. Plants that are damaged by the Contractor's activities shall be replaced with boxed specimen plants of the same species as the plant damaged. Replacement plants shall be 48" box size, minimum, for trees and 15-gallon size, minimum, for shrubs. Replacement plants shall be provided at the Contractor's expense.

3.3 LAYOUT:

A. Layout: The Contractor shall layout his work, staking out the location of plant materials as shown on the drawings. Tree locations shall be approved by the Architect prior to the excavation of plant pits.

3.4 INSPECTION OF MATERIALS AND PLANT PITS:

A. Inspection of Plants at the Source Nursery: The Contractor shall provide the Architect with the name and address of the nursery (or nurseries) supplying the plants to be used on the project a minimum of 21 days before the schedule delivery the plants to the project site. The Contractor shall also make arrangements for the Architect to inspect plants at the source nursery and to
select individual plants for delivery to the project. The Architect may elect to inspect and select individual plant specimens at the source nursery.

B. On-Site Inspection of Plant Materials at Time of Delivery: The Contractor shall notify the Architect of his intent to deliver plants to the project site 72 hours prior to the scheduled delivery time. The Architect may elect to inspect plants at the time of delivery. Plants that are rejected at the time of delivery shall be immediately removed from the project site.

C. Inspection of Plant Pits: All plant pits shall be inspected and approved by the Architect prior to the placement of Prepared Planting Soil Mix or the installation of plants.

3.5 PLANTING OF TREES, SHRUBS AND CACTI:

A. Seasonal Limitations: The planting of trees, shrubs and cacti may be conducted at any time selected by the Contractor consistent with the overall project completion schedule. Planting operations conducted during extremely hot, cold, or windy periods shall be performed at the Contractor's risk. Plants, which die or become damaged due to weather conditions shall be replaced by the Contractor at no additional cost to the Owner.

B. Excavation of Plant Pits: Plant pits and plant beds shall be excavated to dimensions detailed. All rock in the excavated soil with a dimension of three inches (3") or larger, shall be removed and disposed of off-site. Plant pits shall not undermine hardscape nor shall hardscape elements be placed over plant pits.

C. Tests for Drainage: When the excavation of plant pits is difficult and it appears that the drainage of irrigation water may not be adequate, the Architect may direct the Contractor to test selected plant pits for drainage. The testing of up to 25 percent of the total number of plant pits shall be performed by the Contractor, if requested, at no additional cost to the Owner. Testing shall consist of partially filling the pit with water and measuring the rate of infiltration. For acceptance, the pit shall drain at a rate of not less than 6" in 60 minutes. All pits which have not drained at the rate noted shall be deepened or relocated as directed by the Architect. Deepening shall consist of the construction of a 6" diameter "chimney" to the depth required to achieve an acceptable drainage rate. The deepening or relocation of up to 25 percent of the total number of plant pits shall be performed by the Contractor at no additional cost to the Owner.

D. Plant Pit Sizes: Plant pit sizes shall be as indicated on the details for the plant type and container size noted.
E. Removal of Plants from Containers: Plants in containers shall be removed from containers immediately prior to planting in a manner that will not injure the roots, stems, or foliage. Plants that are damaged during planting operations shall be replaced by the Contractor, at his expense, with plants of the same species, variety, and size as originally specified.

F. Planting of Boxed Specimen Trees: Boxed specimen trees shall be handled during transport and during installation in a manner that prevents damage to the root ball (box) or above ground portion of the tree. Appropriate lifting equipment shall be utilized to place salvaged trees. Trees shall be planted / oriented so as not to obstruct pedestrian walkways, buildings, walkways, parking spaces, or other site improvements.

G. Selection of Trees for Specific Locations: The Architect may select individual specimen trees for planting at certain project locations.

H. Planting Depth: Trees and shrubs shall be set such that the top of the rootball relative to finished grade, is as detailed. Plants which settle shall be excavated, removed, and reset to match the detailed condition.

I. Compaction of Soil Prior to Installation of Tree: All backfill placed below the rootball of a tree shall be thoroughly watered and compacted so as to prevent settlement after plant installation.

J. Staking: Nursery grown trees shall be staked the same day they are planted. The number of stakes and the manner in which trees are secured to stakes shall be as detailed. Owner provided salvaged trees shall not be staked.
   1. Requests for Waiver of Staking Requirement: If, based on the Contractor’s assessment, certain nursery grown trees do not require staking, he may request that the staking requirement be waived for the subject trees. The staking requirement may be waived (or not waived) at the sole discretion of the Architect.

3.6 HYDROSEEDING WORK

A. Soil Preparation: All areas to be seeded shall be brought to the lines and grades shown on the plans. Areas used for haul roads or otherwise compacted during project construction shall be scarified to a depth of four inches (4"). Surface rock with a dimension of four inches (4") or greater, shall be removed and disposed of off-site.

B. Hydroseed Slurry: The hydroseed slurry shall be made immediately prior to its application and shall consist of the following materials.
   1. Seed Rates for individual species as noted on the project plans
   2. Wood Fiber Mulch 2000 lbs. per acre
   3. Water: As required for slurry application
C. Slurry Application: The hydoseed slurry shall be applied to provide uniform coverage over the designated area(s). The Contractor shall take appropriate measures to prevent seed from being applied to areas not designated to receive seed, and shall clean-up all over-spray on walls, paved surfaces, or areas surfaced with decomposed granite.

D. Rock Mulch: Rock Mulch shall be applied as indicated in Section 3.7, B.

3.7 INORGANIC SURFACING MATERIALS

A. Decomposed Granite Surfacing: All areas to be surfaced with decomposed granite shall be brought to the lines and grades shown on the drawings with allowances made for the depth of the granite material. Prior to the placement of the decomposed granite, the subgrade shall be treated with pre-emergent herbicide. The herbicide application shall be made in accordance with the manufacturer’s written instructions and shall be made by an Applicator licensed by the State of Arizona. The decomposed granite shall be installed over the treated subgrade to the depth noted on the plans. Once the decomposed granite surfacing has been placed, all areas shall be treated a second time with pre-emergent herbicide by an Applicator licensed by the State of Arizona and in accordance with the manufacturer’s written instructions. Care shall be taken in the placement of the rock mulch so as not to disturb or damage any plant material, adjacent surfaces or irrigation equipment.

1. Reveal at Paved Surfaces: A reveal shall be provided as the interface of decomposed granite areas and paved surfaces. The reveal dimension shall be as detailed. Where not detailed, the reveal shall be 1”.

B. Rock Mulch for Hydoseeded Areas: The contractor shall stake out or paint the boundary of all areas to receive rock mulch / hydoseeded areas. The Architect shall approve the boundary, and subgrade lines and grades prior to placement of the rock mulch. No pre-emergent herbicide shall be applied. All rock mulch areas will be hydoseeded prior to placement and do not require herbicide application. The rock mulch shall be placed in an even application and spread lightly over the hydoseeded areas. The coverage of the rock mulch areas shall not exceed 50% of the finish grade soil surface. The final depth of the rock mulch shall not exceed one inch (1”), excluding the rock materials which are over 1-1/4” to 3” size. Any re-grading that is necessary after placement of the rock mulch shall be at no additional cost to the Owner. Care shall be taken in the placement of the rock mulch so as not to disturb or damage any plant material, adjacent surfaces or irrigation equipment.

C. Landscape Boulders: Landscape boulders shall be placed as indicated on the details.
3.8 LANDSCAPE MAINTENANCE:

A. Maintenance During Construction: The Contractor shall maintain all trees, shrubs, accent plants, decomposed granite areas, and other landscape improvements during project construction. Maintenance shall include, but not be limited to: irrigation, fertilization, pruning, weed removal, clean-up, herbicide application, resetting plants to proper grade, restoration of irrigation basins, and repair of damaged staking. Plants which die or become diseased during the construction period, shall be replaced at no additional cost to the Owner. Maintenance during construction shall continue until issuance of a Certificate of Substantial Completion.

B. Inspection of Completed Landscape Planting Work: Upon completion of the landscape planting work, the Contractor shall notify the Architect who will schedule an inspection of the landscape improvements. During the inspection, items which are incomplete or which must be repaired or replaced will be identified. Completion or correction of items noted will be required prior to the issuance of a Certificate of Substantial Completion.

C. Maintenance after Substantial Completion: After issuance of a Certificate of Substantial Completion, the Contractor shall continue to operate and maintain the landscape improvements for a period of thirty (30) consecutive calendar days. Maintenance shall include, but not be limited to: irrigation, fertilization, pruning, weed removal in decomposed granite areas, site clean-up, herbicide application, resetting plants to proper grade, restoration of irrigation basins, and repair of damaged staking. Plants which die or become diseased during the maintenance period, shall be replaced at no additional cost to the Owner. After satisfactory completion of the maintenance period, the Owner will assume responsibility for landscape maintenance.

D. Suspension of Initial Contractor Maintenance Period for Non-Compliance: Failure to comply with the maintenance requirements specified herein, as determined by the Architect, will result in the number of days being credited to the initial thirty (30) day maintenance period being suspended. The suspension will remain in effect until such time as the remedial action(s) required by the Architect have been implemented by the Contractor.

3.9 GUARANTEE:

A. Contractor Provided Plant Material: The Contractor shall guarantee all Contractor provided plant materials for a period of one year commencing on the date of Substantial Completion. Plants which become diseased or which die during the guarantee period, for reasons other than neglect, improper maintenance, Acts-of-God, or causes deliberate, as determined by the
Architect, shall be replaced by the Contractor at no additional cost to the Owner.

END OF SECTION - 02900