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Utilities & Energy Services has been designated as the official steward for the standards, guidelines, procedures, and specifications for design and sustainability on the campus of Texas A&M University. These preferences have evolved from the department's experience in overseeing the construction, operation and maintenance of Texas A&M buildings over many years. It is intended that these Guidelines serve as a uniform reference for consultants providing architectural and engineering design for Texas A&M construction projects.

The value of being able to transmit the large body of specific information and preferences contained in these Guidelines is obvious. It will result in the use of construction systems and materials which have been proven to be cost-efficient and effective. The use of these Guidelines will also improve the efficiency of the design process itself by insuring that relevant information is communicated to project designers in a timely manner.

This information is provided as a technical resource for engineering and architectural professionals for use in design and construction activities on campus. Design professionals assume responsibility for selection, reference, and appropriate application of these resources. It is your responsibility to verify that you have obtained the most current detail sheets. We recommend checking utilities.tamu.edu/design-standards/ for revisions regularly.
Design Standard

Building Automation Systems (BAS)

INSTRUMENTATION AND CONTROL FOR HVAC

Detailed specifications follow.

PART 1 - GENERAL

1.01 SUMMARY

A. This section provides information on acceptable Building Automation Systems (BAS) and control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Refer to the Construction Documents for engineers Sequences of Operations for BAS HVAC Controls.

1.02 WORK INCLUDED

A. The BAS Contractor will provide an environmental control/energy management system and control function for the entire HVAC system. The BAS will be a Direct Digital Control (DDC) System manufactured by either:
   1. Johnson Controls
   2. Siemens

B. HVAC Systems or building components to be monitored and/or controlled by the central campus systems include, but are not limited to, the following: temperature control, Air flows, building and room pressurization, indoor & outside building lighting, Fume Hoods and Laboratory Control Systems, and the start and stop of HVAC systems.

C. The BAS Contractor will furnish and install all components but not limited to all temperature, pressure, and flow sensors, transmitters, relays, switches, wire, and all DDC panels as required to meet engineers design and sequence of operations. Also furnish all controls, operators, power supplies, control valves, air and water flow measuring stations, transducers and wiring to connect components. Submit for approval, appropriate product data cut-sheets for all material/components intended for use prior to beginning work. Where BAS is used in specifications and drawings, it is understood to be same as DDC. In addition, when required, provide a complete installation of the Laboratory Control System (LCS) completely integrated into the appropriate Campus BAS Software.
D. All Controls, damper actuators, Valve actuators, shall be electronically controlled, no pneumatics of any type are allowed.

E. The BAS Contractor shall provide Direct Digital Control (DDC) panels complete with all microprocessors, software, terminal strips, transducers, relays, and regulated power supply with battery backup at the mechanical room field equipment controllers and supervisory engines.

F. The BAS Contractor shall furnish a HVAC Terminal Equipment Controller (TEC), electronic damper actuator(s), and electronic HW valve and actuator for installation on each VAV terminal unit and fan coil unit, as applicable, by the terminal equipment manufacturer. These DDC devices shall be delivered to the manufacturer's factory in sufficient time for the terminal equipment manufacturer to meet their scheduled delivery obligations.

G. The BAS Contractor shall furnish all DDC LCS components, including TECs, Lab Supply Air Terminal Units with reheat coils (duct mounted), General Exhaust Air Terminals, Fume Hood Exhaust Terminals, and all other associated controls components required to meet the engineers design and sequence of operation. Installation of all air terminals shall be by the mechanical contractor.

H. The BAS Contractor shall provide for each VAV box an inlet flow sensor suitable for interfacing with a pressure transducer, and for VAV boxes and other terminal equipment as the design engineer requires. Also as required, any necessary devices for proper operation to achieve full functionality as required by the engineers design and sequence of operation. The cost of mounting shall be included in the cost of the terminal equipment. All wiring and terminations related to the lab control system components shall be provided by the BAS contractor.

I. The BAS Contractor shall provide for each TEC, a 24 vac, 40 va power source, and mount and connect these devices and the DDC controller as required for proper operation as required under this Section. All other wiring and terminations related to the TEC shall be provided by the BAS contractor.

J. Room temperature, CO₂ sensors and humidity sensors and mounting plates shall be provided and installed by the BAS Contractor.

K. Temperature controls and non-DDC accessories that are standard catalog products as manufactured by Siemens Building Technologies, Inc. or Johnson Controls, Inc., will be acceptable. Industrial instrumentation supplied shall be standard catalog products of Rosemount, Dwyer, Honeywell, Bristol, Foxboro, Leeds and Northrup, Taylor or Brown. All coordination and execution of work pertaining to the installation, service, and guarantee, under this Section of the specifications, shall be the sole responsibility of the BAS Contractor.
L. All controls to be installed, calibrated and adjusted by trained instrument technicians in the full-time employ of the BAS Subcontractor & low voltage electrical subcontractor. The BAS Contractor will be responsible for all work performed by their subcontractors.

M. Submit engineering/wiring drawings and receive approval prior to beginning work. These drawings shall be submitted in a timely manner to provide sufficient time to review drawings so as not to hold up the project.

N. The DDC field panels will be located in mechanical rooms as shown on the drawings. The BAS cabinets shall be labeled with a permanent labeled indicating its name as shown in the control drawings. All sensor and start/stop wiring will be brought back to the panel responsible for controlling/monitoring the mechanical/electrical equipment for which the sensor, start/stop wiring is directly related. The location of these panels may not be shown on the drawings. The DDC panels in the mechanical room shall be provided with a UPS to allow operation of the panels during switchover to emergency power. The UPS shall provide a minimum of 500 va, be similar to an Invensys Powerware 120, and be installed in a NEMA 1 hinged, lockable cabinet.

O. Power to each BAS panel shall be provided from a breakered, 20 amp dedicated circuit on emergency power having an insulated ground wire from the power panel ground buss wired to the duplex receptacle.

P. The BAS Control System will perform all Sequence of Operations as required by the Design Engineer.

Q. Furnish and install a network communications trunk (N.C.T.) between DDC panels, and a separate LAN communications network between each terminal unit controller (or group of controllers) back to the DDC panel associated with the AHU which serves the terminal units. Trunks shall be connected to the panels with CAT-6 conductors and required components (switches). In addition, the N.C.T. trunk shall be extended from the nearest Panel to an Owner-provided, network drop(s) location.

R. The project shall provide a dedicated Ethernet network connection between the BAS panel and the Campus BAS Software. The BAS Contractor is responsible for coordinating the network drop(s) required for integration to the Campus BAS Software and will not receive final payment for the project until the BAS system is fully integrated and accepted by TAMU Utilities & Energy Services (UES).

S. Provide graphics for all new work, compatible with existing campus front end system. Coordinate and provide BAS graphics that are acceptable to TAMU Utilities & Energy Services (UES). See section 1.10 below for more information.
T. All exposed wiring shall be in conduit (3/4" minimum). Concealed wiring shall be plenum rated. All active Ethernet switches, hubs, and routers required for the communication between BAS panels shall be BAS Contractor-provided and installed. The conduit/wiring system required for the BAS shall be a complete, separate, independent system. Conduit sharing with other unrelated electrical systems is not permitted. All conduit shall enter BAS panels and WAGES enclosures from the bottom of the panel or enclosure.

U. A Schneider Electric 9788TAMUWAGESHMI metering panel, of the appropriate capacity, will be provided by the BAS Contractor, complete with all microprocessors, software, programming, point data base, trends, terminal strips, and regulated power supply with battery backup.

V. The WAGES panel will require temperature and flow sensor wiring from the panel to sensors located in the primary supply and return piping on the Chilled Water, Heating Hot Water, and Domestic Hot Water, to be included as part of the BAS Contractor's responsibilities. The WAGES panel will require flow meter wiring from Domestic Cold Water, Irrigation Water, and Steam. Provide all wiring from the flow tubes and flow transmitters to the WAGES panel. This WAGES panel will require a dedicated 110 volt, 20 amp, single phase standby electric circuit source. This WAGES panel will require a category 6 Ethernet cable. The WAGES system will require start-up & integration to the Campus Metering Software, by the Schneider Electric Square D Vendor. A meeting between the TAMU UES and the BAS contractor will be held as early as possible, prior to purchase of any material, to review the installation and finalize panel and wiring locations. The WAGES panel is used only when campus chilled or heating water is servicing the facility.

W. When only electric and domestic water are being metered, the electric meter that is to be installed must have the option of field installable digital input/output modules that can be added at any time thus allowing monitoring of status points, consumption of water, air, gas, and or steam pulses. Also this unit must be easily integrated in the current TAMU power and energy management system.

X. Integration of the WAGES system to the UES Metering Software shall include loading of the TAMU WAGES program into each WAGES panel, connecting to the UES meter software, as well as five Graphic screens that represent the piping and position of temperature sensors and flow tube for each commodity that is being metered in the WAGES system.

Y. The BAS contractor will be responsible for the connection and integration from the BAS in the building, to the Campus BAS software. The Contractor will be responsible for programming the DDC panels with operational sequences and set-points as specified.
1.03 RELATED WORK

A. If the project will include Chillers, Boilers, or other DX system the BAS shall have all points mapped through BacNet, Modbus, or other means that will allow for the BAS to see, monitor, trend, alarm, as well as control, at a minimum, the start/stop and set point of each system.

B. If the BAS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

C. Shop Drawings:
   1. Schematic flow diagrams & graphic display.
   2. Power, signal, and control wiring diagrams.
   3. Details of control panel faces.
   4. Damper schedule.
   5. Valve schedule.
   6. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
   7. Control System Software: Schematic diagrams, written descriptions, and points list.
   8. Sequences of operation.
   10. Samples of Graphic Display screen types and associated menus.
   11. Field quality-control test reports.
   12. Operation and maintenance data.

1.04 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals:
   1. Three (3) copies of the Operation and Maintenance Manuals, Control Drawings, and written Sequence of Operation, shall be provided to the Utilities & Energy Services upon completion of the project. The entire Operation and Maintenance Manual, Control Drawings, and written Sequence of Operation, shall be furnished on Compact Disc media, and include the following for the BAS provided:
      a. Table of contents.
      b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
      c. Manufacturer's product data sheets or catalog pages for all products including software.
      d. Archive copy of all site-specific databases and sequences.
      e. BAS network diagrams.
      f. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

1.05 BAS WIRING

A. All wiring and conduit shall be installed in accordance with related Specification Section Division 26, Electrical.

B. The conduit/wiring system required for the BAS specification Input/Output summary:
   1. Digital Input (D.I.) wiring (Class 2) may be run in a common conduit with Digital Output (D.O.) wiring (Class 1) where local codes permit.
   2. Analog Input (A.I.), Analog Output (A.O.), Digital Input (D.I.), and Network Communications Trunk (N.C.T.) wiring may be run in a common conduit.
   3. Digital Output (D.O.) wiring run in a common conduit with Analog Input (A.I.), Analog Output (A.O.), or Network Communications Trunk (N.C.T.) is not permitted under any circumstances.
   4. AC line power to DDC panel shall be #12 THHN.
   5. Digital Output (D.O.) wiring shall be #14 THHN.
   6. Digital Input (D.I.), Analog Input 4-20 mA (A.I.), and Analog Output (A.O.) wiring shall be #20 TSP (twisted shielded stranded pair with drain wire).
   7. Analog Input/Thermistor/or voltage types (A.I.) wiring shall be #20 TSP (twisted shielded stranded pair with drain wire).
   8. Network Communications Trunk (N.C.T.) between DDC panels and TEC’s shall be 2 individual minimum #24 awg TSP (twisted, shielded stranded pair) cables, not to exceed 12.5 pf capacitance per foot, wire-to-wire, and not to exceed 6 twists per foot. TEC controller LAN networks shall be 1 #24 awg TSP of the same type.

C. Wiring between DDC Panels:
   1. Furnish, install and terminate individual CAT-6 cable assemblies to interconnect each BAS panel. Data is passed through an Ethernet switch before continuing to its destination to other main building panels and to the front end. Each cable shall originate and terminate within one designated DDC panel in each mechanical room. Additionally, furnish, install and terminate individual Cat-6 cable assemblies to connect each DDC panel within the mechanical room(s) with others in that same room, as engineered by the BAS Contractor.
   2. All cable runs between mechanical rooms and/or DDC panels shall be no longer than allowed as specified in Division 27. Where runs are required that will be longer than Division 27, furnish and install an additional enclosure near the midpoint (coordinate location with architect), to be used as a network junction box, complete with 120VAC emergency power.
source. Terminate and label the cables within this junction box and show the location on the as built control drawings, as directed for each DDC panel.

3. Furnish, install and make connections of all interlock, power for sensors (if required), line and low-voltage wiring external and internal to DDC panels. All wiring shall be clearly and permanently labeled as outlined below.

D. Field devices requiring a 4-20 mA DC input signal shall be non-ground referenced.

E. All wiring in mechanical rooms, electrical rooms, inaccessible areas, or located in areas exposed to occupant view shall be run in conduit (3/4” minimum). Plenum rated wiring shall be acceptable for installation in concealed, accessible locations. Conduit fill limit shall not exceed 40% in any portion of the conduit system.

F. In order to facilitate maintenance, where multiple sensors or devices are connected to a common raceway or conduit, each sensor or device shall be individually connected to a common (non-sensor or device) junction box, which shall then be attached to the common conduit. Under no circumstances shall sensor or device wiring or tubing be routed through any other sensor or device's specific enclosure or junction box.

G. All wiring shall be labeled at both ends and at any spliced joint in between. Wire shall be tagged using a system similar to the Panduit P1 Self Laminating System that utilizes a thermal transfer (or equivalent) printer with a minimum font size of Arial 10. In addition to tagging at field device end and at spliced joints, a tag shall be placed 6 inches after entering each DDC panel. Identification and tag information shall be included in engineering/wiring submittal which must be submitted for Owner approval prior to beginning work. Tag information shall coincide with equipment/point information as written in the specification input/output summary. Each BAS DDC panel shall include a paper wiring document, in a clear sleeve permanently attached to the inside door that shows the name of each point and what terminal they are connected to.

1.06 SYSTEM VERIFICATION--PROCEDURE TO BE FOLLOWED

A. Provide minimum 2 week written notice for all inspections.

B. The system verification also includes the Laboratory Control System.

C. Upon completion of all external sensor mounting, terminations, and wiring into and out of the DDC panels (and WAGES panel), the TAMU Project Inspector & UES representative shall inspect and approve this work. The BAS Contractor shall make his representative(s) available and coordinate with the TAMU
Project Inspector & UES representative during this inspection process. At the successful conclusion of this inspection, the BAS Contractor shall provide a written report stating all work is complete. BAS Contractor, General Contractor and TAMU Project Inspector & UES representative shall sign. This should be filed with Project Commissioning/Startup documents.

D. Upon such approval being achieved, the BAS Contractor shall make terminations within the DDC panels and WAGES panel.

E. Following completion of the work in the DDC panel and WAGES Panel tie-in, a performance test shall be conducted by the BAS Contractor in the presence of the TAMU Project Inspector & UES representative.

F. The BAS Contractor shall conduct testing of proper operation of each and every physical system point to which the Contractor has provided devices, wiring, in order to verify the equipment and installation provided by them (their portion of the work), i.e., when the Owner commands a point, the Contractor verifies in the field that the commanded point operates properly. At the successful conclusion of this inspection, contractor shall provide a written report stating all work is complete, calibrated and functioning properly per the specified sequences of operation. An electronic and paper copy of which will be provided to UES for signature by the BAS Subcontractor, General Contractor and TAMU Project Inspector & UES representative. This should be filed with Project Commissioning/Startup documents. A representative of the BAS Contractor that can revise control sequences shall be available on site as necessary to make changes during the system verification.

G. TAMU Project Inspector & UES representative shall attend initial inspection and verification of completed punch list for items in paragraphs 1.5C and 1.5F of this Section. Further inspections required due to incomplete/incorrect work shall be at Contractor's expense.

H. Upon conclusion of final checkout and acceptance, the Contractor's responsibility reverts to warranty of materials and installation herein specified. System shall be warranted for a period of two (2) years.

I. The Contractor shall coordinate and include the Commissioning Agent as required for the above activities. Commissioning agent will coordinate and witness functional performance test procedures. Refer to 01 91 13 for additional details.
1.07 SYSTEM GRAPHICS

A. Provide a cover page for the project to include graphic links including, but not limited to:
   1. Air Handling Equipment
   2. Chilled and Heating Water Pumps (Chilled & Heating Hot Water Flow from WAGES Panel)
   3. Domestic Water Pumps.
   4. Fans
   5. Outside Air Handling Equipment
   6. Supply Air Floor Plan
   7. Exhaust Air Floor Plan
   8. Schedules
   9. Other items as indicated on the construction documents

B. Floor plans shall show the following:
   1. Show room numbers or list of group of rooms within the colored areas
   2. Colored areas indicate different graphic links such as 1st floor North, etc.
   3. Links to other floors along with chilled and heating water system links.
   4. Links to sequence of operations
   5. Links to any operations schedules
   6. Links to AHU serving that area

C. Floor Plan of supply shall show the following:
   1. Indicate room numbers on plan
   2. Indicate different AHU coverage with different colored cloud
   3. Indicate VAV box locations along with ductwork
   4. Indicate room temperatures for each zone.
   5. Separate Graphics will be provided to show each of the following information
      a. Location of 24 volt low voltage xfmrs,
      b. Communications trunk,
      c. Duct pressure sensors with location and value.
      d. Routing of communication lines to each DDC panel and TEC

D. Typical VAV box shall show the following:
   1. AHU serving VAV box and the Dischare Air Temperature of its AHU
   2. Supply CFM and damper position
   3. Reheat valve position
   4. Box status, heat or cool
   5. Fan proof
   6. Room temperature and set point.
   7. Occupancy sensor state (if available) with its current value
E. Exhaust fan floor plan layout shall show the following:
   1. Indicate room numbers on plan
   2. Indicate with different colored bubble or cloud the boundaries of each exhaust fan.
   3. Link to each exhaust fan that is shown on that floor

F. Schematic of outside air units shall show the following:
   1. Schematic indicating what other AHU's the outside air handler serves
   2. Indicate flows to each AHU with set points, run status/proof, damper locations (isolation and fire damper.)
   3. Indicate which AHU's are served.
   4. Show fire alarm status for AHU's on the AHU graphic

G. Air Handling Units shall show the following:
   1. Provide feedback on devices, but not limited to items such as temperatures, fan speed, static pressure set point and actual, valve position, filter status, airflow measuring station CFM, etc.
   2. Graphics to be a true representation of the actual field equipment.
   3. Chilled and Heating Water systems shall show the following:
   4.

H. Pumping Units shall show the following:
   1. Pumps along with their speed and proof of status
   2. Flow meters
   3. Temperature and pressure sensors and their values
   4. Building control valve
   5. Where pumps are lead / lag set up, indicate run time in hours for each pump

I. Other
   1. Refer to construction documents for other systems that require graphics.
   2. Graphics shall include feedback on all devices including set point and actual values.

PART 2 - PRODUCTS

2.01 GENERAL DESCRIPTION

A. The Building Automation System (BAS) shall use an BacNet open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BAS shall support BacNet open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other Owner provided networks.
B. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices. In existing installation, re-use existing controls equipment System architectural design shall eliminate dependence upon any single device for control execution:
   1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
   2. The System shall maintain all settings and overrides through a system reboot.

C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

2.02 ACCEPTABLE MANUFACTURERS:
1. Johnson Controls, Metasys
2. Siemens Building Technologies

B. Integration with Existing Johnson Controls, Siemens or TAC BAS:
1. The BAS Contractor a project shall provide the following:
   a. The BAS contractor shall provide any and all necessary software connectivity licenses within the cost of the bid. Software licenses shall allow specified BAS point information to be broadcast out of the BAS expansion to the existing Johnson Controls or Siemens BAS server software.

2.03 FIELD DEVICES

A. Acceptable Immersion Temperature Sensors and Thermowells
   1) Dwyer Series TTE Explosion Proof RTD Temperature Probe with Dwyer Series W 316 Stainless Steel Thermowells
   2) Rosemount
   3) Honeywell

B. The above Immersion Temperature Sensors shall be equal/better to the specifications below:
   1. Temperature Sensor: RTD using a Pt1000, or Pt 100.
   2. Output Temperature Ranges: User selectable any range between -30 to 250 deg.f. with minimum span of 40 deg.f
   4. Accuracy: Transmitter: +/- 0.1%F.S. Probe: +/- 0.3% F.S.
   5. Thermal Drift Effects: +/-0.02% deg.C max.
   8. Process Connection: ½” male NPT.
   9. Conduit Connection: ½” female NPT.
10. Probe Length: 2" to 18" depending on model
11. Pressure Limits: 2000 PSI.
12. Power Requirements: 10 to 35 VDC.
13. Output Signal 4-20mA (two wire loop powered).
14. Display: 2 lines X 8 character LCD.
15. Enclosure Rating: NEMA 4X (IP66) and explosion proof for Class I, Groups B, C, D; Class II, Groups E, F, G; Class III.

C. Thermowells shall be equal/better to the specifications below:
   1. Hardware: 316SS Sheath
   2. Taper/Bore: Straight/0.260
   3. Inside Threads: ½ NPSF
   4. Process Connections: ½” NPT
   5. Mounting: Threaded
   6. Lag: None
   7. Sheath O.D. Base/Taper: ¼” Straight
   8. Length: From 4” to 24” as needed to fit Temperature sensor length required for tip of probe to be in center of piping.

D. HVAC Air Duct Temperature Sensors:
   1. Duct temperature sensors shall be averaging type. Outside air wall mounted sensors shall be provided with a sun shield. Accuracy of transmitter shall be unaffected by wiring distances up to 700 feet. Siemens Building Technologies, Johnson Controls, Rosemount or Dwyer only.

E. Room Thermostats:
   1. Each room thermostat shall come complete with a terminal jack and override switch integral to the sensor assembly. The terminal jack shall be used to connect the portable operator’s terminal to control and monitor all hardware and software point associated with the terminal unit.
   2. Humidity Sensors shall provide a 0 to 100% range corresponding to an isolated 4 to 20 Ma output. Accuracy of ±2% RH, with maximum drift of 1% per year.
   3. An override switch will initiate override of the night setback or unoccupied mode to normal (day) operation when activated by the occupant. The switch function may be locked out, canceled or limited as to time or temperature in software by an authorized operator or a central or remote operator’s terminal.
   4. Space thermostats may be Thermistor or 4-20 mA output RTD. The room thermostats shall be firmly attached to the wall using approved construction techniques. Double-sided adhesive tape in lieu of screws is not acceptable.
   5. The room thermostats shall be accurate to within ±.5°F and have a setpoint adjustment range of 45°F to 85°F.
6. Room carbon dioxide sensors shall provide a range from 0 to 2,000 ppm CO₂, and be accurate to within ±100 ppm. The CO₂ sensor shall experience less than 1% drift per year for the first two years of operation and negligible drift thereafter, no calibration of the CO₂ sensor is necessary.

7. Room thermostats shall be a full featured unit in all areas.

F. Acceptable Water Flow Meters and Remote Transmitters:

2) Yokogawa AXF Magnetic Flow Meter with AXFA11G Magnetic Remote Converter
3) Siemens Mag 5100 W with MAG 5000/6000 Remote Transmitter

G. The above Water Flow Meters and Remote Transmitters shall be, or equal/better to the specifications below:

a. The Flow Tube and Transmitter shall be calibrated to each other and shall be flow-calibrated and assigned a calibration factor at the factory. The calibration factor is entered into the transmitter, enabling interchangeability of sensors without calculations or a compromise in standard accuracy

b. Accuracy: Includes the combined effects of linearity, hysteresis, repeatability, and calibration uncertainty. ±0.15% of rate ±1.0 mm/sec from 0.04 to 13 ft/s (0.01 to 4 m/s); above 13 ft/s (4 m/s), the system has an accuracy of ±0.2% of rate.

c. Each Flow Tube shall be sized specifically for the pipe and flow in which it is to be installed and to ensure flow velocity is within 2 to 20 ft./s.

d. A calibration certificate shall be provided from the manufacture

e. Class 150 carbon steel flanges, Teflon (PTFE) or EDPM lining, and Type 316L stainless steel or Hastelloy C electrodes.

f. Transmitter: 115Vac/1ph/60hz power supply, NEMA 4X enclosure, 4 – 20 ma output, battery-backup totalizer, and local operator interface.

g. Ambient Temperature Limits: -20 to 140deg.f.

h. Humidity Limits: 0 to 95% RH to 120deg.f.

i. Safety Approvals: FM Class 1 Division 2 for non-flammable; CSA Class 1 Division 2

H. Temperature Transmitters: Temperature transmitters shall be designed for 4-20 mA output for Platinum RTD millivolt input sensor (as specified above). Accuracy shall be the same as specified for the temperature sensors. Stability shall be ±0.2% of calibrated span for 6 months. Transmitter shall be a part of
the temperature sensor assembly and shall be in a moisture-proof housing with a moisture-proof seal between the sensor and transmitter. Immersion sensors for piping shall be Dwyer Series TTE explosion-proof RTD temperature transmitter with fully configurable ranges and display options or equal by Rosemount.

I. Humidity Transmitter Space: Sensor shall provide a 0 to 100 percent range corresponding to an isolated 4-20 mA or 0-10 VDC output. Accuracy of +/ - 2 percent RH, with maximum drift of 1 percent per year. Sensor shall be equipped with LCD display.

J. CO₂ Duct-Stat Indoor AQ Sensor: CO₂ sensor shall be Siemens model number QPA63 or Johnson Controls model number CD-P00-00. The unit shall be self-contained for wall mounting application. The unit shall have a fast response and shall have 0-1 percent range corresponding to an isolated 4-20 mA or 0-10 VDC output. Visual alarm is not to be provided. The monitor shall utilize the photo acoustic sensor with VOC sampling capability.

K. Electric Room Thermostats: Provide line voltage room thermostats with cover. Set point must be adjustable from approximately 50 to 100 Deg. F. Minimum rating is 6 amps at 120 VAC. Provide removable setting knob. Housings shall not contain thermometers.

L. Duct Relative Humidity Sensor: Duct relative humidity sensors used in the calculation of enthalpy shall be Siemens QFM Series Duct Relative Humidity or similar. The sensor shall have an accuracy of +/- 2% RH. Provide unit with housings suitable for return air plenum installations. Filter material shall be Teflon. The unit shall be operating range of 0 to 100% RH and have a 4 to 20 mA or 0 to 10 Vdc linear output.

M. Pressure Transmitters: Transmitters for water pressure shall provide a 4-20 mA DC signal output directly proportional to pressure. Device shall be constructed with corrosive resistant stainless steel wetted parts and have a die-cast aluminum enclosure specifically designed for NEMA4/IP65 service. Accuracy of ±0.5% of calibrated span. Span not over 200% of sensed pressure. Stability ±0.5% of upper range limit for 6 months. Stainless steel diaphragm, viton 0-rings. Temperature limits: -20°F to 220°F.

N. Fan proof-of-flow switches shall be UL listed adjustable setpoint and differential pressure type. Switches shall be piped to fan inlet and outlet. For fractional horsepower and non-ducted fans, relays or auxiliary contacts may be used. Maximum pressure rating shall be at least 10 inch w.c. All pressure tubing on roof shall be stainless steel.

O. Pump motor proof-of-flow Current Status Switch: Provide a high performance miniature split-core current status switch with adjustable set point (where
indicated). The current status switch shall have an operating range of between 1.25 – 50 amps and be able to detect belt loss and mechanical failure.

P. Air flow and static pressure analog sensors shall be ±.5% accuracy, range suitable for the low velocity pressures to be encountered, be selected for approximately 50% over-range, and have an electronic 4 to 20 mA analog output. These differential pressure sensors shall be connected to the air flow measuring station with valved lines for testing and calibration, and shall have adjustments for zero and span.

Q. Electric Low Limit Duct Thermostat: Snap-acting, two pole, single throw, manual reset switch which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, requiring minimum 15 feet length of bulb. Provide one thermostat for every 20 sq ft of coil surface.

R. Air Flow Measurement Station:
1. Industrial Thermal Dispersion Technology Type, Similar to Ebtron, Inc. Model GT. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter.
2. Each unit shall operate on 24 VAC.
3. Each sensing point shall independently determine the airflow rate and temperature, and shall equally weight and average by the transmitter prior to output. Pitot tube arrays are not acceptable.
4. A single manufacturer shall provide probe and transmitter.
5. The operating range shall be from 0 - 5000 fpm with accuracy of ±2% over the entire operating airflow range and be verified against standards that are traceable to NIST.
6. The transmitter shall be capable of communicating with the host controls using 0-10VDC and 4-20ma, RS-485 and BACnet.
7. Sensors shall be UL listed.
8. Manufacturer shall have review and approve placement in field, and provide written report to engineer indicating airflow measuring stations are installed in accordance with manufacturer’s installation requirements.

2.04 CONTROL VALVES

A. Terminal Unit Control Valves:
1. Characterized Ball, Forged brass body, Stainless Steel trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.
2. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
3. Sizing: 5-psig maximum pressure drop at design flow rate, to close against pump shutoff head. Select control valves for a minimum Cv of 1.0 to reduce the risk of system dirt accumulating in very small orifices in characterizing-discs.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

B. Butterfly Valves:
   1. 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   3. Disc Type: Elastomer-coated ductile iron.
   4. Sizing: 1-psig maximum pressure drop at design flow rate.

PART 3 - EXECUTION

3.01 GENERAL

   A. All DDC and LCS panels shall be connected to emergency power system.

3.02 INPUT/OUTPUT SUMMARY

   A. The I/O Summary on the drawings is provided as a list of the minimum points required by this contract for connection to the Energy Automation system. Furnish all devices, wiring, tubing, etc., necessary to serve and transmit to the DDC panels. Any points not shown on the I/O Summary yet required to accomplish the sequence of operation shall be provided under this contract at no additional cost to the Owner.

3.03 EQUIPMENT, AIR HANDLING UNIT AND FAN START-UP AFTER POWER FAILURE

   A. In case of power failure, all AHUs and fans with 7-1/2 HP and larger motors shall be started sequentially at 15 second intervals (adjustable) through the DDC system.

   B. DDC to send alarm if any equipment does not start within 15 minutes and omit that item from remaining starting sequence.
Design Standard

Building Energy Efficiency Analysis

PART 1  GENERAL

1.1 The objective is to ensure the efficient use of energy at the planning and design phase of a new or renovated building project, rather than attempt to manage and pay for an inefficient design over the life of the building. Implementing this strategy can be a positive game changer when it comes to the future of energy consumption on campus as well as ensuring that Texas A&M will not be taking on undue financial exposure as a result of inefficient building design. It is much more cost effective to ensure that efficiency is designed into a building when built or renovated so the university can benefit from an ongoing annuity of reduced operating cost over the life of the building. The work required to implement this strategy will be called Energy Efficiency Analysis (EEA). The EEA will start with an initial requirement for all project managers for new or renovated buildings to perform a design review to ensure university standards will be met for design and ensure overall building operating efficiency will meet or exceed the campus standard. The recommended university building energy design standard is a requirement that the project design engineer demonstrate that the new or renovated building will meet or exceed the ASHRAE 90.1-2010 efficiency standard by 14% for new construction and 11% for existing building renovations. Achieving this target will require that cost-effective energy conservation measures be used which do not compromise building performance or occupant comfort.

1.2 Utilities & Energy Services (UES) will work directly with the project manager and through the CBE sub-council review process to ensure that the required steps have been completed for all new construction or renovation projects budgeted at $4 million and above. Each project manager shall complete the EEA and obtain written verification from UES Technical Services. An overview of the Energy Efficiency Analysis (EEA) is provided below.

PART 2  ENERGY EFFICIENCY ANALYSIS (EEA)

2.1 Buildings shall be designed to exceed the requirements of the ASHRAE 90.1-2010 energy standard by 14% for new construction and 11% for existing building renovations, and incorporate cost effective energy conservation measures that do not compromise building performance or occupant comfort. Energy modeling by the project team will be required to verify energy performance of buildings. Energy modeling shall be conducted with the latest version of Trane Trace 700, Carrier HAP, or IESVE for Engineers. The use of other energy modeling software shall only be permitted with the prior approval of the Utilities and Energy Services Department’s Manager for Technical Services. ASHRAE 90.1-2010 Appendix G shall be used for establishing the baseline building. Modeling to demonstrate EEA
compliance shall be completed during the Design Development (DD) phase of a project.

2.2 Residential projects, as defined by the State Energy Conservation Office (SECO), shall be designed to comply with International Code Council's International Energy Conservation Code, IECC 2009.
Design Standard

Cable Splicing & Termination Qualifications

The majority of premature cable accessory failures in the electrical industry are due to poor workmanship. To ensure that TAMU has safe and reliable power to the campus, the following guidelines have been implemented to ensure only authorized personnel perform terminations on the TAMU Campus.

Splicer – A person who installs terminations, joints, and insulated separable connectors as required to install, operate, and/or maintain a medium voltage, shielded, solid dielectric, insulated conductor distribution system. At TAMU, most of the splices consist 200A loadbreak elbows, 600A deadbreak elbows, stress cones, and splicing.

Detailed specifications follow.

PART 1  SPLICING / TERMINATIONS REQUIREMENTS AT TAMU

1.1 Minimum of 2 years experience in 2.1kV to 12.5kV systems.

1.2 Must have performed at least 25 terminations over the last 2 years.

1.3 Must have completed and documented formal training (splicing school or manufacturer training).

1.4 Must complete T-body termination demonstration for TAMU Utilities Distribution Department.

A. Must supply own T-Body and material to complete termination

B. Must supply own 500 MCM demonstration cable

PART 2  STANDARD PROCEDURES

2.1 Prior to cable termination or splicing, contractor shall submit in writing to the Supervisor of Electrical Distribution the qualifications of personnel directly responsible for completing the work required. The following information should be provided for approval:

A. Training certificate and/or professional license.

B. Years of experience in cable termination and/or splicing.

C. Number of cable terminations and/or splices performed.

D. Manufacturer certifications if applicable.
E. Must be able to successfully perform a termination and/or splice under the supervision of the Supervisor for Electrical Distribution.

2.2 After successfully meeting the above requirements and receiving approval of the Supervisor for Electrical Distribution:

A. The personnel that have been approved will be added to the university’s list of approved installers for the TAMU campus.

B. The contractor may proceed on the requested work once approval is received from the Supervisor of Electrical Distribution.

C. All cable terminations and/or splicing must be tagged with the installer name and the date of the work performed. (See Figure 1 on the following page).

D. The tag must be made of brass with letters and or numbers minimum 1/8-inch-high.

E. The contractor shall submit a list of all terminations completed for the project; the list shall have manhole number, type of termination, date and the installer’s name.

F. Qualifications shall be updated every two years to remain on the authorized personnel list.

PART 3 DISTRIBUTION

3.1 After each update to the TAMU Utilities Approved Splicer List, the list and updated TAMU Utilities Electrical Distribution Guidelines shall be distributed to:

A. TAMU Utilities Manager for Electrical Distribution & Controls

B. TAMU System Facility Planning & Construction System Electrical Engineer

C. Compass SSC
FIGURE 1

FIRST & MIDDLE INITIAL

FULL LAST NAME

2in

AA MALDONADO

007 01-30-2009

TAMU INSTALLER NUMBER

DATE OF INSTALLATION

0.125in

1in
Design Standard

Emergency Generator Systems

Detailed specifications follow.

PART 1 GENERATORS

1.1 Generator equipment shall be supplied by a single manufacturer who has been regularly engaged in the sales and service of engine-generator sets, generators, engine auxiliaries, transfer switches, and controls for a minimum of fifteen years.

1.2 A manufacturer's representative shall provide local factory-trained services, all required stock of replacement parts, and technical assistance.

1.3 Accessibility to the generator for service and fueling is critical. Coordinate each emergency generator installation with TAMU Utilities & Energy Services.

1.4 The fuel shall be diesel and be contained by a 24-hour double wall tank.

1.5 Approved Generator Manufacturers:
   A. Caterpillar
   B. Onan
   C. Kohler
   D. Stewart & Stephenson

PART 2 LIFE SAFETY TRANSFER SWITCH

2.1 Life safety loads are to be on a separate transfer switch from the legally required and optional generator loads.

2.2 The switch shall be fed from a separate overcurrent protective device in the generator.

2.3 Approved Transfer Switch Manufacturers:
   A. Russelectric
   B. ASCO
   C. Zenith
Design Standard

Exterior Lighting and Installation

Detailed specifications follow.

Pedestrian & General Area Lighting (Primary Campus Standard)

PART 1 FIXTURE

1.1 Gardco Round Form 10 or Kim CC/CCS
1.2 Finish: Bronze Anodized Hiawatha Metal #311
1.3 Distribution Type specific for location or Type 5 open area.

PART 2 POLES

2.1 Gardco or Sterner
2.2 Finish: Bronze Anodized Hiawatha Metal #311
2.3 All pedestrian lighting applications shall have poles at least ten feet tall. Ten foot pole mounted fixtures are preferred, Fifteen foot poles are an acceptable alternative if site lighting needs require the additional height

PART 3 LAMPS

3.1 Light Emitting Diodes (LED)

PART 4 LIGHTING CONTROL

4.1 Owlet Luco / Shark Fin Antenna / Light Pipe

<table>
<thead>
<tr>
<th>Pedestrian Light Poles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
</tr>
<tr>
<td>10'</td>
</tr>
<tr>
<td>10'</td>
</tr>
<tr>
<td>15'</td>
</tr>
<tr>
<td>15'</td>
</tr>
</tbody>
</table>

Note: D1-Light Duty Pole – engineer to specify correct relative strength based on site wind load factors.
Historical Pedestrian & Heritage Area Lighting (standard per noted locations)

Historic District Lighting Areas include New Main Roadway and Military Walk.

PART 1 FIXTURE AAL FEDERAL GLOBE FIXTURE

1.1 Roman Bronze finish of decorative cast 356 aluminum.

1.2 Hood: spun aluminum with disk to block the up light out from hood.

PART 2 POLES

2.1 AAL

2.2 Shaft: 12 fluted round cast 356 aluminum tapered shaft, .250” wall thickness

2.3 Base: round fluted cast 356 Aluminum, .357” avg. wall thickness, double fuse double fuse holders, and a cast-in anchor plate

PART 3 LAMPS

3.1 Light Emitting Diodes (LED)

PART 4 LIGHTING CONTROL

4.1 Owlet Luco / Shark Fin Antenna / Light pipe

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacture</th>
<th>Style</th>
<th>Catalog Number Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>66W</td>
<td>Kim</td>
<td>CC/CCS LED</td>
<td>FM-CCS17P2-60L4K277-277-DBA311-OWLET LUOC</td>
</tr>
<tr>
<td>70W</td>
<td>Gardco</td>
<td>Form 10 LED</td>
<td>CP17L-P22-5-70LA-NW-UNIV-BRA311-OWLET LUOC</td>
</tr>
<tr>
<td>66W</td>
<td>Kim</td>
<td>CC/CCS Wall LED</td>
<td>FM-CCS17W5-60L4K277-277-DBA311-OWLET LUOC</td>
</tr>
<tr>
<td>70W</td>
<td>Gardco</td>
<td>Form 10 Wall LED</td>
<td>CW17L-D1M-4-70LA-NW-277-BRA311-OWLET LUOC</td>
</tr>
</tbody>
</table>

Note: All fixtures to be installed, will come equipped with an Owlet controller that will integrate into the existing TAMU campus lighting automation and control system.

Historical Pedestrian & Heritage Lighting (Fixture/Pole)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacture</th>
<th>Style</th>
<th>Catalog Number Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixture</td>
<td>Gardco</td>
<td>Decorative</td>
<td>C12800</td>
</tr>
<tr>
<td>12'</td>
<td>Gardco</td>
<td>Decorative</td>
<td>CP12800</td>
</tr>
<tr>
<td>Fixture</td>
<td>Kim</td>
<td>Federal Globe</td>
<td>FGS-RB-LL5-T5-LED-DBZ-COS-OWLET LOCO</td>
</tr>
<tr>
<td>12'</td>
<td>Kim</td>
<td>Decorative Fluted</td>
<td>DB5-4R12-125-12-DBZ-FS2</td>
</tr>
</tbody>
</table>

D1-Light Duty Pole – engineer to specify correct relative strength based on site wind load factors.
Parking & Roadway Lighting

PART 1  FIXTURE

1.1 Fixture: Gardco Square Form 10 or Kim EKG402
1.2 Finish: Bronze Anodized Hiawatha Metal #311
1.3 Distribution Type specific for location or Type 4 open area

PART 2  POLES

2.1 Gardco, Sterner or Kim
2.2 Finish: Bronze Anodized Hiawatha Metal #311
2.3 Parking lighting applications for small and medium sized parking areas and the perimeter of large parking areas shall have a cutoff fixture.

PART 3  LAMPS

3.1 Light Emitting Diodes (LED)

PART 4  LIGHTING CONTROL

4.1 Owlet Luco / Shark Fin Antenna / Light pipe

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacture</th>
<th>Style</th>
<th>Catalog Number Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>20' Gardco</td>
<td>Tapered</td>
<td>TAMU-TRA-CB-20M-D1-BRA-#311</td>
<td></td>
</tr>
<tr>
<td>20' Kim</td>
<td>Tapered</td>
<td>LTRA20-6156-1A-DBA311/BC/PC4RDB/96068/95518</td>
<td></td>
</tr>
<tr>
<td>30' Sterner</td>
<td>Tapered</td>
<td>RTA30-8.0x4.5-0.188-10-L-VD-LBZ#311</td>
<td></td>
</tr>
<tr>
<td>30' Gardco</td>
<td>Tapered</td>
<td>TAMU-TRA-CB-30L-D1-BRA#311</td>
<td></td>
</tr>
<tr>
<td>30' Kim</td>
<td>Tapered</td>
<td>LTRA30-7156-1A-DBA311/BC-PC4RDB/96068/95518</td>
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</tbody>
</table>

Note: D1- Light Duty Pole – engineer to specify correct relative strength based on site wind load factors.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacture</th>
<th>Style</th>
<th>Catalog Number Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>130W Kim</td>
<td>EKG402 LED</td>
<td>1A-EKG402-80L3K277-DBA311-OWLET LUCO-LI/00-05-166/00-05-918/00-05-919</td>
<td></td>
</tr>
<tr>
<td>160W Gardco</td>
<td>Form 10 LED</td>
<td>EH19L-1-5-160LA-NW-UNIV-BRA#311-OWLET LUCO</td>
<td></td>
</tr>
</tbody>
</table>
Pedestrian Bollard Lighting

PART 1  FIXTURE

1.1 Fixture: Gardco 830 Series LED Bollard with Demand Response

1.2 The Bollard can be specified with or with lighting capability in effort to provide a standardized bollard type, but have the flexibility of installing the luminaire type in only the locations that ground lighting is needed.

PART 2  LIGHTING CONTROL

2.1 Owlet Luco / Shark Fin Antenna / Light pipe

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manufacture</th>
<th>Style</th>
<th>Catalog Number Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixture</td>
<td>Gardco</td>
<td>LED</td>
<td>TAMU-BRM830-42-DR-NW-360-277-SC/BRA#311</td>
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<tr>
<td>Pole</td>
<td>Gardco</td>
<td>Nonlit</td>
<td>TAMU-42-NONLIT-SC/BRA#311</td>
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<tr>
<td>Fixture</td>
<td>Kim</td>
<td>LED</td>
<td>VRB1-15L-3KUV-DBA311</td>
</tr>
<tr>
<td>Pole</td>
<td>Kim</td>
<td>Nonlit</td>
<td>VRBC-BR-C</td>
</tr>
</tbody>
</table>

Note:  Engineer to review bollard specifications (height/coverage/voltage) to ensure specification meets actual bollard application.
General Exterior Campus Lighting Guidelines

Examine all available lighting source technologies to determine the appropriate source for the application, lowest life cycle cost and energy requirements for any given project. High performance HID, Compact Fluorescent, Induction, and LED technologies all have appropriate applications, based on energy efficiency, lighting level requirements, color of light, maintenance, cost, and other project criteria. Any deviation from the campus standards must be approved through Utilities & Energy Services (UES).

- All fixtures must be dark-sky compliant as required by state law.
- Manufacturer specifications for fixture and poles are available from TAMU Utilities & Energy Services (UES) Electrical Distribution at 979-845-3234.

**Typical Design Lighting Level:** TAMU follows the lighting level chart below as a guide, refer to IESNA, TXDOT, and local codes requirements for additional information.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Ways Parking Lots</td>
<td>1.0</td>
<td>-</td>
<td>0.1</td>
<td>2.2</td>
<td>-</td>
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<tr>
<td>Roadways</td>
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<tr>
<td>Major</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
<td>-</td>
<td>3:1</td>
</tr>
<tr>
<td>Collector</td>
<td>-</td>
<td>0.8</td>
<td>-</td>
<td>-</td>
<td>4:1</td>
</tr>
<tr>
<td>Local</td>
<td>-</td>
<td>0.6</td>
<td>-</td>
<td>-</td>
<td>6:1</td>
</tr>
</tbody>
</table>
IES Roadway Luminaire Classifications (Types I, II, III, IV and V) Summary:

The Illuminating Engineering Society of North America (IESNA) defines roadway and area lighting fixtures by their photometric properties and distance to the half maximum candela trace and the maximum candela value.

The definitions of the IES classifications follow:

The lateral classification describes the lateral light distribution with regards to the lighted area width described as multiples of the mounting height (MH). The width of the half-maximum candela trace within the longitudinal distribution range (Short, Medium or Long) is used. The boundaries for each classification in terms of Longitudinal Roadway Lines (LRL, running along the roadway) are as follows:

- **Type I** - Half-maximum candela trace falls between 1 MH LRL on the House side and 1 MH LRL on the Street side.
- **Type II** - Half-maximum candela trace on the Street side is beyond the 1 MH LRL but not beyond the 1.75 MH LRL.
- **Type III** - Half-maximum candela trace on the Street side is beyond the 1.75 MH LRL but not beyond the 2.75 MH LRL.
- **Type IV** - Half-maximum candela trace on the Street side is beyond the 2.75 MH LRL.
- **Type V** - Has circular symmetry being essentially the same at all lateral angles around the luminaire.

Informally, there is also a Type V-S, similar to Type V, but square in shape.

This image is from the IESNA Lighting Handbook, 9th Edition, © 2000, In this example, the luminaire is a Type III -- Medium distribution.
## Pedestrian Sterner Tapered Pole

### Ordering Example

| RTA20 | 6.0 x 4.5 | 0.188 | A28 | B | DF | BK |

### Ordering Sequence

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Description</th>
<th>Thickness</th>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA10</td>
<td></td>
<td>0.125&quot;</td>
<td></td>
</tr>
<tr>
<td>RTA12.5</td>
<td></td>
<td>0.156&quot;</td>
<td></td>
</tr>
<tr>
<td>RTA15</td>
<td></td>
<td>0.188&quot;</td>
<td></td>
</tr>
<tr>
<td>RTA20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTA25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTA30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pole Data

<table>
<thead>
<tr>
<th>Pole Cat. No.</th>
<th>Diameter x Wall Thickness</th>
<th>Rise Height</th>
<th>Top Circle</th>
<th>Anchor Bolts</th>
<th>Beam Style</th>
<th>Thread Connection</th>
<th>Contacting Shipping Weight</th>
<th>Allowable Load (Based on M14 x 1.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA10</td>
<td>4.5&quot; x 0.125&quot;</td>
<td>15&quot;</td>
<td>1&quot;</td>
<td>1/4-20</td>
<td>D104</td>
<td>0.415&quot; x 0.020&quot;</td>
<td>402</td>
<td>19.0 / 15.2 / 13.5 / 12.0 / 10.4 / 9.0 / 7.6 / 6.2 / 4.8 / 3.4</td>
</tr>
<tr>
<td>RTA12.5</td>
<td>4.5&quot; x 0.125&quot;</td>
<td>15&quot;</td>
<td>1&quot;</td>
<td>1/4-20</td>
<td>D104</td>
<td>0.415&quot; x 0.020&quot;</td>
<td>402</td>
<td>19.0 / 15.2 / 13.5 / 12.0 / 10.4 / 9.0 / 7.6 / 6.2 / 4.8 / 3.4</td>
</tr>
<tr>
<td>RTA15</td>
<td>4.5&quot; x 0.125&quot;</td>
<td>35&quot;</td>
<td>1&quot;</td>
<td>1/4-20</td>
<td>D104</td>
<td>0.415&quot; x 0.020&quot;</td>
<td>402</td>
<td>19.0 / 15.2 / 13.5 / 12.0 / 10.4 / 9.0 / 7.6 / 6.2 / 4.8 / 3.4</td>
</tr>
<tr>
<td>RTA20</td>
<td>5.0&quot; x 0.125&quot;</td>
<td>30&quot;</td>
<td>1&quot;</td>
<td>1/4-20</td>
<td>D104</td>
<td>0.415&quot; x 0.020&quot;</td>
<td>402</td>
<td>19.0 / 15.2 / 13.5 / 12.0 / 10.4 / 9.0 / 7.6 / 6.2 / 4.8 / 3.4</td>
</tr>
<tr>
<td>RTA25</td>
<td>5.0&quot; x 0.125&quot;</td>
<td>30&quot;</td>
<td>1&quot;</td>
<td>1/4-20</td>
<td>D104</td>
<td>0.415&quot; x 0.020&quot;</td>
<td>402</td>
<td>19.0 / 15.2 / 13.5 / 12.0 / 10.4 / 9.0 / 7.6 / 6.2 / 4.8 / 3.4</td>
</tr>
<tr>
<td>RTA30</td>
<td>5.0&quot; x 0.125&quot;</td>
<td>30&quot;</td>
<td>1&quot;</td>
<td>1/4-20</td>
<td>D104</td>
<td>0.415&quot; x 0.020&quot;</td>
<td>402</td>
<td>19.0 / 15.2 / 13.5 / 12.0 / 10.4 / 9.0 / 7.6 / 6.2 / 4.8 / 3.4</td>
</tr>
</tbody>
</table>

### Notes:
1. 1/2" nipple applies to both arm & pole round fixtures.
2. C, D, & N style bases available 20" max. 6" dia. base only.
4. See below table for dimensions & bolt information.
The Philips Gardco TRA tapered round aluminum pole consists of a one-piece design fabricated aluminum tubing circumferentially welded to a structural quality hot rolled carbon steel plate. The poles are finished with either Architectural Class I anodizing or electrostatically applied TGIC polyester powdercoat. All poles include anchor bolts, hand hole, ground lug and top cap.

**Hinged Base**

**Options**
- DR: Duplex Receptacle
- GFCI: Ground Fault Receptacle
- VUA: Vibration Damper

**Suffix Options**
- BRP: Bronze Paint
- BLP: Black Paint
- WP: White Paint
- NP: Natural Aluminum Paint
- BRA: Bronze Anodized #311
- BLA: Black Anodized
- NA: Natural Anodized
- OC: Optional Color Paint
- SC: Special Color Paint

**Motion Response Provisions**
- GMR: Provision for Gardco HID Motion Response System
- NL: Nipple- External thread
- CL: Coupling - Internal thread

**Single Mount Anodized Brackets**
- A15BH-19: Single - 1.9" OD
- A15BH-24: Single - 2.4" OD
- A21E4H-19: 2-Tanon - 1.9" OD
- A21E4H-24: 2-Tanon - 2.4" OD

**Motion Sensor Mounting**
- Luminaries available with Motion Response

**Minimum Pole Height & Riser**
- 18" includes a 12" coupling placed at two hand holes, 12" above the pole base.

---

PHILIPS

GARDCO
## Tapered Round Aluminum - Hinged Base

The Philips Gardco TRA tapered round aluminum pole consists of a one-piece design fabricated aluminum tubing circumferentially welded to a structural quality hot rolled carbon steel plate. The poles are finished with either Architectural Class 1 anodizing or electrostatically applied TGIC polyester powdercoat. All poles include anchor bolts, hand hole, ground lug and top cap.

### OPTIONS

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>BASE</th>
<th>HEIGHT</th>
<th>DRILLING</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAMU-TRA</td>
<td>HB</td>
<td>15L</td>
<td>D1</td>
<td>BRA#311</td>
</tr>
</tbody>
</table>

Enter the order code into the appropriate box above. Note: Gardco reserves the right to refuse a configuration. Not all combinations and configurations are valid. Refer to notes below for exclusions and limitations. For questions or concerns, please consult the factory.

### PREFIX

<table>
<thead>
<tr>
<th>TRA</th>
</tr>
</thead>
</table>

### BASE

<table>
<thead>
<tr>
<th>CB</th>
<th>Fixed Cast Base</th>
</tr>
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<tbody>
<tr>
<td>HB</td>
<td>HINGED BASE</td>
</tr>
</tbody>
</table>

### HEIGHT

<table>
<thead>
<tr>
<th>D1</th>
<th>1 Way</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DRILLING

<table>
<thead>
<tr>
<th>D2</th>
<th>2 Way</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### OPTIONS

<table>
<thead>
<tr>
<th>DR</th>
<th>Duplex Reception</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFCI</td>
<td>Ground Fault Reception</td>
</tr>
<tr>
<td>YUA</td>
<td>Vibraton Damper</td>
</tr>
</tbody>
</table>

### PHILIPS GARDCO

1111 Clifty Park Road, San Marcos, TX 78666
(800) 227-2785 (512) 533-1000 FAX: (512) 533-7865 philipslighting.com
© 2011 Koninklijke Philips Electronics N.V. All rights reserved. Philips Gardco reserves the right to change materials or modify the design of its products without notification as part of the company's continuing product improvement program.
Specifications

17” Diameter
60 Light Emitting Diodes
Total System Watts = 60W

Housing: Spun aluminum. Rolled-formed linear reveals: CC: Three equally spaced reveals; ¾” wide, separated by ½” ribs; ⅜” deep, CCS: One ¾” groove, ⅜” deep. Side rails have a maximum ½” of taper and are free of welds or fasteners. A rolled-formed aluminum flange is hemmed into the bottom providing support for the reflector module. An internal aluminum casting provides for mounting of the electrical module and support for the housing hinge.

Lens Frame and Yoke: One-piece cast aluminum lens frame is attached to the housing by a zinc plated cold rolled steel hinge with a stainless steel pin. Closure of the housing is by a single self-retained stainless steel screw. A stainless steel self-locking stop arm is provided to hold the housing in the open position while servicing. A ¾” thick clear flat tempered glass lens is fully gasketed by a one-piece extruded and vulcanized silicone gasket. Lens is retained in the frame by removable zinc plated steel clips. Lens frame is supported at four points two aluminum U-shaped tubular arms cradled in a cast aluminum hub. Arms are welded to the lens frame, and welded to the hub along their longitudinal axis. Hub contains a field-splice compartment, a cast aluminum cover, and one of the following pole attachment means: FM - Flush Mounting or PT - Pole Tenon Mounting (See page 2 for complete descriptions).

Electronic Module: All electrical components are UL and CSA recognized, mounted on a single plate and factory prewired with quick-disconnect plugs. Module includes a driver, LifeShield™ temperature control device and surge protector. Electrical module attaches to housing with no-tool hinges and latches, accessible by opening the lens frame only. Driver is rated for -40°F starting and has a 0-10V dimming interface for multi-level illumination options.

Optical Module: Precision, replaceable MicroMitter reflectors are positioned to achieve directional control toward desired task. The entire EmitterDeck™ mounting assembly fastens to the housing as a one-piece module.

Finish/Color: Finish is Super TGIC thermoset polyester powder coat paint. 2.5 mil nominal thickness. Standard colors are Black, Dark Bronze, Light Gray, Stealth Gray, Platinum Silver, or White. Custom colors are available.

Warranty: Kim Lighting warrants Curvilinear LED products (“Product(s)”) sold by Kim Lighting to be free from defects in material and workmanship for (i) a period of five (5) years for metal parts; (ii) a period of ten (10) years for exterior housing, paint finishes; (iii) a period of six (6) years for LED Light Engines (MicroMitter reflectors) and; (iv) a period of five (5) years for LED power components (LED Driver, LifeShield temperature control device, surge protection), from the date of sale of such goods to the buyer as specified in the Kim Lighting shipment documents for each product.

CAUTION: Fixtures must be grounded in accordance with national, state and/or local electrical codes. Failure to do so may result in serious personal injury.
### Standard Features

#### Mounting

<table>
<thead>
<tr>
<th>EPA</th>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. No.:</td>
<td>FM Flush Mount</td>
</tr>
<tr>
<td>Pole Top Requirements:</td>
<td>3¾&quot;, 4&quot;, 4½&quot;, or 5&quot; Dia.</td>
</tr>
</tbody>
</table>

**Pole Top**
- 2" Pipe-size Tenon (2¼" O.D. x 4¾" L)

#### Fixture

- Cat. No. designates CC/CCS fixture and light distribution.
- **Housing:** CC, CCS
- **Size:** 17 = 17" Small 60 LEDs
- **P = Pod Top Mount**

#### Distribution:
- 1 = Type I Full Cutoff
- 2 = Type II Full Cutoff
- 3 = Type III Full Cutoff
- 4 = Type IV Full Cutoff
- 5 = Type V Square Full Cutoff
- 1 = Type L Left Full Cutoff
- R = Type R Right Full Cutoff

#### Light Distribution:

- Type I
- Type II
- Type III
- Type IV Forward Throw
- Type V Square
- Type R Right
- Type L Left
## Standard Features

### Electrical Module

<table>
<thead>
<tr>
<th>Cat. Nos. for Electrical Modules available:</th>
<th>60L</th>
<th>xK</th>
<th>x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: 60L = 60 LED’s</td>
<td>14K = 4000K</td>
<td>277 = 277V</td>
<td></td>
</tr>
<tr>
<td>5K = 5000K</td>
<td>2D = 240V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2K = 580nm - Amber</td>
<td>240 = 240V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3K = 3000K</td>
<td>347 = 347V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>480</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Curvilinear system employs Nichia's SSL product. Part number: NS6x183 (NS6x183-H3, NS6W183-H3)

**3000K** is also available on an "Engineered-to-Order" (ETO) basis.

**Due to current unavailability of 347V and 480V drivers, specification of these voltages may feature an integral step down transformer.**

### Finish

TGC powder coat paint over a baked zincium conversion coating.

<table>
<thead>
<tr>
<th>Color:</th>
<th>Black</th>
<th>Dark Bronze</th>
<th>Light Gray</th>
<th>Stealth Gray*</th>
<th>Platinum Silver</th>
<th>White</th>
<th>Custom Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. No.:</td>
<td>BL</td>
<td>DBA311</td>
<td>LG</td>
<td>SG</td>
<td>PS</td>
<td>WH</td>
<td>CC</td>
</tr>
</tbody>
</table>

*Custom colors subject to additional changes, minimum quantities and extended lead times. Consult representative. Custom color description: ________________________
## Optional Features

### Photocell

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Voltage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-30</td>
<td>120V</td>
<td>Factory installed photocell inside housing with a fully gasketed sensor on the side wall.</td>
</tr>
<tr>
<td>A-31</td>
<td>208V</td>
<td>(See right)</td>
</tr>
<tr>
<td>A-32</td>
<td>240V</td>
<td>(See right)</td>
</tr>
<tr>
<td>A-33</td>
<td>277V</td>
<td>(See right)</td>
</tr>
<tr>
<td>A-35</td>
<td>347V</td>
<td>(See right)</td>
</tr>
<tr>
<td>A-34</td>
<td>480V</td>
<td>(See right)</td>
</tr>
</tbody>
</table>

**Photocell Sensor**

### Dimming Controls

The Curvilinear LED driver is a 0-10V dimming interface, allowing 0-100% illumination output when synchronized with a control and dimming system, provided by others. Kim Lighting is working with several control system manufacturers to develop a variety of proven turnkey solutions to meet any application’s need. Kim Lighting will advise availability of complete control packages, and even two-way monitoring systems, once they have been tested and exceed Kim’s high quality standards.

### Convex Glass Lens

- **Cat. No.**: CGL
- **Size**: 1 3/8”
- **Material**: Clear, tempered glass
- **Application**: Use in uniformity where pole spacing is extreme, increases effectiveness of houseside shielding.

### Polycarbonate Lens

- **Cat. No.**: L17F
- **Material**: Clear UV stabilized polycarbonate
- **Application**: Replaces standard flat glass lens, gasketed and integral with lens frame.

**CAUTION**: Use only when vandalism is anticipated to be high. Useful life is limited by UV discoloration from sunlight.

### Accent Reveal

- **(For CC series only)**
- **Cat. No.**: BL-REV, DB-REV, LG-REV, SG-REV, PS-REV, WH-REV, GC-REV
- **Color Options**: Black, Dark Bronze, Light Gray, Stealth Gray, Platinum Silver, White, Custom Colors

*Custom color subject to additional charges, minimum quantities and extended lead times. Consult representative, Custom color description.*
### Lumen Data

#### Spectroradiometric

<table>
<thead>
<tr>
<th></th>
<th>5000K Average</th>
<th>4000K Average</th>
<th>5000K Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlated Color Temp. CCT (K)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Color Rendering Index (CRI)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Power Factor</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

#### Electrical Drive Current

<table>
<thead>
<tr>
<th>Volt AC</th>
<th>Amp AC</th>
<th>System Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>58</td>
<td>66</td>
</tr>
<tr>
<td>268</td>
<td>32</td>
<td>66</td>
</tr>
<tr>
<td>240</td>
<td>28</td>
<td>66</td>
</tr>
<tr>
<td>277</td>
<td>24</td>
<td>66</td>
</tr>
<tr>
<td>547</td>
<td>19</td>
<td>66</td>
</tr>
<tr>
<td>480</td>
<td>14</td>
<td>66</td>
</tr>
</tbody>
</table>

#### B.U.G. Rating (TM15) in Luminaries wherein B = Backlight, U = Uplight, G = Glare

<table>
<thead>
<tr>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>B2 U3 C2</td>
<td>B1 U6 C1</td>
<td>B3 U6 C1</td>
<td>B1 U9 C1</td>
<td></td>
</tr>
</tbody>
</table>

#### Absolute Lumens

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000K Amber</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4000K</td>
<td>3414</td>
<td>3379</td>
<td>3428</td>
<td>3480</td>
<td>5228</td>
<td></td>
</tr>
<tr>
<td>5000K</td>
<td>4163</td>
<td>4117</td>
<td>4180</td>
<td>4240</td>
<td>4091</td>
<td></td>
</tr>
</tbody>
</table>

LED performance and lumen output continue to improve at a rapid pace. Log onto www.kimlighting.com to download the most current photometric files and from Kim Lighting's LED File Library for custom optic and color temperature configurations, contact factory.

*Data is provided from 5000K NS Flats.*
Form 10 Round LED

CP / MP Post Top Mount

The Philips Gardco post top mounted Round Form 10 LED products are cutoff luminarias featuring LED arrays. Round Form 10 LED luminarias provide performance excellence and advanced Philips Gardco thermal management technology. High performance Class 1 LED systems offer the potential for energy savings up to 50% when compared to HID systems. Housings are one-piece seamless spun aluminum and finished with either Architectural Class 1 anodizing, with hardcoat, fade resistant, electrostatically applied TGIC polyester powdercoat or polyurethane. Optional twin grommets at post tops are available in (4) colors and are illuminated by the primary source. Luminarias provide full cutoff performance.

PREFIX

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>MOUNTING</th>
<th>DISTRIBUTION</th>
<th>LED WATTAGE</th>
<th>LED SELECTION</th>
<th>VOLTAGE</th>
<th>FINISH</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP17L</td>
<td>P22</td>
<td>5</td>
<td>70LA</td>
<td>NW</td>
<td>UNIV</td>
<td>BRA #311</td>
<td>OW/LET</td>
</tr>
</tbody>
</table>

Enter the order code into the appropriate box above. Note Philips Gardco reserves the right to refuse a configuration. Not all combinations and configurations are valid. Refer to notes below for exclusions and limitations. For questions or concerns, please consult the factory.

Available in 70LA and 85LA LED Wattages Only

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>MOUNTING</th>
<th>DISTRIBUTION</th>
<th>LED WATTAGE</th>
<th>LED SELECTION</th>
<th>VOLTAGE</th>
<th>FINISH</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP17L</td>
<td>P12</td>
<td>(B)</td>
<td>70LA</td>
<td>NW</td>
<td>UNIV</td>
<td>BRA #311</td>
<td>OW/LET</td>
</tr>
</tbody>
</table>

CP17L: 17° Cylindrical Luminaria LED - Constant Wattage
CP17L-DIM: 17° Cylindrical Luminaria LED - 0.10V Dimming

Available in 110LA and 160LA LED Wattages Only

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>MOUNTING</th>
<th>DISTRIBUTION</th>
<th>LED WATTAGE</th>
<th>LED SELECTION</th>
<th>VOLTAGE</th>
<th>FINISH</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP22L</td>
<td>P12</td>
<td>(B)</td>
<td>110LA</td>
<td>NW</td>
<td>UNIV</td>
<td>BRA #311</td>
<td>OW/LET</td>
</tr>
</tbody>
</table>

CP22L: 22° Cylindrical Luminaria LED - Constant Wattage
CP22L-DIM: 22° Cylindrical Luminaria LED - 0.10V Dimming

MP17L: 17° Semi-Spherical Luminaria LED - Constant Wattage
MP17L-DIM: 17° Semi-Spherical Luminaria LED - 0.10V Dimming

Retrofit Kits for existing Form 10 Round 17° and 22° HID luminarias are available. See Legacy LED Retrofit Kits Submitted Data Sheet (G200-21) for retrofit Kit information.

Mounting

<table>
<thead>
<tr>
<th>See Mounting Illustrations on Page 3 for more information.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>POLES</th>
<th>TENONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBS1</td>
<td>RA/SSR1</td>
</tr>
<tr>
<td>MIN O.D. 2.88&quot;</td>
<td>MAX O.D. 3.00&quot;</td>
</tr>
<tr>
<td>MP17</td>
<td>P11 (B)</td>
</tr>
<tr>
<td>CP17</td>
<td>P13 (B)</td>
</tr>
<tr>
<td>MP12</td>
<td>P31 (B)</td>
</tr>
<tr>
<td>CP22</td>
<td>P31 (B)</td>
</tr>
</tbody>
</table>

Distribution

2 Type II
3 Type III
4 Type IV
5 Type V

Type II, Type III and Type IV optics are field rotatable.
Type V optics feature internal lens.

LED WATTAGE AND LUMEN VALUES

<table>
<thead>
<tr>
<th>Ordering Code</th>
<th>Average System Watts</th>
<th>LED Current (mA)</th>
<th>LED Selection</th>
<th>Luminary Initial Absolute Lumen</th>
<th>Back of Lumen Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>70LA</td>
<td>70</td>
<td>350</td>
<td>CW</td>
<td>6,517</td>
<td>Photometric tests performed in compliance with IESNA LM-79, except where otherwise indicated.</td>
</tr>
<tr>
<td>85LA</td>
<td>85</td>
<td>350</td>
<td>CW</td>
<td>6,735</td>
<td>Notes: 1. Wattage may vary by ± 5% due to LED manufacturer threshold output specification and ambient temperature. Wattage shown is average for 120°V through 277V input. Actual wattage may vary by an additional ± 10% due to actual input voltage. 2. Wattage shown for luminaire without the HSL external shield option. Tests are in progress for luminaire with the HSL option and luminaires. Contact GardcoGardcoGardco.com for additional information. 3. LED lens feature LEDs that provide from 100 to 130 lumens per watt when operated at 350 mA. Lumen values listed on test performance in compliance with IESNA LM-79.</td>
</tr>
<tr>
<td>110LA</td>
<td>110</td>
<td>350</td>
<td>CW</td>
<td>7,805</td>
<td>Notes: (1) Photometric tests performed in compliance with IESNA LM-79.</td>
</tr>
</tbody>
</table>
FORM 10 ROUND LED
CP / MP Post Top Mount

LUMINAIRE CONFIGURATION INFORMATION

CONSTANT WATTAGE CONFIGURATIONS: Standard LED luminaires provide constant wattage and constant light output when power to the luminaire is energized.

DIMMING "DIM" CONFIGURATIONS: Dimmable LED luminaires are provided with 0 - 10V dimming for connection to a control system provided by others.

SPECIFICATIONS

GENERAL: The Philips Gardco post top mounted Form 10 Round LED products are cutoff luminaires featuring LED arrays. Form 10 Round LED luminaires provide performance excellence and advanced Philips Gardco LED thermal management technology. High performance Class 1 LED systems offer the potential for energy savings up to 50% when compared to HID systems.

HOUSING: Housing is one piece, 100° (25cm) seamless aluminum with integral rolled circumferential reveal and lower section aperture incorporating a returned flange stiffener to protect against housing edge deflection.

YOKE: The 9/16" (1.42cm) diameter parallel yokes of high strength, low mass schedule 40 steel are precision contoured to match the CP or MP housing silhouette. Welds or fasteners are not visible at the luminaire or pole attachment. The yoke is electroplated and coated with satin black polyurethane or polyester powder coat.

LENSES: One piece, diecast aluminum door frame retainer is optically clear, heat and impact resistant tempered flat glass, in a sealed manner using hollow section, high compliance, memory retention extruded silicone rubber.

THERMAL MANAGEMENT: The Philips Gardco Form 10 Round LED luminaires utilize extruded aluminum integral thermal radiation fins to provide the excellent thermal management so critical to long LED system life.

LED RELIABILITY:

<table>
<thead>
<tr>
<th>PREDICTED LUMEN DEPRECIATION DATA</th>
<th>Ambient Temperature °C</th>
<th>Drive mA</th>
<th>L lesbians</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 °C</td>
<td>350 mA</td>
<td>150,000</td>
<td></td>
</tr>
<tr>
<td>40 °C</td>
<td>530 mA</td>
<td>100,000</td>
<td></td>
</tr>
</tbody>
</table>

* Predicted performance derived from LED manufacturers’ data and engineering design estimates, based on IESNA Lumen methodology. Actual performance may vary due to field application conditions. L lesbians is the predicted time when LED performance depreciates to 70% of initial lumen output.

FULL CUT-OFF PERFORMANCE: Full cut-off performance means a luminaire distribution where zero candela intensity occurs at an angle of at or above 90° above nadir. Additionally, the candela per 1000 lumen lumina does not numerically exceed 100 (10 percent) at a vertical angle of 80° above nadir. This applies to all lateral angles around the luminaire.

CUTOFF PERFORMANCE: Cutoff performance means a luminaire distribution where the candela per 1000 lumen lumina does not numerically exceed 35 (3.5 percent) at an angle of at or above 90° above nadir, and 100 (10 percent) at a vertical angle of 80° above nadir. This applies to all lateral angles around the luminaire.
**FGS – Federal Globe™ Small Housing Scale**

|------|---------------------------------------------|--------------------------------------|

<table>
<thead>
<tr>
<th>LUMINARE</th>
<th>DECORATIVE STYLE</th>
<th>GLOBE STYLE</th>
<th>OPTIC STYLE</th>
<th>LAMP/BALLAST</th>
<th>COLOR</th>
<th>OPTIONS</th>
<th>MOUNTING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2D Only</td>
<td>3D LL3 Type</td>
<td>3D LL5 Type</td>
<td>3D 01</td>
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<td>1. WALL MOUNT</td>
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<td>1. MWA 1M</td>
<td>2. MWA 95</td>
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</tr>
</tbody>
</table>

**SPECIFICATIONS**

**HOUSING**
- Decorative, cast aluminum fixture shall support the lamp base, reflector assembly and luminaire housing. The slip fit shall slip over a 2 ½" diameter O.D. pole, and secure with four M16-1.5 stainless steel set screws. Lamp and ballast compartments shall be too tightly accessible through a hinged cap. The ballast is accessible by lifting ballast plate by handle.

**ELECTRICAL**
- Fixtures shall be ETL approved for use in outdoor wet locations. Ballast shall be high power factor multi-tap style (120/208/240/277V). Sockets shall be pulse rated porcelain. The electrical assembly shall be factory wired and installed in the fixture. Quick electrical disconnects shall be provided as standard.

**OPTICAL SYSTEMS**
- The ContraLite® optical system is a multi-tiered reflector assembly composed of four reflective elements for T8 or six reflector elements for Type 3. Peak candleia shall be at 700° and sharp cutoff at 80°. Lamp (by others) shall be in a vertical, base down position. Other optical systems available consist of an internal glass reflector optic, which features a GR3 for Type 3 light distribution and GR5 for the Type 5 light distribution (up to 105° SRM and 110° HSR), external refractor globes in non-yellowing acrylic, as well as a bare lamp optic.

**ARCHITECTURAL AREA LIGHTING**
16655 East Gate Ave. 1 City of Industry CA 91745
P 626.989.5696  F 626.390.2695  www.sal.net
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**NOTES**
Exterior Lighting and Installation
Pedestrian Poles and Fixture Datasheets

FGS – Federal Globe™ Small Housing Scale

FINISH
Finish consists of a five-stage pretreatment regimen with a polymer primer sealer, oven dry off and top coated with a thermoset super TGIC polyester powder coat finish. The finish shall meet the AAMA 605.2 performance specification which includes passing a 3000 hour salt spray test for corrosion resistance.

CERTIFICATION
Listed with E.T.T.L. for outdoor, wet location use, in all mounting orientations, conforms to UL1998 and Can. Canadian CSA Std. C22.2 no. 200 standard. (Test FGS-SAL)

WARRANTY
Federal Globe LED, including housing, LEDs and electrical components, is warranted for five years. Non-LED fixture is warranted for three years. Ballast components carry the ballast manufacturer’s limited warranty. Any unauthorized return, repair, replacement or modification of the Product(s) shall void this warranty. This warranty applies only to the use of the Product(s) as intended by AAI, and does not cover any misapplication or misuse of said Product(s), or installation in hazardous or corrosive environments.

FGS CCO 150MH
WATTAGE: 185
LUMEN OUTPUT: 6950
EFFICACY: 75.6

<table>
<thead>
<tr>
<th>B3 U4 G3</th>
<th>FORWARD LIGHT</th>
<th>LUMEN</th>
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</thead>
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<tr>
<td>FL 30°</td>
<td>0.3%</td>
<td>44</td>
</tr>
<tr>
<td>FM 60°</td>
<td>6.6%</td>
<td>801</td>
</tr>
<tr>
<td>FH 90°</td>
<td>14.7%</td>
<td>1834</td>
</tr>
<tr>
<td>FVH 90°</td>
<td>2.4%</td>
<td>304</td>
</tr>
<tr>
<td>BACK LIGHT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BL 30°</td>
<td>0.3%</td>
<td>44</td>
</tr>
<tr>
<td>BM 60°</td>
<td>6.6%</td>
<td>801</td>
</tr>
<tr>
<td>BH 90°</td>
<td>14.7%</td>
<td>1834</td>
</tr>
<tr>
<td>BVH 90°</td>
<td>2.4%</td>
<td>304</td>
</tr>
<tr>
<td>UPLIGHT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UL 100°</td>
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<td>287</td>
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<tr>
<td>UN 180°</td>
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FGS TS 35LED BW
WATTAGE: 32.9
LUMEN OUTPUT: 2200
EFFICACY: 66.9

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<td>FH 90°</td>
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<tr>
<td>FVH 90°</td>
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<td></td>
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<td>BL 30°</td>
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<td>30</td>
</tr>
<tr>
<td>BM 60°</td>
<td>19.4%</td>
<td>427</td>
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<tr>
<td>BH 90°</td>
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<td>UL 100°</td>
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</tr>
<tr>
<td>UN 180°</td>
<td>4.5%</td>
<td>100</td>
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</tbody>
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AAI reserves the right to change product specifications without notice.

IES files can be found at www.aai.net

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**Ordering Guide:**
C12800: LUMINAIRE
CP12800: POLE

**Color:** BRONZE
Custom

**Pole:** CP12800
5" Round Straight Flat Fluted Aluminum W/ 3" O.D. Tenon,
0.188" Wall Thickness,
Cast Aluminum Base W/ Access Cover

**Base:** 21.01" H x 17.00" W

**Technical Details:**
- Philips LED Engine: 80, (specify color temperature) Philips Lumileds Luxeon R LEDs, typical 75 Color Rendering Index (CRI), >100,000 hours of operational life (at 25°C ambient temperature & 70% lumen maintenance), injection molded type V optical plates, IP66 rated LED module.
- Integral Philips Advance Xitanium LED driver, class 1, IP66 rated, 350mA, IntelVolt 120-277 VAC, 50-60 Hz, RoHS compliant, additional 10kA/10kV surge suppression.

**Product Approvals:**
HADCO: JLN

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**Notice:**
This drawing is for reference only. Check for latest revision prior to ordering.

**Full Specification Drawing**
(Complete Assembly)

**Philips HADCO**
160 Cuffley Drive
Ulhaden, PA 17340
Phone 800-331-4185
Fax 717-359-9289
www.hadco.com

**Job Name:**
Texas A&M University

**Rep. Territory:**
01

**Drawn By:**
SMK

**Scale:**
1:20

**Date:**
05/06/14

**Drawing Number:**
C12800-DWG01

**Rep.:**
CW Lighting

**Rev.:** A

**Rev. No.:** 14-022

**By:**

**Date:**
Form 10 Round LED
CW / MW Wall Mount

The Philips Gardco wall mounted Round Form 10 LED products are cutoff luminaires featuring LED arrays. Round Form 10 LED luminaires provide performance excellence and advanced Philips Gardco LED thermal management technology. High performance Class 1 LED systems offer the potential for energy savings up to 50% when compared to HID systems. Housing is one-piece seamless spun aluminum and finished with either Architectural Class 1 anodizing, with hardcoat, fade resistant, electrostatically applied TOC polyurethane powdercoat or polyurethane. Luminaires provide full cutoff performance.

Prefix: CW17L-DIM
Mounting: 1
Distribution: 4
LED Wattage: 70LA
LED Selection: WW
Voltage: 277
Finish: BRA#311
Options: OWLET

Prefix: CW17L-DIM
Available in 70LA and 85LA LED Wattages Only
- CW17L-DIM 17’ Cylindrical Luminaire LED - Constant Wattage
- MW17L 17’ Semi-Spherical Luminaire LED - Constant Wattage

Prefix: CW22L
Available in 110LA and 160LA LED Wattages Only
- CW22L 22’ Cylindrical Luminaire LED - Constant Wattage
- MW22L 22’ Semi-Spherical Luminaire LED - Constant Wattage

Retrofit Kits for existing Form 10 Round 17’ and 22’ HID luminaires are available. See Legacy LED Retrofit Kits Submitted Data Sheet (C2000-2) for Retrofit Kit information.

LED Wattage and Lumen Values

| Ordering Code | Average System Watts | LED Current (mA) | LED Selection | Luminous Initial Absolute Lumen** | Basis of Lumen Data: Photometric tests performed to compliance with IESNA LM-79, except where otherwise indicated. Notes:
<table>
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<tr>
<td>70LA</td>
<td>70</td>
<td>350</td>
<td>CW</td>
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<td>85LA</td>
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<td>160LA</td>
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<td>530</td>
<td>WW</td>
<td>13,170</td>
<td>Photometric tests performed to compliance with IESNA LM-79, except where otherwise indicated.</td>
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</tbody>
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LED Selection
- CW: Cool White - 5700K - 75 CRI
- NW: Neutral White - 4000K - 70 CRI
- WW: Wall White - 3000K - 80 CRI

Voltage
- UNIV: 120V through 277V, 50Hz or 60Hz
- HVU: 347V through 480V, 50Hz or 60Hz (High Voltage Universal)

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C200-026/1012

Page 46
Form 10 Round LED
CW / MW Wall Mount

**FINISH**
- BRP: Bronze Paint
- BLP: Black Paint
- WP: White Paint
- NP: Natural Aluminum Paint
- BRA: Bronze Anodized
- BLA: Black Anodized
- NA: Natural Anodized
- OC: Optional Color Paint
- SC: Special Paint

**OPTIONS**
- F*: Fusing
- PC*: Photocontrol and Receptacle
- PCR*: Photocontrol Receptacle only
- SP*: Surge Protection for 120V through 277V input meeting ANSI C62.41.2
- SP RH*: Surge Protection for 347V through 480V input meeting ANSI C62.41.2

**DIMENSIONS AND EPA**

**CW**

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<tr>
<th>CW Style</th>
<th>Size A</th>
<th>B</th>
<th>C</th>
<th>Weight Single</th>
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<tbody>
<tr>
<td>1&quot;</td>
<td>17&quot;</td>
<td>8&quot;</td>
<td>7.5&quot;</td>
<td>28 lbs 12.70 kg</td>
</tr>
<tr>
<td>22&quot;</td>
<td>32.2&quot;</td>
<td>11&quot;</td>
<td>7.5&quot;</td>
<td>44 lbs 19.56 kg</td>
</tr>
</tbody>
</table>

**MW**

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<th>MW Style</th>
<th>Size A</th>
<th>B</th>
<th>C</th>
<th>Weight Single</th>
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<td>17&quot;</td>
<td>17&quot;</td>
<td>11&quot;</td>
<td>7.5&quot;</td>
<td>29 lbs 13.15 kg</td>
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<tr>
<td>22&quot;</td>
<td>32.2&quot;</td>
<td>14&quot;</td>
<td>7.5&quot;</td>
<td>45 lbs 20.41 kg</td>
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</tbody>
</table>

Wall Mounting Dimensions

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G200-025/10/14
Sterner Tapered Pole

**ORDERING EXAMPLE**

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<th>(5)</th>
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<th>(7)</th>
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<td>RTA20</td>
<td>6.0 x 4.5</td>
<td>0.188</td>
<td>A28</td>
<td>B</td>
<td>DF</td>
<td>BK</td>
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**ORDERING SEQUENCE**

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<td>See Pole Data Table Below</td>
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<tr>
<td>RTA12.5</td>
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<td>RTA20</td>
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<td>30</td>
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<td>RTA25</td>
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**POLE DATA**

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<th>Standard Diameter</th>
<th>Standard Thickness</th>
<th>Pole Height</th>
<th>Side Opening</th>
<th>Anchor Bolt</th>
<th>Base Style</th>
<th>Base Dimensions</th>
<th>Standard Weight</th>
<th>Assemble Pole/Strap (Minimum Total Fastening Word = 1.5)</th>
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<tr>
<td>RTA10</td>
<td>4.5&quot; x 0.125&quot;</td>
<td>10&quot;</td>
<td>9.80&quot;</td>
<td>7.00&quot;</td>
<td>0.278&quot;</td>
<td>0.225&quot;</td>
<td>0.100&quot;</td>
<td>1.00&quot; x 1.00&quot;</td>
<td>40&quot;</td>
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<tr>
<td>RTA12.5</td>
<td>4.5&quot; x 0.133&quot;</td>
<td>10&quot;</td>
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<td>1.00&quot; x 1.00&quot;</td>
<td>40&quot;</td>
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<td>0.225&quot;</td>
<td>0.100&quot;</td>
<td>1.00&quot; x 1.00&quot;</td>
<td>40&quot;</td>
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**NOTES:**
1. "10" applies to both arm and pole mount fixtures.
2. "10" is for S40; stud bars available 20" max. 4.5" dia. only.
3. Reduces OS will lower below to indicated fixture drilling.
4. 20" OS will lower below to indicated fixture drilling.
5. See pole data for dimensions & bolt information.
### Poles

#### Tapered Round Aluminum - Cast Base

The Philips Gardco TRA tapered round aluminum pole consists of a one-piece design fabricated aluminum tubing circumferentially welded to a structural quality hot rolled carbon steel plate. The poles are finished with either Architectural Class 1 anodizing or electrostatically applied TGIC polyester powdercoat. All poles include anchor bolts, hand hole, ground lug and top cap.

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>BASE</th>
<th>HEIGHT</th>
<th>DRILLING</th>
<th>FINISH</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRA</td>
<td>CB</td>
<td>30L</td>
<td>D1</td>
<td>BRA 311</td>
<td>VDA</td>
</tr>
</tbody>
</table>

Enter the order code into the appropriate box above. Note: Gardco reserves the right to refuse a configuration. Not all combinations and configurations are valid. Refer to notes below for exclusions and limitations. For questions or concerns, please consult the factory.

- **PREFIX**: TRA
- **BASE**: CB - Fixed Cast Base
- **HEIGHT**: 8', 10', 12', 14', 16', 20' H, L, M, H1
- **DRILLING**: D1 - 1 Way; D2 - 2 Way; D2@90 - 2 Way at 90°; D3 - 3 Way; D3@120 - 3 Way at 120°; D4 - 4 Way
- **FINISH**: BRP - Bronze Paint; BLP - Black Paint; WP - White Paint; NP - Natural Aluminum Paint; BRA - Bronze Anodized 311
- **OPTIONS**: DR - Duplex Receptacle; GECI - Ground Fault Receptacle; VDA - Vibration Damper

**Nipples and Couplings**
- Indicate height above base and orientation to hand hole. See Pole Orientation Information on Page 4.
  - NL - Nipple - External thread
  - CL - Coupling - Internal thread

**Single Mount Bulbhead Brackets**
- Indicate height above base and orientation to hand hole. See Pole Orientation Information on Page 4.
  - A1SBBH-19 - Single - 1.9" OD
  - A1SBBH-24 - Single - 2.4" OD
  - A2SBBH-19 - 2-Tenon - 1.9" OD
  - A2SBBH-24 - 2-Tenon - 2.4" OD

---

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79415-24/0611
## Standard Features

### Pole Data

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<th>Q</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Allowable Pole EPA</th>
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<td>85</td>
<td>90</td>
<td>100</td>
<td>110</td>
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<tr>
<td></td>
<td></td>
<td>120</td>
<td>130</td>
<td>140</td>
<td>150</td>
</tr>
<tr>
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<td>6'</td>
<td>1.56</td>
<td>4'</td>
<td>21.80</td>
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<tr>
<td>LTRA16-6188</td>
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<td>4'</td>
<td>26.32</td>
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<tr>
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<td>1.56</td>
<td>3'</td>
<td>9.67</td>
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<td>LTRA20-6188</td>
<td>20</td>
<td>6'</td>
<td>1.88</td>
<td>4'</td>
<td>22.70</td>
</tr>
<tr>
<td>LTRA25-6156</td>
<td>25</td>
<td>6'</td>
<td>1.56</td>
<td>4'</td>
<td>10.73</td>
</tr>
<tr>
<td>LTRA25-6188</td>
<td>25</td>
<td>6'</td>
<td>1.88</td>
<td>4'</td>
<td>13.39</td>
</tr>
<tr>
<td>LTRA25-7156</td>
<td>25</td>
<td>7'</td>
<td>1.56</td>
<td>4'</td>
<td>16.32</td>
</tr>
</tbody>
</table>

### Anchor Base and Bolt Detail

<table>
<thead>
<tr>
<th>Pole Height</th>
<th>Y Pole Diameter</th>
<th>Bolt Circle Dia</th>
<th>Anchor Bolt Projection</th>
<th>Anchor Bolt Size</th>
<th>Base Size</th>
<th>Conduit Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>20'</td>
<td>5&quot;</td>
<td>9 1/2&quot;</td>
<td>3 1/4&quot;</td>
<td>3/4&quot; x 30&quot; + 4&quot;</td>
<td>9 1/2 sq.</td>
<td>4 1/2&quot; Dia.</td>
</tr>
<tr>
<td>16-25'</td>
<td>6&quot;</td>
<td>9 1/2&quot;</td>
<td>3 1/4&quot;</td>
<td>3/4&quot; x 30&quot; + 4&quot;</td>
<td>10 1/2 sq.</td>
<td>5&quot; Dia.</td>
</tr>
<tr>
<td>25'-30'</td>
<td>7&quot;</td>
<td>11&quot;</td>
<td>3 1/2&quot;</td>
<td>3/4&quot; x 30&quot; + 4&quot;</td>
<td>10 1/2 sq.</td>
<td>6 1/2&quot; Dia.</td>
</tr>
<tr>
<td>25'-39'</td>
<td>8&quot;</td>
<td>11 1/2&quot;</td>
<td>3 1/2&quot;</td>
<td>1&quot; x 36&quot; + 4&quot;</td>
<td>11 1/2 sq.</td>
<td>7 1/2&quot; Dia.</td>
</tr>
<tr>
<td>35'-48'</td>
<td>10&quot;</td>
<td>14 3/4&quot;</td>
<td>4 3/4&quot;</td>
<td>1&quot; x 48&quot; + 4&quot;</td>
<td>14 3/4 sq.</td>
<td>9 1/2&quot; Dia.</td>
</tr>
<tr>
<td>50'</td>
<td>10&quot;</td>
<td>14 3/4&quot;</td>
<td>4 3/4&quot;</td>
<td>1 1/4&quot; x 42&quot; + 6&quot;</td>
<td>14 3/4 sq.</td>
<td>9 1/2&quot; Dia.</td>
</tr>
</tbody>
</table>

*48' and 50' poles are 2-piece assemblies.*
Form 10 Square LED

EH / H / Arm Mount

The Philips Gardco arm mounted Square Form 10 LED products are cutoff luminaires featuring LED arrays. Square Form 10 LED luminaires provide performance excellence and advanced Philips Gardco LED thermal management technology. High performance Class 1 LED systems offer the potential for energy savings up to 50% when compared to HID systems. The EH units are manufactured from mitered extruded aluminum and finished in an Architectural Class 1 anodizing. The H style luminaires are die formed aluminum with a thermoset polyester finish. Form 10 Square LED luminaires provide full cutoff performance and feature a flat glass lens.

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>MOUNTING</th>
<th>DISTRIBUTION</th>
<th>LED WATTAGE</th>
<th>LED SELECTION</th>
<th>VOLTAGE</th>
<th>FINISHES</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH19L</td>
<td>1</td>
<td>5</td>
<td>160LA</td>
<td>NW</td>
<td>UNIV</td>
<td>#311</td>
<td>OWLET</td>
</tr>
</tbody>
</table>

Enter the order code into the appropriate box above. Note: Philips Gardco reserves the right to refuse a configuration. Not all combinations and configurations are valid. Refer to notes below for exclusions and limitations. For questions or concerns, please consult the factory.

**PREMIUM MOUNTING OPTIONS**

1. Single Pole Mount
2. Type II
3. Type III
4. Type IV
5. Type V

**LED WATTAGE LUMEN VALUES**

<table>
<thead>
<tr>
<th>Ordering Code</th>
<th>Average System Watts</th>
<th>LED Current (mA)</th>
<th>LED Selection</th>
<th>Luminaire Initial Absolute Lumens (LM)</th>
<th>Basis of Lumen Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>70LA</td>
<td>70</td>
<td>350</td>
<td>CW</td>
<td>6,517</td>
<td>6,735</td>
</tr>
<tr>
<td>NW</td>
<td>5,938</td>
<td>6,124</td>
<td>5,999</td>
<td>5,874</td>
<td></td>
</tr>
<tr>
<td>85LA</td>
<td>85</td>
<td>350</td>
<td>CW</td>
<td>7,660</td>
<td>8,114</td>
</tr>
<tr>
<td>NW</td>
<td>7,468</td>
<td>7,907</td>
<td>7,491</td>
<td>7,112</td>
<td></td>
</tr>
<tr>
<td>110LA</td>
<td>110</td>
<td>350</td>
<td>CW</td>
<td>9,520</td>
<td>9,980</td>
</tr>
<tr>
<td>NW</td>
<td>8,911</td>
<td>9,250</td>
<td>9,010</td>
<td>8,903</td>
<td></td>
</tr>
<tr>
<td>160LA</td>
<td>160</td>
<td>350</td>
<td>CW</td>
<td>12,308</td>
<td>13,608</td>
</tr>
<tr>
<td>NW</td>
<td>12,228</td>
<td>12,508</td>
<td>12,270</td>
<td>12,111</td>
<td></td>
</tr>
</tbody>
</table>

**LED SELECTION**

- **CW**
  - Cool White - 5700K - 75 CRI
- **NW**
  - Neutral White - 4000K - 70 CRI
- **WW**
  - Warm White - 3000K - 80 CRI

**VOLTAGE**

- **UNIV**
  - 120V through 277V, 50Hz or 60Hz
- **HVU**
  - 347V through 480V, 50Hz or 60Hz (High Voltage Universal)

---

**PHILIPS GARDCO**

1611 Clevis Barker Road, San Marcos, TX 78666
(800) 327-0758 | (512) 753-1008 | Fax: (512) 753-7855 | wholesalesite@philips.com
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G203-032/1012

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Version 2.3.2014

Exterior Lighting and Installation

Roadway / Parking Poles and Fixture Datasheets

Page 51
**Specifications**

**Housing:** Fabricated from a one-piece extruded aluminum side panel with filtered corners that are internally welded and sealed for weather tightness. A press-form aluminum top cover interlocks with housing, and has a continuous seal of silicone rubber resistant to weathering, moisture, UV and ozone. Top is peaked for increased strength and efficient water runoff.

**Reflector Module:** Specular Alzak® optical segments are rigidly mounted within a die-cast aluminum enclosure that attaches to the housing as a one-piece module. HPS and PMSI sockets are porcelain 4kV pulse rated mogul base. All reflector modules are factory prewired with quick-disconnect plugs.

**Lens Frame Assembly:** A 3/8" thick impact resistant clear tempered glass lens enclosed by a one-piece molded high temperature gasket. Lens and gasket interlocks in an extruded aluminum frame which hinges at the pole end, and closes and tightens the optical chamber by four captive fasteners. Lens frame is removable without tools by means of quick-disconnecting hinges.

**Electrical Module:** All electrical components are UL and CSA recognized, mounted on a single plate and factory prewired with quick-disconnect plugs. Ballast components are mounted directly to the luminaire housing. Feeder wiring is provided for by prewiring all electrical components with quick-disconnected plugs. Ballast is high power factor of 90% or better and with starting temperatures of -20°F. Fixtures must be grounded in accordance with local codes or the National Electrical Code. Failure to do so may result in serious personal injury.

**Support Arm:** One-piece rectangular extruded aluminum with internal centering guides. Luminaire-in-pole attachment is by internal mechanical draw bolts, and includes a pole reinforcing plate with wire strain relief.

**Finish:** Super TGIC thermoset polyester powder coat paint, 2.5 mil nominal thickness, applied over a tinplated zinc conversion coating 2500 hour salt spray test endurance rating. Standard colors are Black, Dark Bronze, Platinum Silver, Stealth Grey® or White. Custom colors are available and subject to additional charges, minimum quantities and longer lead times. Consult representative.

**Optional Anodized Finish:** Dark Bronze Architectural Class 1 Anodize over satin paint.

**Certification:** Fixtures must be grounded in accordance with national, state and/or local electrical codes. Failure to do so may result in serious personal injury.

---

**Listings and Ratings**

<table>
<thead>
<tr>
<th>UL cUL 1598 standards</th>
<th>IP66 Rated</th>
<th>25C Ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Suitable for wet locations)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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6605616447

EKG402
Shoebox Luminaire

Revision 2-16-10 • klm_kg402_spec.pdf

Date: Page: 1 of 3

Select pole from Kim Arms and Poles Selection Guide. If pole is provided by others indicate O.D. for arm fitting.
# Standard Features

**Mounting**

<table>
<thead>
<tr>
<th>Plan View:</th>
<th>Wall Mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA: 2.1</td>
<td>4.5</td>
</tr>
<tr>
<td>Cat. No.:</td>
<td>□ 1A</td>
</tr>
<tr>
<td></td>
<td>□ 2B</td>
</tr>
<tr>
<td></td>
<td>□ 2L</td>
</tr>
<tr>
<td></td>
<td>□ 3T</td>
</tr>
<tr>
<td></td>
<td>□ 4C</td>
</tr>
<tr>
<td></td>
<td>□ 1W</td>
</tr>
</tbody>
</table>

**Fixture**

Cat. No. designates fixture with standard mounting arm.

- Cat. No.: EKG402

**Electrical Module**

- HPS = High Pressure Sodium
- PMH = Pulse Start Metal Halide
- LED
  - Lamp: Lamp Line
  - Watts: 400
  - Type: HPS
  - Volts: 277

Cat. Nos. for Electrical Modules available:

- 80L3K277

**Finish**

- Super TGIC powder coat paint over titanated zirconium conversion coating.
- Optional Architectural Class 1 anodized finish is available at extra cost.

**Standard Finishes:**

- Color: Black
- Dark Bronze
- Stealth Gray™
- Platinum Silver
- White
- Custom Color

Cat. No.: □ BL □ DBA 311 □ $G □ PS □ WH □ CC

*Custom colors subject to additional charges, minimum quantities and extended lead times. Consult representative. Custom color description:__

**Optional Anodized Finish:** (Available at extra cost.)

- Color: Dark Bronze Anodize
- Cat. No.: □ DB-A
## Optional Features

### Wall Mounting

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ 1W</td>
<td>A modified arm containing an access hole to allow field splices within the arm. A wall embedment bracket (WEB) is provided to accept fixture mounting rods, and a trim plate shall be provided to cover the wall embedded junction box (J-box by others). All exposed parts are finished to match the fixture. For concrete mounting only.</td>
</tr>
</tbody>
</table>

### Polycarbonate Shield

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ LS</td>
<td>May ONLY be used with 400HPS in outdoor locations where ambient air temperature during fixture operation will not exceed 85°F. Polycarbonate Shield replaces standard tempered glass lens. One-piece vacuum formed clear polycarbonate. Polycarbonate Shield is semi-pyramidal in shape for high thermal resistance, impact resistance and light transmission. <strong>CAUTION:</strong> Use only when vandalism is anticipated to be high. Useful life is limited by discoloration caused by UV from sunlight and metal halide lamps.</td>
</tr>
</tbody>
</table>

### Houseside Shield

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ HS</td>
<td>For highly reduced light on houseside. Two shielding components permanently installed at the Kim factory: One component reduces light directly from the lamp; the other component reduces reflected light. Recommended for use with clear lamps only.</td>
</tr>
</tbody>
</table>

### Photocell Receptacle

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ A-25</td>
<td>A fully gasketed receptacle installed above the electrical compartment for NEMA base photocell (by others). For all multiple-fixture pole mountings with two or three fixtures, one fixture has a receptacle to operate the others. Four fixtures require two fixtures with receptacles.</td>
</tr>
</tbody>
</table>

### Poles

See Kim Arms and Poles Selection Guide for a complete selection of square and round poles in aluminum or steel.
**LED BOLLARD**

**BRM830/831/833 Dome Top Louver**

**BRM834/835/837 Bevel Top Louver**

Featuring

- **Motion Response**
- **Lighted Coverage**

Gardco's dome top and bevel top LED Louver Bollards provide uniform illumination, superior spacings and solid vandal resistance. Rugged extruded and cast construction with silicone seals and gasketing assure years of trouble free service. The BRM830 and BRM834 are complete assemblies with an aluminum base. BRM831 and BRM835 bollard only units sit on custom architectural columns. BRM833 and BRM837 luminaires include a concrete base assembly. Gardco's advanced stack-louver LED technology and Motion Response provide maximized light output and maximum energy savings.

**Table:**

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>HEIGHT</th>
<th>LED CONTROL</th>
<th>LED SELECTION</th>
<th>LIGHTED COVERAGE</th>
<th>VOLTAGE</th>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRM830</td>
<td>42</td>
<td>DR</td>
<td>BRM834</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
<tr>
<td>BRM831</td>
<td>42</td>
<td>DR</td>
<td>BRM835</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
<tr>
<td>BRM833</td>
<td>11</td>
<td>Head Only</td>
<td>BRM837</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
<tr>
<td>BRM834</td>
<td>42</td>
<td>Head Only</td>
<td>BRM838</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
<tr>
<td>BRM835</td>
<td>42</td>
<td>Head Only</td>
<td>BRM837</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
<tr>
<td>BRM836</td>
<td>42</td>
<td>Head Only</td>
<td>BRM837</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
<tr>
<td>BRM837</td>
<td>42</td>
<td>Head Only</td>
<td>BRM837</td>
<td>360</td>
<td>347</td>
<td>LC/BRM831</td>
</tr>
</tbody>
</table>

**Notes:**
- *DR* is an approved line draw.
- Bollard reserves the right to refuse a configuration. Not all combinations and configurations are valid.
- Refers to notes below for exclusions and limitations. For questions or concerns, please consult the factory.

**LED SELECTION**

- **CW:** 6,500K, 75CRI
- **NW:** 4,300K, 75CRI
- **WW:** 3,000K, 75CRI

**Solid Colors**

- **LA:** Amber
- **LB:** Red
- **LG:** Green
- **LB:** Blue
- Consult factory for bead series or LED colors other than CW,NW,WW

**FINISH**

- **BRP:** Bronze Paint
- **BLP:** Black Paint
- **WIP:** White Paint
- **WNP:** Natural Aluminum Paint
- **BGP:** Beige Paint
- **VPP:** Verde Green Paint
- **LGP:** Light Granite Paint
- **DGP:** Dark Granite Paint
- **LSP:** Light Sandstone Paint
- **DSP:** Dark Sandstone Paint
- **RBP:** Red Brick Paint

**Options:**

- **SPR:** Surge Protection for 120V through 277V Input meeting ANSI C62.41.2
- **SPRH:** Surge Protection for 347V through 480V Input meeting ANSI C62.41.2

---

**Notes:**
- LED's vary on low level (8 watts) when no motion is present. LED's increase to full light output (47 watts) when motion detected.
- CWL: Constant Wattage Full Light Output
- Full light output only (47 watts) No motion sensor included.
- (Note: A minimum of LED voltage (14-16V) may occur due to LED manufacturer’s general voltage specification and ambient temperature.)

**Version:** 2.3.2014

**Bollard Fixture Datasheets**

Gardco Bollard

1611 Circle Barkley Road, San Marcos, TX 78666
(800) 327-0558 (512) 753-1000 FAX: (512) 753-7655 siteslighting.com
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G200-09916-2
### LED BOLLARD

**BRM830/831/833 Dome Top Louver**  
**BRM834/835/837 Bevel Top Louver**

Gardco's dome top and bevel top LED Louver Bollards provide uniform illumination, superior spacing and solid vandal resistance. Rugged extruded and cast construction with silicone seals and gasketing assure years of trouble free service. The BRM830 and BRM834 are complete assemblies with an aluminum base. BRM831 and BRM835 head only units affix to custom architectural elements. BRM833 and BRM837 luminaires include a concrete base assembly. Gardco's advanced stack-louver LED technology and Motion Response provide maximum light output and maximum energy savings.

#### PREFIX - HEIGHT - LED CONTROL

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>HEIGHT</th>
<th>LED CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dome Top</td>
<td></td>
<td>Motion Response</td>
</tr>
<tr>
<td>Bevel Top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRM830</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM831</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM833</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM834</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM835</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM836</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM837</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM838</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
<tr>
<td>BRM839</td>
<td>42&quot; 36'</td>
<td></td>
</tr>
</tbody>
</table>

(Note: Not Available in 347V.)

#### LED SELECTION

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW</td>
<td>6,500K, 75CRI</td>
</tr>
<tr>
<td>NW</td>
<td>4,000K, 75CRI</td>
</tr>
<tr>
<td>WW</td>
<td>3,000K, 75CRI</td>
</tr>
</tbody>
</table>

#### LIGHTED COVERAGE

<table>
<thead>
<tr>
<th>Lighted Louvers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>360</td>
<td>360° lighted louvers</td>
</tr>
<tr>
<td>180</td>
<td>180° lighted louvers (Provide reduced backside light.)</td>
</tr>
</tbody>
</table>

#### VOLTAGE

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIV</td>
<td>120V through 277V, 50Hz to 60Hz input</td>
</tr>
<tr>
<td>347V</td>
<td>347V</td>
</tr>
</tbody>
</table>

#### OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPR</td>
<td>Surge Protection for 120V through 277V input meeting ANSI C62.41.2</td>
</tr>
<tr>
<td>SPRH</td>
<td>Surge Protection for 347V through 480V input meeting ANSI C62.41.2</td>
</tr>
</tbody>
</table>

---

**PHILIPS**

1611 Clavia Barker Road, San Marcos, TX 78666  
(800) 217-0758 (512) 753-1000 FAX: (512) 753-7855 sitallighting.com  
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G200-00910012

---

**GARDCO**
Specifications

**VRB-LED Models**
10 - 20 Diodes

**VRB1**
*Single Function Luminaire (Aluminum Shaft)*
Maximum weight: 30 lb.

---

**Domed Top Cap**
One-piece die-cast aluminum secured to louvers by concealed allen screws in keyhole slots. For relamping access, allen screws shall not require complete removal.

**Louver**
Aluminum die-cast with vertical support ribs at 90° intervals. Horizontal louvers shall have a 1 1/4° depth, a 45° upward pitch and provide light source cutoff above horizontal. Louver assembly shall be secured to shaft by four internal tie rods.

**Lamp Enclosure**
One-piece tempered molded glass with internal flutes and full gasketing at bottom edge.

**Fixture Head**
Allows flow-through ventilation around and above the lamp enclosure.

**Shaft**
One-piece extruded aluminum, .125" wall thickness with a heavy cast aluminum twist-lock anchor base concealed within the shaft. Concealed set screws shall lock shaft onto the cast anchor base.

**Electronic Module**
All electrical components are either UL or ETL recognized, mounted on a single plate and factory prewired with quick disconnect plugs. Driver is rated for 40°F starting and has a 0-10V dimming interface for multi-level illumination options.

**Optical Module**
Each LED equipped with a directional optic for maximum beam angle projecting through louvers and back spacers. LED boards to be mounted to an anodized interlocking heat sink extrusion. Type I: Two 5-LED boards for a total of 10-LED, Type II: three 5-LED boards for a total of 15-LED, Type III: four 5-LED boards for a total of 20-LED. Available in 3500K and 5100K color temperatures.

**Anchor Bolts**
Four 3/8" x 10" + 2" zinc plated L-hooks, each with two nuts, washers and a rigid pressed board template.

**Finish**
TGIC thermoset polyester powder coat paint, 2.5 mil nominal thickness, applied over a tin-plated zinc conversion coating. 2500 hour salt spray test endurance rating. Standard colors are Black, Dark Bronze, Light Gray, Stealth Gray™, Platinum Silver, or White. Custom colors are available.

**CAUTION**
Fixtures must be grounded in accordance with national, state and/or local codes. Failure to do so may result in serious personal injury.

---

**Listings and Ratings**

<table>
<thead>
<tr>
<th>UL or ETL to UL Standards</th>
<th>15308 &amp; 6750*</th>
<th>25C Ambient</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP46 Rated</td>
<td>FS = Fully Shielded²</td>
<td>-</td>
</tr>
</tbody>
</table>

*Suitable for wet locations.

²Dark Sky Legislation Compliant

KIM LIGHTING RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
## Standard and Optional Features

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Cat. No. VRB1 Single Function, Aluminum Shaft, Domed Top</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Module</strong>&lt;br&gt;LED – Light Emitting Diode</td>
<td></td>
</tr>
<tr>
<td><strong>Source:</strong></td>
<td><strong>Color Temperature:</strong></td>
</tr>
<tr>
<td>☐ 10L – 10 LED (IES Type I)</td>
<td>☐ 3K – 3500K</td>
</tr>
<tr>
<td>☐ 15L – 15 LED (IES Type III)</td>
<td>☐ 5K – 5100K</td>
</tr>
<tr>
<td>☐ 20L – 20 LED (IES Type V)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIXTURE</th>
<th>TOTAL SYSTEM WATTS</th>
<th>VOLT</th>
<th>OPERATING AMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRB1 – 10 LED</td>
<td>12</td>
<td>120 / 208 / 240 / 277</td>
<td>.10 / .06 / .05 / .04</td>
</tr>
<tr>
<td>VRB1 – 15 LED</td>
<td>18</td>
<td>120 / 208 / 240 / 277</td>
<td>.15 / .09 / .08 / .07</td>
</tr>
<tr>
<td>VRB1 – 20 LED</td>
<td>24</td>
<td>120 / 208 / 240 / 277</td>
<td>.20 / .12 / .10 / .09</td>
</tr>
</tbody>
</table>

**Finish**<br>TCGIC thermoset polyester powder coat paint applied over a titanated zirconium conversion coating on fixture and shaft.

**Color:**<br>Black | Dark Bronze | Light Gray | Stealth Gray™ | Platinum Silver | White | Custom Color®

**Cat. No.:**<br>☐ BL | ☑ DBA 311 | ☐ LG | ☐ SG | ☐ PS | ☐ WH | ☐ CC

**NOTE:** Black and Dark Bronze colors will produce slightly less louver brightness than Light Gray or White.

*Custom colors subject to additional charges, minimum quantities and extended lead times. Consult representative. Custom color description:*
**VRBC Round Bollard**

*Unlighted Concrete*

**Specifications**

**VRBC - Unlighted Concrete Bollard**

Maximum weight: 150 lb

**Material:** Cement shall conform to current specifications for "Portland Cement." ASTM C150, Type I or II. Aggregates shall meet current requirements of "Specifications for Concrete Aggregates," ASTM C33. Water shall be clean and free from deleterious amounts of silt, oil, acids, alkali or organic materials. Wire for reinforcement shall conform to ASTM A185. Steel for lugs and plates shall conform to ASTM A36, or A283 grade D.

**Surface:** Medium sand-blasted with anti-graffiti sealer. Available colors are Charcoal, Brown, Natural Gray or White, integral in concrete mix.

**Cure and Strength:** Allows for completion of the hydration process, and result in a 28-day compressive strength of not less than 4,500 psi.

**Manufacture:** Fiberglass molds used to insure uniform parts. Mold parting lines may be slightly visible in finished parts.

**Anchorage:** Four steel mounting tabs for installation on four ½" x 10' + 2' zinc electroplated L-hook anchor bolts. Each anchor bolt is supplied with two nuts, two washers, and a rigid pressed board template.

**Shipment:** Palletized with adequate hold-downs to prevent load movement in transit.

**Concrete Finish**

- **BR-C** Brown
- **CH-C** Charcoal
- **NG-C** Natural Gray
- **WH-C** White

*Shaft surface color is integral in concrete mix.*

**Note:** No fixture, electrical elements, or conduit openings. Flat top not available.
Overview

System description

Owlet Nightshift is a monitoring and control system for street lighting. Owlet Nightshift allows every lamp to be monitored and controlled individually:

- Metering and documenting the current energy consumption
- Measuring the electrical light point values
- Controlling using dimming profiles for customised illumination levels and the best possible energy savings
- Real-time monitoring and manual control when needed
- Recording the consumption values in a database for comprehensive analysis
- Automatic reporting in the event of faults (by e-mail/SMS, when applicable).

The system can be controlled by internet using any standard web browser (1) (or using a mobile end device, e.g. a smartphone). The server (2) is connected to the lamp via a segment controller (3) which is connected to the internet, from where it is transmitted to the lamps wirelessly (4).
Overview

Open technologies

To ensure you can work effectively today and are ready to use the technology of the future, Owlet focuses on open technologies, using widespread standards and open concepts which are supported by a wide group of users and developers.

<table>
<thead>
<tr>
<th>Level</th>
<th>Technology used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>Apache web server&lt;br&gt;The Apache http server is an open-source and free product made by the Apache Software Foundation, and is the most widely used web server on the internet.</td>
</tr>
<tr>
<td>Segement controller</td>
<td>MySQL database&lt;br&gt;MySQL is a relational database management system. It is available as both open-source software and as a commercial enterprise version for various operating systems, and forms the basis for many dynamic websites.</td>
</tr>
<tr>
<td></td>
<td>PHP&lt;br&gt;PHP is a scripting language for creating dynamic websites or web applications. PHP is circulated as free software under the PHP licence.</td>
</tr>
<tr>
<td></td>
<td>JavaScript&lt;br&gt;JavaScript is a scripting language for automating websites.</td>
</tr>
<tr>
<td>Wireless network</td>
<td>Python&lt;br&gt;Python is a universal programming language.&lt;br&gt;The language has an open, community-based development model, which is supported by the non-profit organisation Python Software Foundation.</td>
</tr>
<tr>
<td></td>
<td>ZigBee&lt;br&gt;ZigBee is a WiFi standard which allows household appliances, sensors and many other devices to be connected over short distances (10 to 100 metres). The standard was developed by the ZigBee alliance. It is an association currently comprised of more than 230 companies which are promoting the worldwide development of this technology.&lt;br&gt;www.zigbee.org Owlet is a member of the ZigBee alliance.</td>
</tr>
</tbody>
</table>
Overview

Hardware

The Nightshift system requires very little hardware for monitoring and controlling the lamps.

<table>
<thead>
<tr>
<th>Server</th>
<th>Segment controller</th>
<th>Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>The server is operated by Owlet. The operator of the system does not require any hardware.</td>
<td>The segment controller is connected to the internet (server connection). It connects to the lamps wirelessly. A SeCo controls one segment with up to 150 controllers.</td>
<td>A controller, which controls the lamps, is integrated into every lamp. There are different shapes and designs available.</td>
</tr>
</tbody>
</table>
Overview

Certificates

The certificates can also be found on the Owlet FAE website.

LuCo / CoCo

<table>
<thead>
<tr>
<th>CE</th>
<th>Based on the EU R&amp;TTE DIRECTIVE 1999/5/EC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAFETY:</td>
</tr>
<tr>
<td></td>
<td>EN 61347-2-11:2001</td>
</tr>
<tr>
<td></td>
<td>EN 61347-1:2008</td>
</tr>
<tr>
<td></td>
<td>EN60950-1:2006+A11:2009</td>
</tr>
<tr>
<td></td>
<td>EMC</td>
</tr>
<tr>
<td></td>
<td>EN 301 489-1 V1.8.1:2008-04</td>
</tr>
<tr>
<td></td>
<td>EN 301 489-17 V2.1.1:2009-05</td>
</tr>
<tr>
<td></td>
<td>RADIO:</td>
</tr>
<tr>
<td></td>
<td>EN 300 328 V1.7.1:2006-10</td>
</tr>
<tr>
<td>UL</td>
<td>Will be added to asap</td>
</tr>
</tbody>
</table>

SeCo

Will be added to asap.
Outdoor Luminaire Controllers (OLC)
The "LuCo" and "CoCo" are available in various configurations. All members of the family share the reliable Zigbee communication, switching and dimming capabilities and the lamp failure detection. The OLC’s are ballast Independent, supporting conventional gears like magnetic ballasts and bi-pole ballasts as well as electronic ballasts and LED drives with 1-10V Interface or the DALI standard. Each output is able to switch a 1000W load @ 230V.

CoCo (Column Controller)
IP 67 fully potted ruggedized version for in-pole mounting, shipped with up to two independent power switches, each individual energy metered, ideal if more than one load is attached to a pole, i.e. double flamed luminaries, festive lighting, advertising signs, etc. The energy consumption of each output is individually metered through Class 1 meters on board. Current, voltage and power factor are also continuously monitored and logged. An in built back-up astronomical clock provides switching after sunset / before sunrise even when the superordinated systems (Segment controller, Web server) fail to operate.

LuCo (Luminarie Controller)
LuCo is the choice if you want to install the system into luminaries. The controller is available in three versions: LuCo-D with DALI-Interface, LuCo-M with in built Class 1 energy meter and the LuCo-U without metering for applications where a common energy meter is mounted in the feeder pillar. Like the CoCo, current, voltage and power factor are also continuously monitored and logged. An in built back-up astronomical clock provides switching after sunset / before sunrise even when the superordinated systems (Segment controller, Web server) fail to operate.

Segment Controller (SeCo)
The SeCo manages a segment of up to 150 CoCo’s and LuCo’s. It collects the data from the OLC’s through the self-healing Zigbee mesh network and transmits it over the Internet to the Webserver, assuring security through a VPN. The connection to the Internet is done either to ADSL, GPRS or 3G. Equipped with 2 Digital and 2 Analog Inputs and a Modbus Interface the SeCo can acquire data from a segment-wide energy meter for billing purposes as well as send and receive commands from remote sensors and actors, i.e. switching a complete lighting feeder or receiving a ripple control command.

Due to it’s in built Python engine, the segment controller is fully programmable if customization is needed. As a matter of course light points can be organized in groups (i.e. intersections, main roads, crosswalk, etc.) receiving and executing switch and dim commands synchronously.

Owlet Nightshift Web-UI/Webserver
Are you familiar with booking flights on a webpage or using a web search engine? If so, you can commission and manage the Owlet Nightshift System as well.

No special skill set or expensive integrators are required for setup and manage the system. The basic idea of open systems is also reflected in the Nightshift server which can be hosted everywhere. Locate and monitor your installation in geographic maps, access predefined reports, customize your personal reports, configure the system, change dimming profiles or switching schedules etc., all on the system webpage.

All the received information is stored in a MySQL Database making the data available for long term evaluations like energy analysis, lamp life time forecasting, problem detection, etc.
Overview

Controller

LuCo MD / LuCo DA for installing in the lamp.
LuCo NX for installing in the lamp.
LuCo PD / LuCo PN for installing on the lamp.
CoCo (FU/SI/DA) for installing in the pole.

A controller is installed in every lamp.

The controller:
- Activates and controls the lamps
- Measures consumption
- Communicates wirelessly (ZigBee)
- Features an analogue (1 - 10 V) and/or digital (DALI) dimmer output
- Features a switching output (relay) to disconnect the power to the lamps
- Comes in a variety of forms: LuCo NX/PD/PN
- LuCo NX/PD/PN are multi voltage-compatible (110-240V),
  all others are available in special designs (120V, 230V, 240V, 270V)
- Transmission power: LuCo NX/PD/PN is 6mW,
  all others are available in special designs (2 or 10mW transmission power)

All controllers are protected from jets of water:
- CoCo: IP66
- LuCo-NX/PD/PN: IP20

All controllers are equipped with an astronomical clock allowing them to operate the lamps in accordance with the local position of the sun in the event of a fault
(ON at -0° after sunset, OFF at -0° after sunrise).

LuCo NX/PD/PN are additionally equipped with a photocell that can control the lamp according to brightness.
Overview

SeCo (Segment Controller)

A SeCo controls one segment of up to 150 controllers.

- Its position is not restricted to a particular location within the segment.
  Minimum requirement: the nearest lamp should not be more than 100 m away from the SeCo.
  The best place is in the middle of the segment, with as many lamps as possible within a radius of 100 m.
- The SeCo is connected to the internet (by mobile data transmission or LAN cable).
- The SeCo receives the control data from the server during the configuration.
- It stores the control data and controls the lamps as specified.
- Furthermore, the SeCo records the consumption data from its controllers and saves this.
- The server retrieves the consumption data from the SeCo in regular intervals, saving it to its database.

Using the inputs and outputs

The SeCo features the following inputs and outputs:

- 2 digital inputs
- 2 analogue inputs
- 1 or 2 switching outputs
- 1 modbus interface

The digital inputs are supported by default. They can also be used to integrate a broadcast, or photocells used for controlling.

Needs-based activation by motion detector is also possible by default, e.g.: in the event of movement, the lamps are switched to 100% for a short period.

Enhancement options

The SeCo also provides the option of being programmed to process other external signals and to allow the implementation of complex control systems.
Overview

Owlet cloud

Owlet Cloud

The cloud is operated by Owlet.

- The programs which you use to manage and control your lamps run in the cloud.
- The cloud saves the operating and consumption data (every 90 min. by default).

The customer does not require any hardware.

A server can also be operated by the customer.

In this case, Owlet installs all the software required on the customer’s server.
Owlet Wireless Outdoor Lumencontroller and -meter LuCo-NX 1-10V/DALI Datasheet

Product Information
General Description
The Lumencontroller LuCo-NX is a luminaire-based controller that monitors and controls luminaires based LED-Drivers or HID-Ballasts. The controller controls the driver/ballast by switching the mains and by the means of either DALI or 1-10V interfaces. A built-in utility grade meter offers the highest metering accuracy available on the market today, better than 1% over the complete diming range.

The LuCo-NX offers as well a sensor input compatible with the dry contacts of a wide range of presence, movement or traffic detectors to adjust the light levels on demand and the patented LightSync™ technology ensuring dusk/dawn operation in unswitched power grids, as a failsafe function in case of disruption of the control network or the dusk/dawn switching in un-commissioned installations. The controller monitors and stores electrical characteristics from the Led-Drive/Ballast. In addition to the above it offers driver / ballast independent energy saving algorithms, Constant Lumen Output CLO which compensates the luminance depreciation over time and VPO which equalizes wattage jumps in a luminaire range to prevent over lighting.

Based on the wireless industry standard ZigBee, the LuCo-NX forms together with Segment Controller ScCo a robust and reliable mesh network which ranges from a couple of luminaires to tens of thousands of luminaires.
Owlet Wireless Outdoor
Lumencontroller and -meter LuCo-NX 1-10V/DALI
Datasheet

Application
The LuCo-NX controls LED-Drivers/Ballast units according to the wiring diagrams below. It is designed for use inside outdoor luminaires for residential, road and urban applications including Ambiance, Sport, Industry and Campus.

General operation
The LuCo-NX is designed to perform four major tasks.

1. Controlling and sensing
The LuCo receives the incoming commands (group commands, manual override, detection events) from the segment controller SeCo or sister controllers in the mesh network and acts accordingly to regulate the light output of the luminaire using its 1-10V/DALI interface (ON, OFF, 0…100% Light). In case of a sensor attached to the sensor input the LuCo sends a detection event to RF mesh net and all to the event associated light points will act accordingly to the event and idae dim profile stored in the LuCo’s.

Fail-safe
In case of a disrupted RF communication the LuCo falls back to dusk/dawn switching based on astronomic sunset/sunrise calculations. With the optional LightSync™ attached the failback scenario can be extended to dusk/dawn switching based on ambient light conditions.

2. Energy Saving
The LuCo firmware has two inbuilt remote configurable energy savings algorithms:
Constant Lumen Output CLO compensates the luminance depreciation over time according to the maintainance factor of the luminaire/lamp/LED assembly and VPO equalizes wattage jumps in a luminaire range to prevent over lighting.

3. Monitoring
The monitoring function in the controller measures mains voltage, current, power factor, burning hours and accumulative energy consumption of the connect lamp/LED driver assembly and transmits its value on request to the SeCo.

4. Reporting
Based on these measurements and/or the information received through DALI the controller determines if the luminaire/lamp/LED assembly is operating in the configured threshold. Violations of these thresholds will be reported to the SeCo and an alarm will be created. This includes as well the energy consumption measurements.

The Luco-NX is able to drive up to eight DALI or 1-10V drivers with a maximum load current of 8 A (880VA@110V, 1,9kVA@240V, 2,2kVA@277V). An un-commissioned LuCo-NX will switch ON its output at max. level on power up. If the optional LightSync™ is attached an un-commissioned LuCo-NX will operate in dusk/dawn switching based on ambient light conditions.
Mounting informations
The LuCo-NX is designed to fit into the gear compartment of the luminaire. The recommended antenna position is on top of the luminaire to provide optimum conditions for wireless communication.

1. Antenna Installation
   Connector Type: RP-SMA
   Installation by technical staff.

2. Luminaire Controller Installation
## ZigBee/IEEE address

The Luco-Nx will become a node in a large mesh network of nodes, all controlled from one or multiple SeCos. To represent the controller in a map and address it individually, the SeCo needs to know the geographic position and the unique ZigBee address. This address is printed on four barcode labels on the controller. After installation on-site, the barcode must be scanned during configuration of the system.

<table>
<thead>
<tr>
<th>Operating conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>-(A)-40°C to +80°C / -40°F to 175 °F</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>10% to 90%</td>
</tr>
<tr>
<td>Max. housing temp.</td>
<td>0°C to 80°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-operating conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-30°C to +80°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>5% to 90%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mains connection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains voltage</td>
<td>110-277VAC ±10%</td>
</tr>
<tr>
<td>Mains frequency</td>
<td>50/60 Hz ± 5%</td>
</tr>
<tr>
<td>Maximum load current of 8 A</td>
<td>(80VA@110V, 1,589VA@240V, 2,789VA@277V)</td>
</tr>
<tr>
<td>Required external fuse</td>
<td>≤ 10A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power consumption</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-by wattage</td>
<td>≤ 0.7W</td>
</tr>
<tr>
<td>Operating wattage</td>
<td>≤ 0.2W</td>
</tr>
<tr>
<td>Accuracy integrated powermeter</td>
<td>1% (between 0% and 100% dimming)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installation terminal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Tension clamp connection with a 135° outlet direction</td>
<td></td>
</tr>
<tr>
<td>- Lever for simple opening of terminal point</td>
<td></td>
</tr>
<tr>
<td>- Solid, flexible 0.13-2.5mm² (ECQ/26-14AWG) with wire end ferrule DIN 46228 pt 1 min 0.25mm² - 1.5mm² stripping length 6mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DALI output Interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DALI Compliant to IEC62386 part 101/102</td>
<td></td>
</tr>
<tr>
<td>Load capacity</td>
<td># DALI lamp drivers</td>
</tr>
<tr>
<td>Protection</td>
<td>Interface is short circuit proof</td>
</tr>
<tr>
<td>DALI voltage</td>
<td>11.5 to 20.5Vdc</td>
</tr>
<tr>
<td>DALI current</td>
<td>8 to 20mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1-10V interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliant to 1-10VDC IEC60929 (Annex I)</td>
<td></td>
</tr>
<tr>
<td>Load capacity</td>
<td>eight 1-10V lamp drivers</td>
</tr>
<tr>
<td>Load current</td>
<td>Interface is current sinking max 16mA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Radio Frequency</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEEE802.15.4 / Zigbee Pro Meshnet</td>
</tr>
<tr>
<td>Frequency band</td>
<td>2.4 GHz (2400.0...2483.5 MHz)</td>
</tr>
<tr>
<td>Range open field (as an installation height of 1.5 m):</td>
<td>- 300m/1000 ft from controller (to be confirmed at validation)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Toyolac® T884-1 ABS RESIN</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP20 (installed condition) provides insulation Class II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standards &amp; Legislation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Approvals</td>
<td>R&amp;TTE directive 1999/5/EC</td>
</tr>
<tr>
<td></td>
<td>EMC directive 2004/108/EC</td>
</tr>
<tr>
<td></td>
<td>LV directive 2006/95/EC</td>
</tr>
<tr>
<td></td>
<td>EN 50614, 61000-4, 61508</td>
</tr>
<tr>
<td></td>
<td>UL 916</td>
</tr>
<tr>
<td>Conducted emission</td>
<td>FCC Part 15</td>
</tr>
<tr>
<td>Radiated emission</td>
<td>FCC Part 15</td>
</tr>
<tr>
<td>Safety</td>
<td>EN60950-1 / EN 61347-2-11</td>
</tr>
</tbody>
</table>
Mounting informations
The LuCo-NX is designed to fit into the gear compartment of the luminaire. The recommended antenna position is on top of the luminaire to provide optimum conditions for wireless communication.

1. Antenna Installation
   Connector Type: RP-SMA
   Installation only by technical staff.

2. Luminaire Controller Installation
Owlet Wireless Outdoor Technical Data

ZigBee/IEEE address
The Luceo-Nix will become a node in a large mesh network of nodes, all controlled from one or multiple SeCos. To represent the controller in a map and address it individually, the SeCo need to know the geographic position and the unique ZigBee address. This address is printed on four barcode labels on the controller. After installation on-site, the barcode must be scanned during configuration of the system.

<table>
<thead>
<tr>
<th>Operating conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>0°C to +40°C / -40°F to 104°F</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>10% to 90%</td>
</tr>
<tr>
<td>Max. housing temp.</td>
<td>0°C to 80°F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-operating conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-30°C to +80°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>5% to 90%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mains connection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains voltage</td>
<td>110-277VAC ±10%</td>
</tr>
<tr>
<td>Mains Frequency</td>
<td>50/60 Hz ± 5%</td>
</tr>
<tr>
<td>Maximum load current of 8 A</td>
<td>(80VA@110V, 1.9kVA@240V, 2.2kVA@277V)</td>
</tr>
<tr>
<td>Required external fuse</td>
<td>≤ 10A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power consumption</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-by wattage</td>
<td>≤ 0.7W</td>
</tr>
<tr>
<td>Operating wattage</td>
<td>≤ 0.8W</td>
</tr>
<tr>
<td>Accuracy integrated powermeter</td>
<td>1% (between 0% and 100% dimming)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Installation terminal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Tension clamp connection</td>
<td>with a 135° outlet direction</td>
</tr>
<tr>
<td>- lever for simple opening of terminal point</td>
<td></td>
</tr>
<tr>
<td>- Solid, flexible 0.13-2.5mm2(EC)/26-14AWG(UL)</td>
<td></td>
</tr>
<tr>
<td>- with wire and ferrule DIN 46228 pt 1 min 0.25mm2 - 1.5mm2 stripping length 6mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DALI output Interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DALI Compliant to IEC62386 part 101/102</td>
<td></td>
</tr>
<tr>
<td>Load capacity</td>
<td>8 DALI lampdrivers</td>
</tr>
<tr>
<td>Protection</td>
<td>Interface is short circuit proof</td>
</tr>
<tr>
<td>DALI voltage</td>
<td>11.5 to 20.5Vdc</td>
</tr>
<tr>
<td>DALI current</td>
<td>8 to 20mA</td>
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<table>
<thead>
<tr>
<th>1-10V interface</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Compliant to 1-10VDC IEC60929 (Annex E)</td>
<td></td>
</tr>
<tr>
<td>Load capacity</td>
<td>8 light 1-10V lampdrivers</td>
</tr>
<tr>
<td>Load current</td>
<td>Interface is current sinking max 16mA</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Radio Frequency</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEEE802.15.4 / Zigbee Pro Meshnet</td>
</tr>
<tr>
<td>Frequency band</td>
<td>2.4 GHz (2400,0...2483.5 MHz)</td>
</tr>
<tr>
<td>Range open field (at install)</td>
<td>800W/1000 ft from controller to controller (to be confirmed at Kalender)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Teyslac® TR84-1 ABS RESIN</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP20 (installed condition) provides insulation Class II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standards &amp; Legislation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Approvals</td>
<td></td>
</tr>
<tr>
<td>- R&amp;TTE directive 1999/5/EC</td>
<td>EN301489-17 / EN61000-4 / EN55022</td>
</tr>
<tr>
<td>- EMC directive 89/106/EC</td>
<td></td>
</tr>
<tr>
<td>- LV directive 2006/95/EC</td>
<td></td>
</tr>
<tr>
<td>- H&amp;O directive 2002/96/EC</td>
<td></td>
</tr>
<tr>
<td>- UL 916</td>
<td></td>
</tr>
<tr>
<td>Conducted emission</td>
<td>FCC Part 15</td>
</tr>
<tr>
<td>Radiated emission</td>
<td>FCC Part 15</td>
</tr>
<tr>
<td>Safety</td>
<td>EN60950-1 / EN 61347-2-11</td>
</tr>
</tbody>
</table>
Design Standard

General Overhead Electrical Distribution

Detailed specifications follow.

PART 1 MATERIALS

1.1 All poles shall use S&C brand cutouts.
1.2 All materials shall be hot-dipped galvanized including nuts, bolts, and others.
1.3 Rebuilds (refurbished poles) are prohibited.

PART 2 GROUNDING

2.1 All poles shall be butt wrap grounded and ground-rod attached.

PART 3 PLAIN POLES

3.1 All Poles, regardless of length, shall be of Class 2 (C-2) designation.
3.2 Poles shall be used only at the discretion of the University. Overhead distribution is generally being replaced by underground lines.
3.3 All Poles shall be creosote pressure treated.

PART 4 RISER POLES

4.1 Any primary or secondary riser poll shall have no other equipment mounted onto it including transformers.
4.2 All riser poles shall have riser brackets.
4.3 Any primary or secondary riser shall have a OZ bushing.
4.4 A spare conduit for a riser pole will be installed with cap.

PART 5 DEAD END POLE

5.1 One guy-strain insulator shall be used in each respective guy.
5.2 Conductor size shall depend on anchor size.
5.3 Clearance shall be 20 feet wide and clear of all potential obstructions.
6.1 Transformer mounted poles shall not have a device arm installed. Single transformer installations may be bolt-mounted. However, any transformer bank cluster consisting of two or more transformers shall utilize an aluminum-form transformer bank rack.
40' CLASS 2 POLE

GROUND WIRE TO HAVE MINIMUM CONDUCTIVITY OF NO. 6 SOLID COPPER OR EQUIVALENT

STABLES ON GROUND WIRE SHALL BE 2' APART EXCEPT FOR A DISTANCE OF 8' ABOVE GROUND AND 8' FROM TOP OF POLE WHERE THEY SHALL BE 6' APART TYP

WOOD CROSSARM BRACE

44" TYP

15KV PIN INSULATOR

8' CROSSARM

18" TYP

RIDGE PIN

FINISHED GRADE

6' TYP

5" X 8' GROUND ROD

GROUNDED (EARTH)

BUTT WRAP
Design Standard

High Density Polyethylene (HDPE) Piping Installations

Texas A&M University requires the use of Extra High Molecular Weight Plus (EHMW Plus) High Density Polyethylene (HDPE) pipe due to its additional performance against abrasion, higher pressure and elevated temperatures. This pipe is manufactured with the PE4710 resin.

For chilled water and domestic cold water a minimum of SDR 17 is required. For heating water and domestic hot water a minimum of SDR 11 is required. For sanitary sewer a minimum of SDR 26 is required (SDR 17 is recommended under mall and paver areas).

The following standards and practices shall be adhered to:

Polyethylene fabricated fittings shall be manufactured from polyethylene pipe, sheet stock or molded fittings meeting the material requirements of this specification and all appropriate requirements of AWWA C-901 or AWWA C-906.

Polyethylene fittings, including custom fabrications, shall have the same internal pressure rating as the mating pipe. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with AWWA C-901 or AWWA C-906 for the same pipe size.

Thermal lines shall be insulated in accordance with the Underground Piping Systems Design Standard.

Detailed specifications follow.

PART 1 JOINING

1.1 Heat Fusion

A. Pipe and fittings shall be joined by one of the following types of thermal fusion per the Manufacturer’s recommended procedures: Butt fusion, Saddle fusion or Socket fusion.

B. Upon request, the Manufacturer shall provide fusion training by authorized personnel or an authorized Representative. The Contractor shall be responsible for ensuring that personnel have received proper training per the Manufacturer’s recommended procedure. Records of training shall be maintained by the Contractor and should not exceed 12 months from date of construction.

C. Butt fusions performed between pipe ends or pipe ends and fitting outlets shall be within the following allowable wall mismatches:

1. 2 DR difference for pipe and fitting diameters 6"IPS and smaller.

2. 1 DR difference for above 6" through 18".
3. No difference for diameters above 18".

The difference in DR’s is determined from the following DR values: 7.3, 9, 11, 13.5, 17, 21, 26 and 32.5

1.2 Other Methods of Joining

A. Polyethylene pipe and fittings may be joined together or to other materials through the use of electrofusion fittings, flange adapters with back-up rings, mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material, or MJ adapters. The Manufacturer of the joining device shall be consulted for proper installation procedures.

PART 2 MARKING

2.1 Pipe and tubing shall be permanently marked in accordance with all applicable standards per this specification. Marking shall be heat stamped indent print and shall remain legible under normal handling and installation practices.

2.2 Fittings shall be marked on the body or hub. Marking shall be in accordance with the applicable standard depending upon the fitting type. Mechanical fittings shall be marked with size, body material designation code, pressure rating and the Manufacturer’s name or trademark.

PART 3 WORKMANSHIP

3.1 Pipe, tubing and fittings shall be homogenous throughout, and free of visible cracks, holes, foreign inclusions, blisters, dents or other injurious defects. The pipe, tubing and fittings shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

PART 4 TESTING

4.1 The Contractor shall be responsible for field set-up and performance of the fusion equipment and the fusion procedure used by the operator. Upon request, the Contractor shall verify the fusion quality by making and testing per the Manufacturer’s recommended qualification procedure. The Contractor shall be responsible for the necessary adjustments to the set-up, equipment, operation and fusion procedure. Fusions that fail the qualification procedure shall be remade.

4.2 Hydrostatic testing shall be conducted in accordance with the Manufacturer’s recommended testing procedures.

4.3 Low pressure pneumatic testing may be conducted on gravity sewer lines in accordance with ASTM F1417. Other methods of pneumatic testing are not recommended.
PART 5  THIRD PARTY CERTIFICATION

5.1 The performance requirements of the pipe and fittings shall comply with the most current version of AWWA C-901 or AWWA C-906. The Manufacturer shall be listed with NSF-61 certification and include the third party certification within the print line of the product.
PART 1 GENERAL

1.1 Above ground hydronic piping 2 inches and less in diameter shall be ASTM B88, hard drawn, Type L seamless copper tube with wrought copper fittings, ASTMB16.22 or PEX-a cross linked polyethylene piping, ASTM 876 with oxygen-diffusion barrier that meets DIN 4726 and F1960 cold expansion fittings.

1.2 Above ground hydronic piping 2.5 to 10 inches in diameter shall be ASTM A52, Grade B standard weight seamless or electric resistance welded black steel pipe with standard weight seamless steel welded fittings, satisfying ASTM A234, Grade WPA or WPB, ANSI B16.9

1.3 For condensate drain piping provide one of the following:
   A. Copper piping as specified above
   B. PEX-a piping as specified above

1.4 For PEX-a applications for piping 2” and less in diameter, PEX shall be terminated at the control valve at the AHU. Piping from the control valve to the coil shall be copper.

1.5 Isolation Valves
   A. Provide the piping systems with line size shutoff valves located at risers, at main branch connections at each floor, at branch takeoffs serving equipment and at each heating and cooling coil. Valves shall be provided on both supply and return lines.
   B. At air handling units where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge, thermometer and a balancing valve with memory stop and valves for isolation of each coil.

1.6 Provide insulation with minimum thickness and conductivity values in compliance with ASHRAE Standard 90.1-2010, Table 6.8.3A & B. Consider additional insulation to ensure compliance with requirements of Building Energy Efficiency Analysis Design Standard.
PART 2  PEX-a REQUIREMENTS

2.1  Standard Grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-3 as listed in TR-4. The following three standard-grade hydrostatic ratings are required:

A. 200 Degrees F at 80 psi
B. 180 Degrees F at 100 psi
C. 73.4 degrees F at 160 psi

2.2  Certification of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 when encased with ½ inch fiberglass insulation at tube spacing of not less than 4 inches apart.
Design Standard

Interconnection of Facilities to Utility Infrastructure

Detailed specifications follow.

PART 1    GENERAL

1.1  This standard defines requirements for connection of new facilities to existing utility infrastructure as well as minimum clearances required between new facilities and existing infrastructure. For the purposes of this standard, utility infrastructure includes overhead and underground electrical distribution lines and underground chilled water, heating hot water, domestic hot water, domestic cold water and sanitary sewer lines owned and operated by Texas A&M University.

PART 2    CONNECTIONS TO EXISTING INFRASTRUCTURE

2.1  All new buildings to be constructed on the Texas A&M University Campus shall connect to existing utility infrastructure. Any exceptions to this requirement must be approved in writing by the Utilities & Energy Services Department at Texas A&M before completion of the schematic design phase of the project.

2.2  The project is responsible for bearing all costs associated with the design and installation of utility infrastructure connections.

2.3  Design and installation shall comply with the requirements of all applicable Utilities and Energy Services Design Standards. The complete set of design standards can be found at the following link:  https://utilities.tamu.edu/design-standards/

PART 3    MINIMUM CLEARANCE REQUIREMENTS

3.1  No structures or facilities are to be built or placed underneath or on top of existing utility lines or easements.

3.2  The project is required to maintain a minimum clearance of 8 feet from the closest point of any existing underground utility infrastructure.

3.3  The project is required to maintain a minimum clearance of 15 feet from the closest point of any overhead electrical distribution lines and transformers.

3.4  The project shall bear all costs associated with utility infrastructure modifications required to maintain minimum clearances defined above.

3.5  Assistance in locating existing utility infrastructure on a proposed project site can be obtained from the Technical Services group at Utilities and Energy Services at 979-862-4604.
Design Standard

Laboratory Control Systems (LCS)

Detailed specifications follow.

PART 1 - GENERAL

1.01 DESCRIPTION

A. When a construction project includes Fume Hoods, the engineer will design a Variable Air Volume (VAV) laboratory airflow control system, (LCS). Constant Air Volume Systems (CAV) are not acceptable. The VAV LCS shall be furnished and installed to comply with the engineer’s design of airflow into and out of laboratory rooms and fume hoods. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain a constant average face velocity into the fume hood when the sash is open. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). Air Changes per Hour (ACH) will be engineered, and balanced, to provide 8 ACH when occupied, and 4 ACH when unoccupied, (with fume hood sash closed). The laboratory will have dual technology, ceiling mounted, occupancy sensors installed that control general lighting in the room, as well as connect to the LCS, in order to manage the Air Changes per Hour during occupied and unoccupied periods.

1.02 RELATED WORK

A. The LCS shall be included within the scope and responsibilities of the projects Building Automation System (BAS) Contractor.

1.03 ACCEPTABLE BAS Contractors and Laboratory Control Systems

A. The following are acceptable BAS Contractors and Laboratory Control Systems
   1. Siemens Building Technologies with Siemens Laboratory Control Systems
   2. Johnson Controls Metasys and TSI Laboratory Control Systems

B. The above vendors will supply a LCS that will use varying LCS products, methods and technologies to meet the engineers design. The BAS contractor will be responsible for providing the LCS to meet the engineers design.
1.04 WARRANTY PERIOD

A. Warranty shall be for a period of twenty-four months (starting from the date of final acceptance) whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the Owner.

1.05 SHOP DRAWINGS:

The BAS contractor shall provide to the engineer and owner in an electronic and paper format:
1. Schematic flow diagrams.
2. Power, signal, and control wiring diagrams.
3. Details of control panel faces.
4. Equipment schedule.
5. Valve schedule.
6. Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
7. Control System Software: Schematic diagrams, written descriptions, and points list.
8. Sequences of operation.
10. Samples of Graphic Display screen types and associated menus.
11. Operation and maintenance data.

PART 2 - SYSTEM PERFORMANCE REQUIREMENTS AND COMPONENTS

2.01 Fume Hood Monitor/Controller

1. A fume hood monitor shall be provided. This same monitor shall generate an exhaust airflow control signal for the appropriate airflow control device in order to provide a constant average face velocity.
2. Audible and visual alarms shall be provided for both flow alarm and emergency exhaust conditions.
3. The fume hood monitor shall indicate the average face velocity for the fume hood, and have indicator lights to indicate normal, warning and alarm status. The fume hood monitor shall have an audible alarm and alarm silence button

2.02 AIRFLOW CONTROL DEVICE

A. The airflow control device shall be pressure independent over its specified operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manif Aerosol
B. Each fume hood exhaust terminal will have a factory mounted, removable, air flow transmitter with output of 4-20 mA proportional to velocity pressure. The air flow transmitter will have an accuracy of at least ±.5% of the transmitter range.

C. The laboratory general exhaust valve (GE) shall meet one of the following requirements:

Actuation:
1. For electrically-actuated VAV boxes the actuator shall be mounted to the VAV box. Loss of main power shall cause the actuator to position itself in an appropriate failsafe state. Options for these failsafe states include: normally open-maximum position, normally closed-minimum position, or last position. This position shall be maintained constantly without external influence, regardless of external conditions on the actuator (within product specifications).

2.03 LABORATORY CONTROL UNIT

A. Each Laboratory Control Unit (LCU) shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each LCU shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of LCUs as a minimum:
   1. VAV Fume Hood, temperature general exhaust and supply controllers.
   2. Laboratory Room Controllers.

B. A laboratory control unit shall control the supply and/or general exhaust and laboratory exhaust airflow control devices to maintain proper room pressurization polarity (positive or negative). Each individual laboratory shall have a dedicated laboratory control unit.

C. The control unit shall be electronic. The inputs shall accept linear feedback signals from fume hood, canopy, snorkel, biosafety cabinet, and office supply airflow control devices. The output signals shall control supply, general exhaust/return airflow control devices and/or variable frequency drives with signals that are linearly proportional to the desired supply or exhaust airflows.

D. The control unit shall maintain a constant design offset between the sum of the room’s total exhaust and make-up/supply airflows. This offset shall be field adjustable and represents the volume of air which will enter (or exit) the room from the corridor or adjacent spaces.

E. The control unit shall provide linear signals that are proportional to all airflow sources, sash sensors, and flow alarms. The signals shall be available for hard wired connection to the facility’s direct digital control (DDC) system, or through an integrated control unit that interfaces directly into the facility’s DDC system.
F. Refer to the DDC Control specification for the required input/output summary for the necessary points to be monitored and or controlled.

G. The LCU shall be equipped with a dynamic auto-zero module to automatically recalibrate the flow sensors every 24 hours without reducing flow through the boxes.

H. Each laboratory shall have a dedicated 120 Vac line connection to power the laboratory's airflow control system power supply.

2.04 INTERFACE TO BUILDING AUTOMATION SYSTEM

A. The laboratory airflow control system shall fully interface with the project Building Automation System (BAS). The LCS system shall include all necessary devices and software to monitor and control all items indicated in on the Contract Documents. All points shall be able to be monitored and adjusted thru the BAS

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Building Automation System (BAS) contractor shall install sensors, interface boxes, presence and motion sensors, and fume hood monitor on the fume hood. Sash interface boxes with interface cards shall be mounted in an accessible location.

B. The BAS contractor shall install the laboratory control unit (if panel-mounted) and wall-mounted power supply (as required) in an accessible location in the designated laboratory room.

C. The BAS contractor shall terminate and connect devices as required. In addition, integrated laboratory control unit connectors shall be furnished by the BAS.

D. The laboratory control unit or power supply shall be from a dedicated, single phase 120 vac power circuit.

PART 4 - SYSTEM START-UP AND TRAINING

A. System start-up shall be provided by a factory authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination flow sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust, or return).
B. The balancing contractor shall be responsible for final verification and reporting of all airflows. All balancing shall be coordinated with the commissioning efforts of the BAS system.

C. The BAS contractor shall furnish a minimum of eight hours of owner training, by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures.

D. Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided.
Design Standard

Medium Voltage Power Systems

Detailed specifications follow.

PART 1 MEDIUM-VOLTAGE CABLE

1.1 Shielded MV105 Cable

A. Provide medium-voltage shielded power cables that are NTRL-listed as Type MV105 for use in raceways, trays, underground ductbanks, manholes, vaults, and within switchgear and equipment of sufficient interior dimensions to allow for the proper bending & and termination of shielded cables.

B. Comply with the NEC®, IEEE C2™, ICEA S-93-639 / NEMA WC-74, and UL 1072.

C. Select voltage ratings for power cables and terminations based on the operating voltage of the medium-voltage distribution system as follows:

<table>
<thead>
<tr>
<th>Distribution System Operating Voltage</th>
<th>Power Cable Nominal Voltage Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,160 volts</td>
<td>5kV</td>
</tr>
<tr>
<td>5,000 volts to 15,000 volts</td>
<td>15kV</td>
</tr>
<tr>
<td>25,000 volts</td>
<td>25kV</td>
</tr>
<tr>
<td>35,000 volts</td>
<td>35kV</td>
</tr>
</tbody>
</table>

D. Specification

1. Conductor: Single uncoated annealed copper conductor with Class B stranding
2. Strand Screen: Extruded semi-conducting ethylene-propylene rubber (EPR).
3. Insulation: 133% EPR 140 mils thick for 5kV & 220 mils for 15kV.
4. Insulation Screen: Extruded semi-conducting EPR.
5. Shielding: Copper tape 5 mils thick helically applied with a minimum of 12.5% overlap.
6. Jacket: Chlorosulfonated polyethylene (Hypalon), 80 mils thick.
7. Continuous Operating Temperature: 90°C

**Note:** Operating temperature is limited to 90°C because PVC power ducts are listed for 90°C conductors.

8. Emergency Temperature Rating: 105°C
9. Short-Circuit Rating: 250°C
10. Conductor Sizes (for 15kV only): AWG Nos. 1, 1/0, 4/0, & 500kcmil.
1.2 Non-shielded MV105 Power Cable

A. Use non-shielded medium-voltage power cables only for short jumpers within switchgear or transformer enclosures where it is not feasible to install shielded cables due to inadequate space for bending or terminating shielded cables.

B. Use non-shielded medium-voltage transformer cable with 133% EPR / 140 mils thick for 5kV and 133% EPR / 220 mils thick for 15kV insulation, chlorosulfonated polyethylene (Hypalon) jacket.

C. Conductor AWG Sizes (for 15kV only): 1, 1/0, 4/0, & 500kcmil.

D. Obtain approval from the Owner for each installation of non-shielded medium-voltage cable

E. Acceptable Manufacturers:
   1. General Cable Prysm
   2. Okonite
   3. Southwire

1.3 Medium-Voltage Cable Terminations

A. Terminating materials must be compatible with the cable supplied.

B. Submit proof of the acceptability by the cable manufacturer of any splicing or terminating materials.

C. Separable Insulated Connectors: Specify pre-molded EPDM-type, submersible, fully shielded, separable insulated connectors for use with MV105 power cable as specified above. Connector system components shall comply with IEEE Std 386™, Separable Insulated Connector Systems for Power Distribution Systems Above 600V

D. Match voltage-class ratings of cable at 5kV, 15kV, or 25kV voltage-class. Provide 200A-rated load break elbow connectors for outdoor terminations at medium-voltage transformers and switchgear with switch-ways rated at 200A continuous, and 600A-rated dead break elbow connectors for terminations at medium-voltage switchgear with switch-ways rated at 600A continuous.

E. Indoor Terminators: Silicone rubber, cold shrink, tubular or skirted.

F. Outdoor Terminator: Silicone rubber, cold shrink, skirted.

G. Acceptable Manufacturers:
   1. Elastimold
   2. RTE
   3. 3M
1.4 Medium-Voltage Cable Testing

A. Upon completion of the installation, the Owner shall secure and pay for the services of a qualified, independent testing firm to conduct a test of all medium-voltage cable, including terminations, as part of the electrical acceptance test project phase.

B. The testing firm shall perform a high-potential proof test using a non-destructible DC testing device such as a “Kenotron” Westinghouse “High-Pot Tester”, or approved equal, capable of generating approximately 100,000 VDC under normal leakage conditions of acceptable cable.

C. All cables shall be tested in place with all splices and pothead terminations made up but not connected to switchgear or any other equipment, load device, or dead-end seal. Cables with dead-end seals shall be temporarily opened and then re-sealed.

D. In case of failure during the test, the Contractor shall locate the faulty splice, termination, or cable section and notify the Owner before making any repairs.

E. The testing firm shall submit to the Project A/E five copies of all test reports for review by the Engineer-of-Record. Should the test reports indicate, in the opinion of the Owner, that the condition of the new cable is unsatisfactory, the Contractor shall make all repairs and/or replacements to the satisfaction of and no additional cost to the Owner.

F. Additional tests using the same testing firm shall also be made at the Contractor's expense on all repaired sections.

G. The Owner will not accept any cable installations until satisfactory certified proof test reports are obtained.

PART 2 RACEWAY SYSTEMS FOR MEDIUM-VOLTAGE CABLES

2.1 Design Guidance

A. Perform calculations to determine pulling tensions and sidewall pressures for all duct or conduit runs of medium-voltage power cable.

B. Design raceway systems so that the calculated pulling tensions and sidewall pressures will not exceed the cable manufacturer’s recommendations

C. Lacking manufacturer’s recommendations use the following maximum values:

1. Cable tension:
   a. 0.008 lb./cmil for up to 3 conductors, not to exceed 10,000 pounds.
   b. 0.0064 lb./cmil for more than 3 conductors, not to exceed 10,000 pounds.
   c. 1000 lbs. per basket grip

2. Sidewall pressure: 500 lbs./ft
D. The maximum length of raceways between cable pulling points shall be the lesser of 400 feet or a maximum of 90° in total horizontal bends between cable pulling points.

2.2 Above ground Installations

A. Within the perimeter of buildings, install aboveground medium-voltage cables in rigid metal conduit.

B. In areas protected with fire sprinklers, terminate conduits entering equipment enclosures from above with water sealing fittings.

C. Install voltage markers on all conduits containing medium-voltage cables.

PART 3 INDOOR MEDIUM-VOLTAGE SWITCHGEAR

3.1 Design Criteria

A. For facility-level medium-voltage switchgear lineups and unit substation switchgear, provide metal-enclosed interrupter switchgear conforming to IEEE C37.20.3, Standard for Metal-Enclosed Switchgear, with current-limiting E-rated power fuses conforming to IEEE C37.46, Standard Specifications for Power Fuses and Fuse Disconnecting Switches.

B. For facility-level medium-voltage switchgear applications that either exceed the current capacity of fused equipment or require complex or high-speed switching operations, use metal-clad switchgear with vacuum circuit breakers conforming to:
   1. IEEE C37.20.2, Standard for Metal-Clad and Station-Type Cubicle Switchgear
   2. IEEE C37.04, Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
   3. ANSI C37.06, Standard for Switchgear – AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities
   4. IEEE C37.09, Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

C. Provide 5kV medium-voltage switchgear having the following minimum ratings:
   1. 60Hz one-minute withstand voltage at mean sea level: 22kV; this rating may be obtained through insulation coordination with surge arresters.
   2. BIL at mean sea level: 75kV; this rating may be obtained through insulation coordination with surge arresters.
D. Provide 15kV-class medium-voltage switchgear with the following minimum ratings:

1. 60Hz one-minute withstand voltage: 42kV at mean sea level; this rating may be obtained through insulation coordination with surge arresters.
2. BIL at mean sea level: 95kV; this rating may be obtained through insulation coordination with surge arresters.
3. Short-circuit rating: Provide equipment with a short-circuit rating greater than the available short-circuit current and not less than 25kA RMS symmetrical.


PART 4 OUTDOOR MEDIUM-VOLTAGE SWITCHGEAR

4.1 Pad Mount Switches

A. Description

1. For purposes of this Section, “padmount switches” are understood to consist of a single self-supporting enclosure containing interrupter switches.

2. Padmount switches are restricted to outdoor use. A padmount switch may include power fuses and accessory compartments.

3. Padmount switches shall be manufactured in accordance with IEEE C37.74.

B. Application

1. Padmount switches are typically used for sectionalizing applications in the medium-voltage distribution system.

   **Note:** Within the limitations of their current-carrying capability, interrupting duty and available configurations, padmount switches typically offer the lowest-cost switching solution.

2. Because of the relatively limited short-circuit capacity of padmount switchgear, available fault current at the proposed switch location must be carefully considered.
C. Installation

1. Install padmount switches atop or immediately adjacent to manholes.
2. Route cables to padmount switches through manholes.
3. Design a foundation for a padmount switch.

D. Clearances

1. Design installations of padmount switches to permit maintenance access. Design the installation of padmount switches to ensure 10 feet of clear working space in front of the switch enclosure doors for the full width of the enclosure.

   **Note:** In areas where vehicle parking may be possible, bollards, curbs or other structures should be installed to keep vehicles out of the working space. The sides of switches without doors or auxiliary compartments containing electrical control or instrumentation devices do not need working space greater than 30 inches for personnel access. For switches with side-mounted accessories such as fuse storage compartments or crank-type switch operators, this access space is to be measured from the outer face of the accessory or the end of the crank handle.

2. Auxiliary compartments with electrical control or instrumentation devices must be provided with working space in conformance with NESC Rule 125

**PART 5  METAL-ENCLOSED INTERRUPTER SWITCHGEAR**

**5.1 Description**

A. For purposes of this Section, “metal-enclosed interrupter switchgear” is understood to be equipment consisting of interrupter switches housed in individual steel compartments. Switching devices are fixed (not draw out). Busbars are typically exposed when the compartment door is open. The switchgear may include fuses, sensing and metering devices and control equipment, but not power circuit breakers.

B. Metal-enclosed interrupter switchgear is available with enclosures suitable for indoor or outdoor installation.

C. Metal-enclosed interrupter switchgear shall be manufactured in accordance with IEEE C37.20.3.

**5.2 Application**

A. Metal-enclosed interrupter switchgear differs from padmount switches in its higher continuous current and interrupting rating, and wider availability of custom features. Metal-enclosed interrupter switchgear is commonly used as the primary disconnecting means for unit substations.
B. For application of metal-enclosed interrupter switchgear, consultation with the equipment vendors is recommended.

C. Manufacturers’ ratings do not take into consideration the effect of solar radiation on metal-enclosed interrupter switchgear installed outdoors. Use IEEE Standard C37.24 to calculate the derating of the continuous current rating of switchgear exposed to the sun.

PART 6 METAL-CLAD SWITCHGEAR

6.1 Description

A. For purposes of this Section, “metal-clad switchgear” is understood to be equipment consisting of individual steel compartments with draw-out switching devices. Switching devices may be load-break interrupter switches or power circuit breakers. The switchgear may include fuses, sensing and metering devices and control equipment.

B. Metal-clad switchgear is available with enclosures suitable for indoor or outdoor installation.

C. Metal-clad switchgear shall be manufactured in accordance with IEEE C37.20.2.

6.2 Equipment

A. Specify Powell Power/Vac vacuum metal-clad circuit breaker elements for use on 15kV-class systems.

B. Note that the requirement for GE Power/VAC equipment is not intended to unreasonably limit the market for the supply of switchgear equipment. The limitation extends only to the interrupter devices (the vacuum bottles) and the removable circuit breaker mechanism (the breaker” truck”). The switchgear control systems, buswork, and enclosures may be assembled by a qualified fabricator other than General Electric.

6.3 Application

A. Metal-clad offers the most flexible means of control and protection for power systems. Sophisticated protective relay schemes are readily applied to metal-clad switchgear. Of the three available types of switchgear, metal-clad is the most expensive.

B. For application of metal-enclosed interrupter switchgear, consultation with the equipment vendors is recommended.

C. Specify outdoor installations of metal-clad switchgear with walk-in aisle-type enclosures.

D. Provide ventilation (and air conditioning if required) as necessary to ensure that interior temperatures do not exceed 95°F.
E. Manufacturers’ continuous current ratings do not take into consideration the effect of solar radiation on metal-clad switchgear installed outdoors. Use IEEE Standard C37.24 to calculate the derating of the continuous current rating of switchgear exposed to the sun.

PART 7 MEDIUM-VOLTAGE TRANSFORMERS

7.1 Specify dry-type units for locations inside the building and mineral oil-filled pad mounted-type units for locations outdoors.

7.2 Indoor Dry-Type Medium-Voltage Transformers

A. Use dry-type transformers conforming to IEEE Std C57.12.01, *Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings*, where liquid containment is not practical. Use dry-type transformers having an 80°C winding temperature rise over a 30°C average, 40°C maximum ambient. Use cast epoxy resin transformers to serve critical loads or where the transformer is in a dirty environment. Use vacuum pressure impregnated or cast epoxy resin transformers to serve non-critical loads and where the transformer is in a clean environment. Specify copper windings only.

B. Install medium-voltage dry-type transformers indoors only.

C. Install indoor transformers in vaults or rooms with a fire-resistance rating of not less than 1 hour.

D. Doors in transformer vaults or rooms shall be fire-rated and swing outward in the direction of egress.
   1. Equip doors with panic hardware.
   2. Fire rating of doors shall match fire rating of room or vault.
   3. Provide door opening adequate for moving largest equipment in the room or vault.

E. Locate transformers a minimum of 36 inches from building walls.

F. Provide ionization type smoke detectors and automatic sprinkler protection for indoor medium-voltage transformer vaults or rooms. Connect ionization-type smoke detectors to the building fire alarm system.

G. Provide automatic sprinkler protection system with a discharge density of not less than 0.20 gpm/sq. ft. over floor area of the transformer vaults, rooms, or spaces.

H. Provide mechanical cooling or ventilation powered from a reliable source to maintain transformer vaults or rooms within temperature limits appropriate for transformer operation.

I. Provide power ventilation system from an emergency or standby power source if available.
J. Specify primary overcurrent protection devices to provide through-fault protection of transformer in accordance with IEEE Std 242™.

K. Select distribution-class, gapless-type metal-oxide surge arresters for connection to the primary side of the transformer to provide additional protection against abnormally high voltage transients. Specify the maximum continuous operating voltage (MCOV) of the arrester according to its voltage-class rating. Apply arresters in accordance with IEEE Std C62.22, IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems or as recommended by the arrester manufacturer.

7.3 Outdoor Oil-Filled Pad Mounted Medium-Voltage Transformers

A. Install oil-filled medium-voltage transformers outdoors only.

B. Provide outdoor, pad-mounted, mineral oil-insulated, self-cooled medium-voltage transformers with integral dead-front loop-feed primary and live-front radial secondary cable terminating compartments. Windings shall be copper; aluminum windings are not acceptable.

C. Transformers shall be designed, constructed, and tested in conformance with IEEE C57.12.22™, Requirements for Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (High Voltage, 16340 Volts and Below; 2500 KVA and Smaller).

D. Transformers shall be designed to operate at a 65 ºC average winding temperature rise over a 30 ºC average, 40 ºC maximum ambient temperature.

E. Furnish each transformer with the following accessories:
   1. Oil-immersed, load-break, bayonet fuse-holders with expulsion style fuses.
   2. Oil-submersible protector with current-limiting fuses rated for 50kAIC. Current-limiting fuses shall be placed in series with expulsion style fuses.
   3. Distribution-class, metal-oxide varistor elbow (MOVE) type surge arresters
   4. Two 2-1/2% above and two 2-1/2% below rated-voltage, full-current-rated for changing under no load. Include externally-mounted handle for tap-changer.

F. Acceptable Manufacturers
   1. ABB
   2. Cooper
   3. Square D
   4. GE
G. Installation

1. Design a concrete foundation for the transformer. If required, provide an oil-containment system integral to the foundation in accordance with EPA regulations.

2. Install in accordance with the NEC® and the Factory Mutual Insurance Company Loss Prevention Data Sheet 5-412.

H. Transformer Capacity

1. Base transformer capacity on load calculations per the requirements in NEC® and this Chapter and loading guidance in the following IEEE standards as applicable:
   d. IEEE C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.

   **Note:** The IEEE C57-91-1995 Guide combines the data previously issued in the IEEE Guides C57.91-1981, C57.92-1981, and C57.115-1991 (redesignated as Std. 756). It also updates the data and presents equations that approximate the empirical data previously presented in tabular form. The designer may apply either method.

I. Determining Transformer Capacity

1. Use the following loading factors to determine transformer capacity:
   a. Average 24-hour ambient temperature
      1) Use the highest historical average (mean) daily temperature recorded at the University campus or at a location nearest the campus for which accurate data are available, such as the nearest airport or city. This data may be obtained from the National Weather Service at [http://www.nws.noaa.gov](http://www.nws.noaa.gov) or other source with similar reliable and/or official data. Refer to the appropriate sections in the ANSI/IEEE standards referenced above for further guidance concerning the determination of ambient temperature for use in the selection of the “Peak Load Per Unit” or peak load factor presented in the series of tables in both publications.
2) According to Weather.com, the highest 24-hour average temperature for College Station, TX (zip code 77843) is 30°C and occurred on August 4 and 5.


d. Transformers serving facilities having a significant daily load cycle may be operated with the peak load above the transformer nameplate rating as long as normal transformer life expectancy is maintained; refer to the IEEE transformer-loading guides listed above.

2. For single-ended services, the calculated load using the NEC® plus future load growth shall not exceed the calculated transformer self-cooled peak loading capability.

3. Example 1 – For building or facility located on a campus in College Station with a significant daily load cycle: 685kVA calculated load per the NEC® plus 137kVA future load growth of 20% = 822kVA. Select a pad-mounted transformer with a standard base rating equal to or greater than 822kVA / 1.68* = 489kVA, or 500kVA, and a 2-hour peak loading capability of approximately 500kVA X 1.68* = 840kVA based on Table 6 in IEEE C57.91-1981

   a. *The peak load factor (per unit) assuming an ambient temperature of 30°C.
   b. Base the secondary service conductors on the 822kVA calculated load.

4. For double-ended services, the calculated closed-tie load using the NEC® plus future load growth shall not exceed the calculated forced-air cooled peak loading capability of either transformer.

PART 8 ADDITIONAL REQUIREMENTS

8.1 All underground distribution medium voltage electrical switchgear shall be manufactured by Trayer Engineering Corporation. Typically, a new construction project will require a 4 or 5-way 15kV Vacuum Load Interrupter or Vacuum Fault Interrupters with visible disconnects.
8.2 Only the use of new copper wound, loop fed transformers are permitted for use in the 12.5kV TAMU electrical distribution (aluminum wound transformers are not acceptable for use).

8.3 Only use drain wire type cable with the following specifications:
   A. Description conductor: annealed bare copper
   B. Compact class b extruded strand shield
   C. Extruded black conducting stress control layer over conductor
   D. Insulation ethylene propylene rubber (epr) insulation colored to composite with black conducting shield layers.
   E. Composite insulation shield and jacket six corrugated copper drain wires embedded in an extruded black conducting black chlorinated polyethylene (cpe-130) composite insulation shield and jacket trade name: unishield 15kv 133% .220mil mv105.

8.4 Above ground, medium voltage electrical switches used in conjunction with the underground distribution and manhole system, shall be S&C. Switches supplied in switchgear linups shall be supplied by the switchgear manufacturer.

8.5 Medium-Voltage Relays: Manufactured by Schweitzer

8.6 System Configuration: Campus express feeders may not be tapped for distribution to campus buildings.
Design Standard

Storm Drainage Utilities

All new construction should be modeled to demonstrate the impact to the existing storm water flows. The project must be designed in a way that does not create an increase to the storm water run off from the campus.

Detailed specifications follow.

PART 1 GENERAL

1.1 The storm-water management system shall use grading and drainage sufficient to route predicted rain-water for the 100-yr, 24-hr rainfall event. The system should primarily rely on grading to direct water away from the building, with limited reliance on stormwater drainage systems directly adjacent to building openings or outside equipment.

1.2 Building designs with below-grade spaces such as basements, service tunnels, etc. are discouraged in areas subject to flooding. Should below-grade service areas or basements be required, they should not have openings located below the 500yr+2ft in areas subject to flooding, or below grade of the surrounding terrain in areas not subject to flooding.

1.3 Storm sewer shall be RCP Class III (ASTM C76) for 12” and above, SDR 26 PVC (ASTM D3034) or heavier for less than 12”, or Corrugated HDPE (ASTM 2306). RCP joints shall meet ASTM C443. PVC pipe shall have water tight push-on joints meeting the requirements of ASTM F477. Corrugated HDPE fitting shall meet ASTM F2648.

1.4 Storm roof drains shall be run separately from all other storm water sources to the outside of the building. Both sanitary and storm sewers sizes shall be determined by a Texas Professional Engineer (PE) and should be based on existing/future sewer capacities and a drainage study for storm sewers. If the existing infrastructure cannot accommodate the increased loads, then an estimate shall be presented to the Owner to determine if additional funds need to be appropriated for any up-sizing.

1.5 Manholes and/or junction boxes with access openings shall be installed on the storm sewer system at all piping intersections, changes in slope and angle points with the exception of small drain leads which may use appropriate wye fittings. Manholes shall be either pre-cast (ASTM C 478) or cast-in-place with a reinforced concrete foundation. Junction boxes shall be of reinforced pre-cast or cast-in-place construction. Minimum 28 day concrete strength shall be 3,000 psi. Foundation for manholes and/or junction boxes shall be on 1-1/2 sack cement stabilized sand.

1.6 Provide 30 inch diameter minimum size access openings for all manholes. Iron castings for manhole rings shall conform to ASTM A 48, Class 30 and be traffic rated. Area inlets for the storm sewer system shall be either pre-cast or cast-in-place reinforced concrete.
with frame and grate iron castings conforming to ASTM A48 Class 30 and shall be traffic rated. Curb inlets shall also be either pre-cast or cast-in-place with a manhole frame and cover installed in the top to allow access. In high visibility areas near buildings or at pedestrian drop off points, inlet tops shall be cast-in-place. Minimum concrete 28 day compressive strength for inlets shall be 3,000 psi. Typically storm sewer discharge points shall be stabilized with either a pre-cast or cast-in-place headwall structure with adequate surrounding rip-rap to control erosion. Minimum concrete 28 day compressive strength for headwalls shall be 3,000 psi. Manhole covers shall be the university standard of McGard fibershield lockable covers.
Design Standard

Thermal Systems (Chilled Water and Hot Water Systems)

Detailed specifications follow.

PART 1 CHW AND HHW SUPPLY TEMPERATURE RESET

1.1 The Utilities & Energy Services Department (UES) at Texas A&M University is actively identifying and implementing strategies to reduce the energy consumption and cost associated with campus heating and cooling requirements while ensuring customer needs are consistently met. Chilled water (CHW) and heating hot water (HHW) supply temperature reset schedules have been in effect on the campus for many years, with supply temperature adjusted based on outside air temperature. The supply temperature for chilled water ranges from 42 to 46 Degrees F and the supply temperature for heating hot water ranges from 180 to 130 Degrees F. The supply temperature reset schedule charts for both CHW and HHW are attached as Appendix A.

PART 2 HVAC COIL DESIGN DELTA T

2.1 All CHW cooling coils in facility air handling units (AHUs) and fan coil units (FCUs) shall have a minimum of 14 Degrees F design delta T based on a CHW supply temperature of 42 Degrees F, during peak cooling periods, except for spaces with high internal heat loads, such as server rooms. In spaces with high internal heat load, the system should be designed to meet maximum cooling requirements with a CHW supply temperature of 46 Degrees F.

2.2 For HHW, the minimum AHU and FCU design delta T shall be 30 Degrees F based on a design HHW Supply Temperature, during peak heating periods, of 170 Degrees F. The minimum coil design delta T’s specified above are contingent upon maintaining proper coil flow tolerance per 2008 ASHRAE Handbook, pg 12.18, Fig. 34. Coil design delta T (for both CHW and HHW) can be higher than indicated above, but this design requirement must be achieved, unless a modification to this design guideline is approved in advance as indicated at the end of this guideline. Coils shall be designed in accordance with the latest version of ARI Standard 410.

2.3 AHUs having greater than 50 percent outside air supply shall have an energy recovery system incorporated into the design, unless it is proven to not be justifiable based on a life cycle cost analysis. Energy recovery systems shall be designed to operate at a minimum of 70% efficiency and be connected to the Siemens BAS to allow for effective monitoring of the system operation. Pre-filters shall be provided on all energy recovery systems to prevent fouling of the heat transfer element.

2.4 A requirement for testing, balancing and commissioning of both water and air flow shall be included in the specifications for all HVAC systems installed in new buildings and with any significant HVAC system replacement or retrofit.
PART 3  CHW AND HHW DISTRIBUTION SYSTEMS

3.1 CHW and HHW distribution pumps in the buildings shall be equipped with variable speed drives, with pump speed modulated to maintain sufficient differential pressure at desired flow through all HVAC coils in the building. Variable speed drives shall be connected to the Siemens BAS for effective monitoring and control under all flow conditions. The Siemens BAS shall also monitor the status of CHW and HHW control valves and any valve which hasn't opened a minimum of 20% at least once during any 168 hour (one week) period shall be programmed by the BAS to automatically open fully (during unoccupied periods) for a period of 15 minutes, in order to flush the thermal piping and minimize the potential for microbial growth.

3.2 All AHU and FCU fan motors and CHW and HHW pump motors installed in new buildings and with major system replacement or retrofit shall be specified to meet minimum efficiency requirements of National Electrical Manufacturers Association (NEMA) Standards Publication MG1-2006 (or any later edition) Premium Energy Efficiency Motor Standard, if a Premium Energy Efficiency Motor is available in the required size and rating. All new motors shall be sized to operate with a load factor of between 65 and 100 percent.

3.3 Three-way bypass control valves shall not be installed in any new CHW or HHW system. When HVAC systems in existing buildings are upgraded to include direct digital control (DDC), all existing three-way bypass control valves shall be removed and the DDC control system shall be programmed to provide flushing as previously described. Two-way characterized ball-style control valves shall be used for CHW and HHW flow control, rated to handle pressure drop that exceeds the highest differential pressure that the distribution pump(s) can generate, in order to avoid valve seat deterioration and leak-by. Control valve actuators shall have shut-off ratings that exceed the highest potential branch circuit differential pressure to ensure positive valve closure. Electric valve and damper actuators shall be specified for all HVAC systems that have DDC capability.

Notes:

1. See the UES Design Standard titled “Building Automation Systems” for additional requirements.

2. Any deviation from this design standard needs to be reviewed and approved by Utilities & Energy Services (UES).
APPENDIX A
CHW & HHW SUPPLY TEMPERATURE RESET SCHEDULES
Chilled Water Supply Reset Schedule

Note: CHW supply temperature range is 43 to 46°F with reset based on outside air temperature. Actual loop temperature may vary +/- 1°F from target.
Heating Hot Water Supply Temperature Reset Schedule

Note: HHW supply temperature range is 130 to 180°F with reset based on outside air temperature. Actual loop temperature may vary +/- 5°F from target.
Design Standard

Underground Piping Systems

Uninsulated underground thermal piping systems experience significant energy losses to the soil over the course of their operating life. To minimize the heat gain/loss of these piping systems, Texas A&M University has chosen a mineral powder insulation system, similar to Gilsulate 500, as the Campus standard for insulating underground thermal lines. In addition to its insulating properties, this type of insulation system: 1) Is hydrophobic, 2) Has a high electrical resistivity preventing galvanic action between metal pipe and the soil, 3) Has good load bearing properties and 4) Is “green” since it’s made from minerals. All HHW thermal lines and CHW lines **12 inch and below** are required to be insulated.

Work Includes:

An underground piping insulation system must be provided to enclose and provide thermal and waterproofing protection for piping specified and shown on Plans, including but not limited to the following:

- Piping insulation including expansion units.
- Miscellaneous materials incidental to complete installation of insulated underground sections.
- Supervision of installation as specified.

Detailed specifications follow.

**PART 1  GENERAL**

1.1 Insulating material which adheres to or becomes joined in any manner to piping during cycle of operation shall not be used.

1.2 Contractors are solely responsible to complete work for entire run of piping between points specified and shown on plans.

1.3 Adequate space and clearance with insulated underground piping system shall be provided to allow free movement of piping and avoid stress or abrasions to piping. No wood, masonry, metal, or any other abrasive pipe supports or guides, shall be left in contact with piping.

1.4 Provide fittings and accessories necessary and incidental to type of system selected.

1.5 Store materials and equipment on work site on wood platforms or members; stack and pile in substantial and safe manner so products will not easily dislodge while in storage.
1.6 Replace or repair wet or damaged insulation as directed by Engineer or product installation requirements.

1.7 Complete hydrostatic tests for all new lines. Perform hydrostatic leak test at 1.5 times maximum operating pressure to ensure piping system is free from leaks before application of field applied insulation and closures. UEM technical staff must be notified in advance of planned hydrostatic test and be present to witness the test. See pipe manufacturer's recommendations for testing procedures.

1.8 All parts of system to be intact, undamaged, and free from leaks before backfilling with insulation material. Upon completion of backfilling of insulation material, work must be approved by construction inspector and UEM representative before final backfilling is performed. Piping or insulation installation that is deemed to be inadequate or incorrect by Engineer, construction inspector, or UEM representative must be corrected to meet specifications prior to backfilling.

PART 2 EXCAVATION, FILLING & BACKFILLING

2.1 Final grading for setting pipe units to be performed immediately prior to setting units or concrete supporting pad in trenches; backfilling around completed insulated system to be under direction of supervisor for installation of insulated underground system.

2.2 Restore all finished grades and improvements as detailed.

PART 3 TYPE OF CONSTRUCTION

3.1 The system for insulating pipes shall keep water and moisture from pipes.

3.2 Type of material and construction: The insulation shall be a dry, free flowing granular product formulated from selected inert, inorganic materials. It shall be non-toxic, non-flammable, and completely free of asbestos. It shall require no mixing prior to installation, and no curing. It shall be completely compatible with all materials typically used for piping in the service temperature range of +35°F to +230°F. It shall be of sufficient density so any stones or rocks inadvertently falling on insulation will not penetrate or migrate into or through insulation during placement and back-filling operations.

3.3 The insulation shall be composed of granular particles that cohesively bond with each other to form a closed cell compacted mass that effectively isolates pipe surfaces from air, water, moisture and chemicals. The granules shall be surface treated to render it hydrophobic. The compacted insulation shall be capable of withstanding up to 12,000 psf (58,000 kg/M²) at the manufacturer's recommended density.

3.4 The insulation shall have a thermal coefficient of heat conductivity (K factor) of no more than 0.60 BTU/hr. /ft²/oF/in. at manufacturer’s recommended use density and a mean temperature of 175°F and 0.65 at a mean temperature of 300°F by the guarded hot plate method of ASTM C-277. If an insulation with higher thermal conductivity is proposed, bidding shall be based on the equivalent amount of insulation required to minimize heat loss/gain to that which would result with the thermal conductivities
specified in the proceeding sentence. See Figure No. 1 for required insulation envelope dimensions.

3.5 Electrical resistivity of the insulation shall be greater than $10^{12}$ Ohm-cm.

3.6 The insulation shall be mineral powder with characteristics as described above similar to GILSULATE 500 as manufactured by American Thermal Products Inc.

3.7 The system shall be installed according to the published recommendations of the insulation manufacturer. The installer shall consult with and arrange for field assistance from the manufacturer’s representative prior to placement of the insulation system. Pipes, anchors-guides and expansion shall be in compliance with the recommendations of the insulation manufacturer or as shown on plans and specifications. Backfilling operations shall be performed according to Section, EXCAVATION, FILLING, AND BACKFILLING.

PART 4 PLACING MATERIALS

4.1 Insulation materials used must be capable of being placed and consolidated to prescribed density prior to any backfilling operation. Use of backfill to provide compaction of the material is not acceptable.

4.2 Installation Sequence: (Refer to Insulation Manufacturer’s Installation Sequence and notes.)

4.3 Excavate trench as near as possible to the required width of piping and insulation and pile backfill all on one side. Install pipes with required guides, supports, and anchors as shown on drawings and specifications. Perform pressure testing.

4.4 Grade and compact trench under pipes leaving required space for specified thickness of insulation. Clean any dirt or debris off pipes.

4.5 Precut gypsum board with attached spacers on the exterior may be driven into place. Horizontal spacers are used to determine envelope width. Leave forming in place. Forms are held away from pipes by temporary spacers which must be removed as insulation is installed and consolidated. Side forms must not extend above the finished consolidated insulation level of the envelope.

4.6 Provide compact sand or clean backfill behind the forms to pipe height.

4.7 All standing water shall be removed prior to placing insulation.

4.8 To minimize dust, empty the bags near pipes with as little “free fall” as possible. Fill trench to mid pipe height and consolidate. Remove spacers and temporary supports as work progresses.

4.9 Add additional layers of insulation and consolidate to specified thickness and density. A rod type concrete vibrator with a 1½ - 2" diameter head is the best and quickest means of consolidating insulation. Insert the head of the vibrator and pull along slowly.
4.10 Walk on the consolidated insulation envelope to insure use density, footprints of approximately 1” deep or less are expected. Insulation coverage shall be according to insulation manufacturer recommendations or as shown on Plans.

4.11 Additional 2” of insulation is required over pipes in areas passing under streets or parking.

4.12 Complete compaction of sand backfill behind forms. Place a layer of flattened empty bags on top of the insulation envelope. Walk on top of the bags and hand place 6” clean backfill on top of empty bags to protect against damage in case of storms. Complete backfilling to grade level as specified under Section, EXCAVATION, FILLING, & BACKFILLING as soon as possible. Provide a minimum of 12” earth backfill.

PART 5 GUARANTEE

5.1 Contractor shall guarantee installation of insulating system for a period of one (1) year from date of acceptance by Owner against deterioration of insulating value, compaction or water leakage under normal operation conditions. Contractor, however, shall not be responsible for damage or failure of system due to damage caused by other parties.
## Insulation Thickness Table

### Design of the Insulation Envelope

**Pipe Coverage Selection**

**Figure No. 1**

**TABLE 1**

<table>
<thead>
<tr>
<th>Norm. Pipe Size</th>
<th>Outside Dis.</th>
<th>Pipe Area Sq. In.</th>
<th>Chilled Water</th>
<th>Domestic &amp; Heating Hot Water</th>
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</table>

Based on thermal conductivities (K factors) of Gilsulate 500x insulation. If a product with higher K factors is proposed, insulation thicknesses shall be increased to provide a resistance to heat flow equivalent to the Gilsulate insulation shown in Figure 1.

Add 2 inches to C Dimension under streets. Parking lots and railroads tracks.
Design Standard

Utility Manhole Covers

Texas A&M University in College Station has standardized utility manhole covers to be used for all underground utility access on campus. All new utility manhole cover installations must use a fiber reinforced polymer cover manufactured by McGard Special Products (see attached specification sheet).

Detailed specifications follow.

Reinforced Polymer Manhole Covers

Part 1  General

1.1  Reinforced polymer manhole covers can be ordered in a variety of sizes, will all have built-in locking devices with an internal release and have a number of other benefits over conventional cast iron or steel covers:

A. Polymer covers are approximately ¼ the weight of an equivalent size cast cover
B. Standard thickness is used for pedestrian and non-vehicular application
C. Available in DOT-rated thickness to be used for vehicular traffic on roadways and drives
D. Top surface is slip resistant
E. Does not retain heat as readily as conventional cast covers
F. Available with venting if needed for specific application
G. Locking device will be used with a unique key for Texas A&M University in College Station
H. Locking device must be ordered with internal release mechanism to allow for personnel egress
I. Available in standard sizes and also in a variety of round, square, and rectangular sizes
J. Custom sizes with custom locking mechanism available depending upon specific requirement
K. “UTILITIES” to be cast into center of all manholes together with utility commodity name (ELECTRICAL, THERMALS, SANITARY, STORM) where applicable – see attached drawing
L. No commodity name to be shown on access covers for utility tunnels
M. All covers to be ordered with locking device and internal release

N. Use McGard Registration Code No. 9500540 to order cover locking device unique to TAMU

O. TAMU Utilities & Energy Services will maintain and control inventory of unique cover keys

**FiberShield Manhole and Lock Specification**

**PART 1 GENERAL**

1.1 The FiberShield is a lightweight manhole cover with H-20 & AASHTO HS-25 load rating. The FiberShield weighs approximately ¼ of an equivalent size cast iron cover. A special operating key is required to unlock/remove the FiberShield from the frame.

1.2 The FiberShield is designed as a direct replacement for existing cast iron covers. The cover is rated to handle arterial traffic flow. The cover has a self-contained locking system. The locking system provides cover to frame retention and security from unauthorized entry.

**PART 2 DESIGN CRITERIA**

1.1 Base Cover

A. The FiberShield Manhole cover is manufactured from Fiber Reinforced Polymer.

B. The FiberShield is available in multiple colors and custom logos.

C. The FiberShield is manufactured with an “anti-slip” top surface.

D. The FiberShield utilizes an optional rubber gasket around the perimeter to provide dampening and reduce wear.

E. The FiberShield is available in two load ratings – 80,000 lb & 50,000 lb.

F. The FiberShield has maximum deflection of 0.75 inches @AASHTO H-20 wheel loading of 16,000 lb.

G. The FiberShield has been successfully subjected to accelerated fatigue testing @ 29,000 lb and 20,000 cycles. Full details available upon request.

H. The FiberShield has been successfully static and dynamic load tested at both 160°F and -60°F.

I. The FiberShield is available in most common sizes from 24” to 32”. Custom sizes available upon request.

J. The FiberShield has a self-contained locking system mounted on the underside. The locking system prevents the FiberShield from lifting out of the frame.
1.2 Locking System

A. The locking system is manufactured from a combination of molded plastic and fabricated stainless steel components.

B. The locking system consists of security drive bolt, two spring loaded pistons, skid runners, latch plate mechanism, piston actuation cable, and two plastic protective caps.

C. The security drive bolt uses a proprietary key drive system.

D. The security drive bolt is protected with a molded nylon protective cap.

E. The security drive bolt is manufactured from heat treated stainless steel to maximize strength, durability, and resist strong arm tools. The drive bolt actuates the latch mechanism.

F. The latch mechanism is manufactured from heat treated stainless steel for maximum strength and durability. The latch mechanism actuates both spring loaded pistons. The master side is connected directly to the latch mechanism. The slave side is driven via a nylon coated stainless steel braided cable.

G. The spring loaded pistons are manufactured from 304 stainless steel tubing. The springs are manufactured from 302 stainless steel.

H. The skid runners are manufactured from PVC tube. The skid runners are attached to the underside of the cover via molded nylon feet.

I. The skid runners allow the FiberShield to be removed from the manhole cover frame and dragged along the pavement without damaging the lock mechanism.

J. The locking system components can be easily replaced with common tools in the event they become damaged or worn.

K. The locking system has drain slots located near the security drive bolt to allow water and debris to pass thru.

1.3 Operating Key

A. The multi-purpose (MP) T-Key is used to unlock and lock the cover.

B. The MP T-Key is manufactured from alloy steel components which are covered with powder coat paint or zinc plating for corrosion protection.

C. The MP T-Key has a screwdriver storage location in the handle. The screwdriver is used for removing the plastic protective cap and cleaning debris from the security bolt counterbore.

D. The MP T-Key has a security key mounted on the lower end of the long shaft. The security key is manufactured from heat treated alloy steel and zinc plated for corrosion protection.
E. The MP T-Key has a swivel joint on the top of the long shaft. The swivel joint has two features – a threaded stud and a straight stud. The threaded stud is used to remove the FiberShield from the frame. The straight stud is used to disengage the latch mechanism (lock the FiberShield).

F. The MP T-Key has an extra key storage post located on the handle. The extra key storage post is used to store an extra key on the handle.

PART 3  FIBERSHEILD OPERATION

The FiberShield is operated with the following sequence of operations (starting with the FiberShield in the frame in the locked position).

3.1 FiberShield Removal

A. Remove the small screwdriver in the T-Key handle to pierce and remove the protective cap from the security drive bolt and cover lift hole.

B. Insert T-Key drive pattern into security drive bolt.

C. ¼ turn CCW until “audible click.” The pistons are retracted and held in the retracted position via a latch mechanism.

D. Flip T-Key over and screw cover removal stud into the FiberShield lift hole (where it mates with a female thread).

E. Lift and remove cover. Drag cover to a safe location.

F. Leave T-Key attached to the cover. The T-Key acts as safety device insuring the pistons aren’t accidently activated.

3.2 FiberShield Replacement

A. Drag FiberShield to the open frame and insert.

B. Unscrew the T-Key from the FiberShield lift hole.

C. Rotate and exchange the cover removal stud for the cover locking stud.

D. Insert the cover locking stud into the FiberShield lift hole.

E. Using your foot push the T-Key handle to disengage the latching mechanism.

F. Replace the plastic protective cap on the security bolt and lift hole.
Utility Manhole Cover Standards Diagram

<table>
<thead>
<tr>
<th>Cover Diameter</th>
<th>Cover Thickness</th>
<th>Average Frame Clear Opening</th>
<th>Fully Retracted Diameter</th>
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<tbody>
<tr>
<td>24&quot;</td>
<td>1 1/6&quot;</td>
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Overall Design Criteria

The FiberShield is designed as a direct replacement for existing cast iron covers. The cover is rated to handle arterial traffic flow. The cover has a self contained locking system. The locking system provides cover to frame retention and security from unauthorized entry.

See Specification Sheet for more details.
Manhole Cover Marking Standards

EXAMPLE TUNNELS

COVER LOGO INFORMATION
CENTER INSERT (18” x 6”)
UPPER INSERT (10” x 2”)

- Sanitary
- Utilities
- Electrical
- Utilities
- THERMALS
- Utilities
- STORM
- Utilities
Design Standard

Utility Metering

This section specifies the requirements for furnishing and installing metering and other infrastructure associated with the measuring and reporting of utilities consumption. This provides metering of utilities with indication and totalization capabilities.

Detailed specifications follow.

PART 1 GENERAL

1.1 Wages – In the event that a building will receive Heating Hot Water (HHW) and Chilled Water (CHW) from the University thermal system, the building shall be required to have a common data collection point. This data collection point shall be the type manufactured by Schneider Electric (Square D) under the product umbrella “WAGES Metering Box for Electrical and Piped Utilities” - Model A8 or A16 Wages. Each WAGES A8 or A16 Box shall contain an Ethernet Gateway connected to the Momentum processor to provide communications with the network. The gateway device shall be installed per manufacture’s specifications.

1.2 Electrical – The meter shall be the type manufactured by Square D under the product umbrella “Power Logic Series PM-8 or ION-8600A with Ethernet Breakout Package”. PM-8 meters require an Ethernet Gateway (PM8ECC or EGX-300) and Display (PM-8 is PM-8 Faceplate + PM-8RDA Adapter kit). All meter installations must have fused voltage references, meter power source, and all CT’s must be connected through Shorting Blocks appropriate to the installations. CT’s shall be of the appropriate size for the service, and rated at XXX:5 amps. Meter must be installed per the manufactures specifications.

1.3 Chilled Water, Heating Hot Water, Domestic Hot Water Supply & Return, and Domestic Cold Water – The meter shall be exactly like the type manufactured by Rosemount under the product umbrella “Rosemount Magnetic Flow Meter” [Model: 8705TSaaaC1W0N0Q4D1 (xxx is flowtube sized in inches)]. All meters should be equipped with a Rosemount Remote Transmitter [Model 8712ESR1A1N0M4D1]. Meter must be installed per the manufacture’s specifications and approval from the campus must be obtained before sizing the flow meter to ensure it is within allowable flow ranges.

1.4 Steam – The meter shall be the type manufactured by Rosemount under the product umbrella 3051SFP Integral Orifice Flow meter. Meter must be installed per the manufactures specifications and must be field verified by campus personnel. Approval from the campus must be obtained before sizing the flow meter to ensure it is within allowable flow ranges.
PART 2 DETAILS

2.1 PowerLogic “WAGES”: utility monitoring 8 to 16-Channel Analog Input unit, wired and tested, comprised of the following:

A. **NEMA 12 enclosure**: (1) For Momentum Processors, wired and tested, with cables and associated connector sets

B. **Communications Gateway**: (1) To provide communications between RS-485 Device and TCP/IP network.

C. **Base unit**: (2) I/O Base Analog 8-CH Diff Input: wired, tested, w/ required cables
   TSX Momentum170AAI03000 Analog Input base - 8 Ch. "Isolated" Input Module Bases

D. **Communications Adapter**: (1) TSX Momentum172JNN21032 Modbus (RS232/485) Option Adapter, Time of Day Clock with Battery Backup

E. **Process Adapters (Top Hats)**: (2) TSX Momentum171CCC76010 M1 CPU / Processor Adapters; 512K RAM; RS232 and I/O Bus Ports

F. **24 VDC Power Supply**: (1) IDEC PS5R-E24 100W 120VAC to 24 VDC Power Supply

G. **120V Duplex Power Outlet**: To provide power source for Laptops and Test equipment.

H. **Processor Battery**: 2/3AA Battery, TADIRAN, High Energy Lithium, 3.6 Volts

2.2 **Flow meters** for Chilled water, Heating Hot water, Domestic Hot water, and/or Domestic Cold water – as required:

A. **Rosemount Remote Mount Flowmeter** – (2-parts):

B. **Rosemount Transmitter**: Rosemount Remote Transmitter for 2 inch pipe or surface mounting; 115 V ac power Supply Voltage; Factory Mutual Class I, Division 2 Approval for nonflammable fluids; High Accuracy Calibration (3 to 30 ft/s) for matched flow tube and transmitter system; with Local Operator Interface included.

C. **Rosemount Flowtube**: Common specifications for Rosemount Magnetic Flowtubes:
   PTFE Teflon lining, two standard 316L Stainless Steel measurement electrodes, Carbon Steel Flange to ASME B16.5 Class 150, Electrode Access in Sealed Welded Housing, Factory Mutual Certification for Ordinary Locations, High Accuracy Calibration (0.25% of rate from 3 to 30 ft/s) with Matched Flowtube and Transmitter and Calibration Data Sheet.

D. **Transmitter wire**: 2-pair twisted/individual shield 18 AWG wire, and 1 single 22 AWG wire, overall PVC jacket, plenum rated - Belden 1474A
2.3 Sensor wire: 2-wire, 18AWG Plenum-rated, shielded, sensor wire

2.4 Chill water (CHW) Temperature Sensors: Dwyer: programmable 1000 Ohm Platinum Sensor & Transmitter Assembly with LCD display [P/N: TTE-1XX-W-LCD (XX is length of probe in inches: ex. 04 = 4")]; and must be installed in Thermowells in pipe [P/N: W1011-10B-XX (XX is length of probe in inches: ex. 04 = 4")].

2.5 Heating Hot water (HHW) Temperature Sensors: Dwyer: programmable 1000 Ohm Platinum Sensor & Transmitter Assembly with LCD display [P/N: TTE-1XX-W-LCD (XX is length of probe in inches: ex. 04 = 4")]; and must be installed in Thermowells in pipe [P/N: W1011-10B-XX (XX is length of probe in inches: ex. 04 = 4")].

2.6 Pressure Sensors: Setra 256: range 0 - 100 psig, ±0.13% Full Scale, 1/4"-18 NPT pressure port, 4-20 ma output, Cast Aluminum case with two 1/2" conduit ports, removable cover and connectors {P/N: 2561100PG2M11}.

2.7 Steam Metering: Rosemount 3051SFP Integral Orifice Flowmeter [P/N: 3051SFP2S015A3SXXXD52DA1A5WDQC7Q4E5 (XXXX=0748 for 0.748 Bore Size, 1022=1022)]. The primary steam pressure is 65 PSI for all meters (state Max flow when ordering).

2.8 Documentation: Related documents from manufacturers for all operating systems/parts are to be provided to UES.

Notes:

1. Installation and wiring by Schneider-Electric technicians per warranty requirements

2. IP Addresses and network connections facilitated by UES

3. The type of 4-20ma input signals are dependent on specific building application

4. The scaling for raw temps, flow, and pressure signals, as well as, compensated signals from flow computers, BTU-totalizers, or other devices are dependent on specific building application

5. PLC-base program is for base TAMU program only and PLC-configured line- items are for specific building parameters

6. 120VAC power source to be connected to dedicated UPS supply source

7. Loop power for analog signals shall be from the enclosure

8. All cabinet penetrations must enter from the bottom of the watertight NEMA 12 enclosure

9. 3/4” EMT conduit or better with watertight/sealed connections at all penetration points