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.
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Design Standard

Building Automation Systems

Detailed specifications follow.

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes 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 Sequences of Operations for HVAC Controls, for requirements that relate to this Section.

C. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner’s operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 01 91 13, General Commissioning, for detailed commissioning requirements.

1.02 WORK INCLUDED

A. Provide a temperature control/energy management system and control function for the entire building. The system shall include a Direct Digital Control (DDC) System that shall communicate & be integrated to the Johnson Controls or Siemens front end Building Automation System (BAS) at the TAMU Utilities & Energy Services through an owner furnished Ethernet network.

B. The BAS system must be compatible with the existing Johnson Controls or Siemens campus system. 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, fire alarm, outside building lighting, and the start and stop of major equipment. Provide metering of primary building utilities which include electrical, chilled water, heating hot water, domestic cold water, domestic hot water, steam, irrigation water utilizing a WAGES and electrical metering system / Square D ION metering software with indication and totalization capabilities

C. The bidding and Contract Requirements and General Requirements apply to this work.
D. Furnish and install all components but not limited to all temperature, pressure, and flow sensors, transmitters, relays, switches, wire, and all DDC panels. 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, provide a complete installation of the Laboratory Control System (LCS) completely integrated into the campus (building) DDC System, Refer to Specification 23 09 13.

E. The 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 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 Contractor shall furnish all DDC lab control system 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 per Specification 23 09 13. Installation of all air terminals shall be by the mechanical contractor.

H. The terminal equipment manufacturer shall provide for each VAV box an inlet flow sensor suitable for interfacing with a pressure transducer, and for VAV boxes and all other terminal equipment (fan coil units, etc.) a 24 vac, 40 va transformer, any necessary pilot control relays, and factory mount and connect these devices and the DDC controller as required for proper operation as required under this Section. The cost of factory 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, 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.

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. 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. Division 26 shall provide power to a duplex receptacle inside each panel. Power 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. 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.

Q. The Owner shall provide the dedicated network connection between the drop(s) location and the Campus Energy Management System.

R. Provide graphics for all new work compatible with existing campus front end system.
S. All exposed wiring shall be in conduit (1/2" minimum), as per Division 26 Sections. Concealed wiring shall be plenum rated. All active Ethernet switches, hubs, and routers shall be Contractor-provided and installed. The conduit/wiring system required for the Energy Management System shall be a complete, separate, independent system. Conduit sharing with other unrelated electrical systems is not permitted.

T. A Square D Model #PM870 WAGES utility metering panel will be provided by Division 26, complete with all microprocessors, software, programming, point data base, trends, terminal strips, and regulated power supply with battery backup. The WAGES panel will require sensor wiring from the panel to temperature 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. Provide all wiring from the flow meters to the WAGES panel. This WAGES panel will require a dedicated 110 volt, 20 amp, single phase standby electric circuit source installed by Division 26. This WAGES panel will require a category 6 Ethernet cable installed by Division 27. A meeting between the TAMU UES and the BAS contractor will be held as early as possible, prior to installation, to review the installation and finalize panel and wiring locations. The WAGES system will require start-up by the square D vendor.

U. 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 each commodity that is being metered in the WAGES system. Electric Meters by the Square D, Schneider Electric Vendor will include connecting to the UES meter software, logging of meter data as required by UES, as well as many Graphic screens required to represent the electrical system and the meters that are included in the project.

V. The BAS contractor will be responsible for the connection from the Energy Management System to the campus (University). The Contractor will be responsible for programming the DDC panels with operational sequences and set-points as specified.

W. Refer to Division 23 00 10 for additional commissioning requirements.

1.03 RELATED WORK

A. All work of this Division shall be coordinated and provided by the single Building Automation System (BAS) Contractor (Also known as DDC Contractor).

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.
C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

D. 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.

E. Section 01 91 13, Commissioning

1.04 SUBMITTALS

A. General.
   1. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance, prior to installation.
   2. All product data in the submittal shall reference the paragraph number in the specification for the corresponding equipment.
   3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BAS work.
   4. Owner & A/E Submittal Review
      a. Two weeks after submittal has been issued the Contractor, Owner and A/E will have a meeting to review and discuss A/E and Owner’s comments. The submittal will be returned approximately one week after the controls meeting.

B. Product Data: For each control device specified.

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.
1.05 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals:
   1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner’s Representative upon completion of the project. The entire Operation and Maintenance Manual 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.

1.06 ENERGY MANAGEMENT SYSTEM 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 (Class1) 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 mechanical room in a star configuration. Data is passed through the 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 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. 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 and tubing 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.
1.07 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 Owner shall inspect and approve this work. The BAS Subcontractor shall make his Representative(s) available and coordinate with the Owner during this inspection process. At the successful conclusion of this inspection, contractor shall provide a written report stating all work is complete. BAS Subcontractor, General Contractor and Owner’s Rep 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 and the DDC panel and WAGES Panel tie-in, a performance test shall be conducted by the Owner in the presence of the BAS Contractor and his appropriate Subcontractors.

F. The BAS Contractor shall be present for the 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 Owner’s 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. Owner’s 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.

1.08 COORDINATION OF EFFORT

A. It is the responsibility of the Contractor to schedule and coordinate with the installer of all furnished equipment.

B. It is the Contractor's responsibility to schedule the accomplishment of these activities to allow for nominal system checkout, performance tests and balancing within the contract performance period.

1.09 QUALITY ASSURANCE

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

1.10 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
   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

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
D. Typical VAV box shall show the following:
   1. AHU serving VAV box
   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)

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

G. Air Handling Unit (and PTOA) 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.

H. Chilled and Heating Water systems 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 open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BAS shall support 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 Building Automation System shall consist of the following:
   1. Standalone Network Automation Engine(s).
   2. Field Equipment Controller(s).
   3. Input/Output Module(s).
   4. Local Display Device(s).
   5. Portable Operator’s Terminal(s).
   6. Distributed User Interface(s).
   7. Network processing, data storage and communications equipment.
   8. Other components required for a complete and working BAS.

C. 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 (Small Animal Hospital).

D. 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.

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

F. Acceptable Manufacturers:
   1. Johnson Controls, Metasys
   2. Siemens Building Technologies

G. Integration with Existing Johnson Controls or Siemens BAS:
   1. The BAS Contractor for this new project shall provide the following:
      a. The BAS contractor shall provide any and all necessary connectivity
         licenses within the cost of the bid. Licenses shall allow specified
         BAS point information to be broadcast out of the BAS expansion to
         the existing Johnson Controls or Siemens BAS.

2.02 ACCEPTABLE CONTRACTORS

A. Mechanical contractor shall not serve as BAS contractor. Acceptable BAS
contractors, provided they comply with these specifications, are:
   1. Siemens Building Technologies, Inc. (branch office)
   2. Johnson Controls, Inc. (branch office)
   3. No exceptions
2.03 FIELD DEVICES

A. Temperature Sensors: Platinum Resistance Temperature Detector, 0°F to 400°F range, 100 ohms at 0°C, 316 stainless steel sheath, single element, ¼ inch diameter sheath. For water sensing provide 316 stainless steel thermowells. Use 304 stainless steel extension fitting to extend assemblies through insulating materials. Provide spring-loaded sensors to ensure good surface contact in thermowells. Provide matched sensor/transmitter assemblies, NIST certified to be accurate to within ±0.1 degrees F from 20 degrees F to 70 degrees F for chilled water monitoring, accuracy of + / - 0.5 degrees F from 30 degrees F to 250 degrees F for condenser water, hot water, or domestic water monitoring, and accuracy of + / - 0.5 degrees F from 20 degrees F to 120 degrees F for all other temperature monitoring. Install on chilled water lines such that condensation does not collect in connection head. Duct temperature sensors shall be averaging type. Water sensors shall be provided with a separable stainless steel well. 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, Minco, or Hy-Cal only. 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.

B. Room Sensors:
1. Each room temperature sensor 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. The Humidity Sensor 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 temperature sensors may be Thermistor or 4-20 mA output RTD. The room sensor 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 sensor shall be accurate to within ±.5°F and have a setpoint adjustment range of 45°Ft0 85°F.
6. Room carbon dioxide 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 sensors shall be full featured cover in all areas.

C. Water Flow Sensors: Water flow sensors shall be furnished by BAS, Rosemount series 8705 Magnetic flowmeter flow tubes. Each sensor shall be sized specifically for the pipe in which it is to be installed. Sensor shall have ±0.5% accuracy from 1 to 30 feet/second, with Class 150 carbon steel flanges, exterior painted with polyurethane, grounding electrode, Teflon (PTFE) lining, and Type 316L stainless steel electrodes. Contractor shall furnish Rosemount Model 8712 C remote mounted magnetic flowmeter transmitters, with 115Vac/1ph/60hz power supply, NEMA 4X enclosure, 4 – 20 ma output, battery-backup totalizer, and local operator interface.

D. Temperature Transmitters: Temperature transmitters shall be designed for 4-20 mA DC 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.

E. 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. Siemens model number QFA3000 or Johnson Controls number HC-7603.

F. CO₂ Duct-Stat Indoor AQ Sensor: C02 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.

G. 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.

H. 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.
I. Flow Transmitters: Flow transmitters shall provide a 4-20 mA DC signal output proportional to flow. Accuracy of ±0.25% of calibrated span. Temperature Limits: -40°F to +220°F. Stability of ±0.25% of upper range limit for 6 months. Range of transmitter shall match flow conditions. Flow transmitter shall be Rosemont only.

J. 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. Rosemount, Setra, or Bristol, only.

K. 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. Hawkeye or equivalent.

L. Pump proof-of-flow switches shall be UL listed adjustable differential pressure or flow type as specified in the sequence of operation or data point summary. Devices shall be 150 psi rated except chilled water flow switches shall be provided with totally sealed vapor tight switch enclosure on 150 psi body. Differential pressure switches shall have valved manifold for servicing. Hawkeye or equivalent.

M. 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. Shall be Veris Hawkeye H908 or equal.

N. 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. Rosemount, Dresser Industries/Ashcroft XLDP or Setra C-264, only.
O. 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.

P. Air Flow Control Dampers:

1. Rectangular
   a. Frame: 5 inches x 1 inch x minimum 0.125 inch 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.
   b. Blades:
      1) Airfoil-shaped, single-piece.
      2) All proportional (modulating and mixing) control dampers shall be opposed blade type and all two-position dampers shall be parallel-blade types.
      3) Heavy duty 6063-T5 extruded aluminum.
      4) Maximum 6 inches (152 mm).
   c. Bearings: Molded synthetic sleeve, turning in hole in frame.
   d. Seals:
      1) Blade: Extruded type for ultra-low leakage from -0 to 2 00 degrees F Mechanically attached to blade edge.
      2) Jamb: Flexible metal compression type.
   e. Linkage: Concealed in frame.
   f. Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically attached to blade.
   g. Finish:
      1) Mill aluminum for dampers in exhaust airstreams.
   h. Performance Data:
      1) Closed Position: Maximum pressure of 13 inches w.g. at a 12 inch blade length.
      2) Open Position: Maximum air velocity of 6,000 feet per minute.
      3) Leakage: Maximum 5.2 cubic feet per minute per square foot at 4 inches w.g for size 48 x 48 inches.
      4) Pressure Drop: Maximum 0.03 inch w.g. at 1,500 feet per minute across 24 inch x 24 inch damper.
   i. Similar to Ruskin CD-50

2. Round
   a. Frame: Minimum 12 gage x 8 inches deep galvanized steel, 18 inches diameter and above. Flange: Minimum 12 gage x 1-1/2 inches.
   b. Blade: Single skin, minimum 16 gage or Double skin, minimum 18 gage. Provide blade stiffeners as required.
d. Axle: Minimum 1/2 inch diameter continuous plated steel rod to 24 inches diameter, 3/4 inch diameter above 24 inches diameter.

e. Bearings: Flange stainless steel pressed into frame.

f. Blade Seals: Provide seals as required to meet minimum leakage indicated. Mechanically attach blade seals to blade.

g. Finish: Mill galvanized.

h. Maximum Static Pressure: 4.0 inches w.g.

i. Performance Data for Damper Diameter of 48 inches, AMCA 500:
   1) Maximum System Velocity: 2,500 feet per minute.
   2) Leakage with Sponge Seals:
      a) Percent of Maximum Flow: 1.40.
      b) Total Leakage: 35 cubic feet per minute.

j. Similar to Ruskin CDRS82

Q. 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 multipoint 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 SUPERVISORY CONTROLLERS

A. The Supervisory Controller shall be a fully user-programmable, supervisory controller. The Supervisory Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Supervisory Controllers.

B. Processor – The supervisory controllers shall be microprocessor-based with a minimum word size of 32 bits. It shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. Supervisory Controller size and capability shall be sufficient to fully meet the requirements of this Specification.
C. Memory – Each Supervisory Controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

D. Hardware Real Time Clock – The Supervisory Controller shall include an integrated, hardware-based, real-time clock.

E. The Supervisory Controller shall include troubleshooting LED indicators to identify the following conditions:
   1. Power - On/Off
   2. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
   3. Ethernet Connection Speed – 10 Mbps/100 Mbps/1000 Mbps
   4. FC Bus – Normal Communications/No Field Communications
   5. Peer Communication – Data Traffic between Supervisory Control Devices
   6. Run –Running/in Startup/Shutting Down/Software Not Running
   7. Bat Fault – Battery Defective, Data Protection Battery Not Installed
   8. 24 VAC – 24 VAC Present/Loss Of 24VAC
   9. Fault – General Fault

F. Communications Ports – The Supervisory Controller shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
   1. Minimum (1) USB port
   2. Minimum (1) URS-232 serial data communication port
   3. Minimum (1) RS-485 port
   4. One (1) Ethernet port

2.05 APPLICATION CONTROLLERS

A. Based on the Building Automation System selected for the project, the following products are acceptable. If the project has selected Siemens as the Building Automation System (BAS) then the acceptable application controllers must be the Siemens product, if the project has selected the Johnson Metasys System as the BAS, then the acceptable application controllers must be the Johnson Metasys product. In all cases the acceptable application controllers must use BACnet™ as the native communication protocol between controllers, control panel, and front-end software.

B. Acceptable Products:
   1. Siemens Apogee: PXC and programmable TEC line of controllers.
   2. Johnson Metasys: Field Equipment Controllers

2.06 GENERAL - APPLICATION CONTROLLERS

A. Definition: An Application Controller, for this specification, could be an AAC (Advanced Application Controller), an ASC (Application Specific Controller), or
and Terminal Equipment Controller (TEC). These would be used on Primary Equipment and Terminal Equipment, respectively.

B. Each Application Controller must be capable of standalone direct digital operation utilizing its own processor, non-volatile flash memory, input/output, minimum 8 bit A to D conversion, and include voltage transient and lightning protection devices. Firmware revisions to the module must be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LANs.

C. The Application Controllers for Primary Equipment shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. The controller, in conjunction with the expansion modules, shall act as one application controller.

D. All point data, algorithms and application software within the controllers shall be custom programmable.

E. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/write-able nonvolatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.

F. Each Application Controller shall be configured on the workstation/server software as a BACnet™ device. All of the points shall be configured as BACnet objects. Each controller shall include self-test diagnostics which allow the controller to automatically relay to the system supervisory engine(s) any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.

G. Each Application Controller should be capable of scheduling, either by using an on-board real-time clock or by receiving the time from the system supervisory engine(s).

H. Each Application Controller shall contain both software and firmware to perform full DDC PID control loops.

I. Each Application Controller shall contain a port for the interface of maintenance personnel's portable computer. All network interrogation shall be possible through this port.

J. If being installed outdoors, the Application Controllers shall be capable of being mounted directly in or on the equipment located outdoors. The Application
Controllers shall be capable of proper operation in an ambient temperature environment of -20 degrees F to + 150 degrees F.

K. Input-Output Processing:
1. Digital outputs shall be relays or triacs, 24VAC or VDC minimum. Each output shall be configurable as normally open or normally closed.
2. Universal inputs shall be capable of, 0-20mA, dry contact, and 0-5VDC, 2-10VDC or 0-10VDC.
3. Analog output shall be electronic, voltage mode 0-10VDC, 2-10VDC or current mode 4-20mA.
4. Enhanced Zone Sensor Input shall provide one thermistor input, one local set point adjustment, one timed local override switch, and an occupancy indicator.
5. All programming sequences shall be stored in non-volatile memory. All programming tools shall be provided as part of the system. Provide documentation of all programming including configuration files.

L. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the Application Controller. All operating parameters for application programs residing in each Application Controller shall be stored in read/write-able nonvolatile flash memory within the controller. Firmware revisions, application programs and program modifications to the controller shall be capable of being performed over the Wide Area Network (WAN).

M. Each Application Controller shall be able to support various types of zone temperature sensors, such as temperature sensor only, temperature sensor with built-in local override switch, with set point adjustment switch.

N. Each Application Controller for VAV application shall have a built-in air flow transducer for accurate air flow measurement in order to provide the Pressure Independent VAV operation.

O. Each Application Controller for VAV applications shall have an integral direct coupled electronic actuator. If the actuator is not integral to the controller, the controller/actuator assembly shall be factory tested and approved for the intended use. The actuator shall provide on-off/floating point control with a minimum of 35 in-lb of torque. The assembly shall mount directly to the damper operating shaft with a universal V-Bolt clamp assembly. The actuator shall not require any limit switches, and shall be electronically protected against overload. When reaching the damper or actuator end position, the actuator shall automatically stop. The gears shall be manually disengaged with a button on the assembly cover. The position of the actuator shall be indicated by a visual pointer. The assembly shall have an anti-rotational strap.
P. Each Application Controller shall have LED indication for visual status of communication and power.

Q. Astronomical Time: Astronomic capability shall allow the system to calculate sunrise and sunset times based on geographical location, and incorporate Daylight Savings Time, for dusk-to-dawn control or dusk-to-time control. This is required in any Application Controller with I/O for the Exterior lighting circuit(s). The Application Controller may receive this value from the Global Building Controller and fail to a “safe” position (ie., lights fail on) upon a loss of communication from the Global Building Controller.

R. In the event of a loss of communication, the Application Controller shall control from a standalone algorithm which maintains the assigned space temperature until communication is restored.

S. UPS: Uninterruptible Power Supply(s) is(are) required for any Application Controller (on primary or terminal equipment) that monitors or serves emergency and/or critical equipment, locations or points.

T. All Application Controller level objects shall be exposed as BACnet Objects.

U. Primary Equipment shall be controlled using one Application Controller when possible. A single controller with adequate Input/Output and resource capacity shall be used for a single piece of equipment as opposed to using two or more smaller controllers to house the programs for one piece of equipment.

V. Each Application Controller for Primary Equipment shall contain the following as Spare I/O:
   1. Minimum of: (3) Spare Universal Inputs (or 2-DIs and 1-AI), (1) Spare AO, and (2) Spare DOs.
   2. In addition to the Minimum, the Application Controller shall have 10% Spare I/O, of each type; UI (or DI and AI), AO and DO.

2.07 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.

2.08 VALVE AND DAMPER ACTUATORS

   A. Electronic direct-coupled actuation shall be provided.

   B. The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.

   C. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

   D. For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are acceptable for valves larger than 4”.

   E. All spring return actuators shall be capable of both clockwise and counterclockwise spring return operation.

   F. Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA analog control input and provide a 2 to 10VDC or 4 to 20mA operating range.

   G. Actuators capable of accepting a pulse width modulating or three-point floating control signal are acceptable for specific uses only, but are generally not preferred. Typically, these uses would be fin tube radiation control valves or small (less than 1 gpm) re-heat control valves.

   H. All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.
I. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.

J. All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.

K. Actuators shall be provided with a conduit fitting.

L. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.

M. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of start-up, per Start-up Report or Cx documentation.

N. Manufacturer shall be ISO9001 certified.

O. Electronic Damper Actuators:
   1. Electronic damper actuators shall be equal to Siemens EA or SQ or Johnson Controls M Series actuator.
   2. For air handling unit isolation dampers, the actuators shall be electric with spring return. The actuators shall be able to open and close in less than 30 seconds.

P. Butterfly Valve Actuators
   1. Bray model CF Series 70 or approved equal.

2.09 COMPRESSED AIR SYSTEM

A. No controls air compressor is required for this project.

PART 3 - EXECUTION

3.01 GENERAL

A. All DDC and lab-trac panels shall be connected to emergency power system.

3.02 LAMINATED SEQUENCE OF OPERATION

A. For each piece of equipment, including, but not limited to pumps, air handling units, fans, fan coil units, etc., provide a laminated sequence of operation, including control schematic, to be mounted on the wall in the mechanical rooms or at location as indicated by Owner.
3.03 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.

3.04 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 motor shall be energized as follows upon restoration of normal power: Fifteen seconds (adjustable) after restoration of power, motors shall be started sequentially at 15 second intervals (adjustable) through the DDC system. Initiate start-up with:
   1. EF-C4-1/2 System
   2. PTOA-C4-1 though PTOA-C4-5.
   4. AHU-A4-1, followed by AHU-A4-2, etc..
   5. All other equipment to start sequentially after air handling units are verified on.

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

3.05 INSTALLATION

A. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

B. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

C. Contractor shall install labels and nameplates to identify control components according to Section 23 05 53, Identification for HVAC Piping and Equipment.

D. Contractor shall install hydronic instrument wells, valves, and other accessories according to Section 23 21 13, Hydronic Piping.

E. Contractor shall install duct volume-control dampers according to Division 23 Sections specifying air ducts.

F. Install electronic and fiber-optic cables as applicable according to Division 27.
3.06 FIELD QUALITY CONTROL

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

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   4. Test each point through its full operating range to verify that safety and operating control set points are as required.
   5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   6. Test each system for compliance with sequence of operation.
   7. Test software and hardware interlocks.

C. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check instrument tubing for proper fittings, slope, material, and support.
   5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
   6. Check temperature instruments and material and length of sensing elements.
   7. Check control valves. Verify that they are in correct direction.
   8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
   9. Check DDC system as follows:
      a. Verify that DDC controller power supply is from emergency power supply, if applicable.
      b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
      c. Verify that spare I/O capacity has been provided.
      d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section, Demonstration and Training.

B. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 91 13, General Commissioning, for contractor training requirements.

3.08 FUNCTIONAL PERFORMANCE TESTING

A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans.
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
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

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<thead>
<tr>
<th>Pedestrian Light Poles</th>
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<tr>
<td><strong>Equipment</strong></td>
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<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 LUCO</td>
</tr>
<tr>
<td>70W</td>
<td>Gardco</td>
<td>Form 10 LED</td>
<td>CP17L-P22-5-70LA-NW-UNIV-BRA311-OWLET LUCO</td>
</tr>
<tr>
<td>66W</td>
<td>Kim</td>
<td>CC/CCS Wall LED</td>
<td>FM-CCS17W5-60L4K277-277-DBA311-OWLET LUCO</td>
</tr>
<tr>
<td>70W</td>
<td>Gardco</td>
<td>Form 10 Wall LED</td>
<td>CW17L-D1M-4-70LA-NW-277-BRA311-OWLET LUCO</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.
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’</td>
<td>Gardco</td>
<td>Tapered</td>
<td>TAMU-TRA-CB-20M-D1-BRA#311</td>
</tr>
<tr>
<td>20’</td>
<td>Kim</td>
<td>Tapered</td>
<td>LTRA20-6156-1A-DBA311/BC/PC4RDB/96068/95518</td>
</tr>
<tr>
<td>30’</td>
<td>Sterner</td>
<td>Tapered</td>
<td>RTA30-8.0x4.5-0.188-10-L-VD-LBZ#311</td>
</tr>
<tr>
<td>30’</td>
<td>Gardco</td>
<td>Tapered</td>
<td>TAMU-TRA-CB-30L-D1-BRA311</td>
</tr>
<tr>
<td>30’</td>
<td>Kim</td>
<td>Tapered</td>
<td>LTRA30-7156-1A-DBA311/BC-PC4RDB/96068/95518</td>
</tr>
</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</td>
<td>Kim</td>
<td>EKG402 LED</td>
<td>1A-EKG402-80L3K277-DBA311-OWLET LUO-LI/00-05-166/00-05-918/00-05-919</td>
</tr>
<tr>
<td>160W</td>
<td>Gardco</td>
<td>Form 10 LED</td>
<td>EH19L-1-5-160LA-NV-UNIV-BRA#311-OWLET LUO</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 without 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>
</tr>
<tr>
<td>Pole</td>
<td>Gardco</td>
<td>Nonlit</td>
<td>TAMU-42-NONLIT-SC/BRA#311</td>
</tr>
<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>
</tr>
<tr>
<td>Roadways</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<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.
Poles

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.

**PREFIX**
- TAMU-TRA

**BASE**
- CB - Road Cast Base
- HB - HINGED BASE

**HEIGHT**
- 25' LH
- 30' LH
- 35' LH
- 40' LH

**DRILLING**
- D1 - 1 Way
- D2 - 2 Way
- D3@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

**OPTIONS**
- DR - Duplex Receptacle
- GFCI - Ground Fault Receptacle
- VUA - Vibration Damper

**Nipples and Couplings**
Indicates size (1/2", 3/4", 1", 1 1/4", 1 1/2", 2") indicates height above base and orientation to hand hole. See Pole Orientation Information on Page 4.

**Single Mount Batten Brackets**
Indicates size (1 1/2", 2") indicates height above base and orientation to hand hole. See Pole Orientation Information on Page 4.

**Motion Response Provisions**
- GMR - Provision for Gardco HID Motion Response System
  - Minimum Pole Height: 10'
  - Includes a 1" coupling placed 100° to the hand hole, 12" above the pole base.
- MSM - Motion Sensor Mounting Provision for LED Luminaires available with Motion Response
  - Minimum Pole Height: 15'
  - Includes a special hand hole with 1/2" coupling placed in the lower part, 180° to the hand hole, 15" above the pole base.
Poles

Exterior Lighting and Installation
Pedestrian Poles and Fixture Datasheets

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 I anodizing or electrostatically applied TGIC polyester powdercoat. All poles include anchor bolts, hand holes, 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>TAMU-TRA</td>
<td>HB</td>
<td>15L</td>
<td>D1</td>
<td>BRA#311</td>
<td></td>
</tr>
</tbody>
</table>

Enter order code into 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.

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>BASE</th>
<th>HEIGHT</th>
<th>DRILLING</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRA</td>
<td>CB</td>
<td>Hinged Base</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HB</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FINISH

- BRP: Bronze Paint
- BLP: Black Paint
- WP: White Paint
- NP: Natural Aluminum Paint
- BRA: Bronze Anodized #311
- BIA: Black Anodized
- NA: Ni-Cr Anodized
- OC: Optional Color Paint
- SC: Special Color Paint
- GFCI: Ground Fault Raceptacle
- YUA: Vibrator Damper
- DR: Duplex Raceptacles
- NL: Nipple - Internal thread
- CL: Coupling - Internal thread
- Single Mount Bollard Brackets

Options

- Motion Response Provisions
- GMR: Provision for Gardco HID Motion Response System
- Minimum pole height is 18', includes a 1/2" coupling placed 180° to the hand hole, 15' above the pole base.
- HSM: Motion Sensor Mounting Provision for LED Luminaire available with Motion Response
- Minimum pole height is 18', includes a special hand hole with 1/2" coupling placed in the cover plate, 180° to the hand hole, 15' above the pole base.

1411 Clay Barker Road, San Marcos, TX 78666
(800) 327-0758 (512) 753-1000 FAX: (512) 753-7855 atelighting.com
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PHILIPS
GARDCO
Specifications

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

Housing: Spun aluminum. Rolled-formed linear reveals: CC: Three equally spaced reveals, 1/2" wide, separated by 1/2" ribs, 1/4" deep. CCS: One 3/4" groove, 1/4" deep. Sidewalls have a maximum 1/8" tolerances, and are free of sharp edges. A rolled-formed aluminum flange is attached to 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 3/4" 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 - Flash 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 MicroHemitter 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 mill 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") 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/finish, (iii) a period of six (6) years for LED Light Engines (MicroHemitter 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 the fixture to the buyer as specified in 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>
<th>0.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. No.:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pole Top Requirements:</td>
<td>3 ¼&quot;, 4&quot;, 4 ¼&quot;, or 5&quot; Dia.</td>
<td>2&quot; Pipe-size Tenon (2 ⅜&quot; O.D. x 4 ⅝&quot; L)</td>
</tr>
</tbody>
</table>

## Fixture

Cat. No. designates CC/CCS fixture and light distribution.

NOTE: Curvilinear system employs Nichia's SSL product.
Part number: NS6a183 (NS6L183-H3, NS6W183-H3)

<table>
<thead>
<tr>
<th>CC</th>
<th>17</th>
<th>P</th>
<th>x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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
- □ 6 = Type L Left Full Cutoff
- □ R = Type R Right Full Cutoff

**Light Distribution:**

- Type I
- Type II
- Type III
### Standard Features

#### Electrical Module

<table>
<thead>
<tr>
<th>Cat. Nos. for Electrical Modules available:</th>
</tr>
</thead>
<tbody>
<tr>
<td>60L</td>
</tr>
</tbody>
</table>

**Source:**
- 60L = 60 LED's

**Color Temperature:**
- 14K = 4000K
- 5K = 5000K
- 2K = 5800K - Amber
- 3K = 3000K

**Voltage:**
- 120 - 120V
- 208 = 208V
- 240 = 240V
- 277 = 277V
- 347 = 347V
- 480 = 480V

*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

<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>8L</td>
<td>DBA 311</td>
<td>LG</td>
<td>SG</td>
<td>PS</td>
<td>WH</td>
<td>CC</td>
</tr>
</tbody>
</table>

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

### Photocell

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Line Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-30</td>
<td>120V</td>
</tr>
<tr>
<td>A-31</td>
<td>208V</td>
</tr>
<tr>
<td>A-32</td>
<td>240V</td>
</tr>
<tr>
<td>A-33</td>
<td>277V</td>
</tr>
<tr>
<td>A-35</td>
<td>347V</td>
</tr>
<tr>
<td>A-34</td>
<td>480V</td>
</tr>
</tbody>
</table>

Factory installed photocell inside housing with a fully gasketed sensor on the side wall.

### Photocell Sensor

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.

### Dimming Controls

The ¾” thick clear convex tempered glass lens replaces standard flat glass lens. Provides increased lens presence and provides a subtle improvement in uniformity where pole spacing is extreme. Increases effectiveness of houseside shielding.

### Convex Glass Lens

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>CGL</th>
</tr>
</thead>
</table>

### Polycarbonate Lens

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>L17F</th>
</tr>
</thead>
</table>

Clear UV stabilized polycarbonate 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

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>BL-REV</th>
<th>DB-REV</th>
<th>LG-REV</th>
<th>SG-REV</th>
<th>PS-REV</th>
<th>WH-REV</th>
<th>CC-REV</th>
</tr>
</thead>
</table>

(For CC series only) These aluminum bands riveted inside the housing reveals. Available in five standard Kim powder coat finishes. Custom colors available.

*Custom colors 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 - Amber 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>Voltage AC</th>
<th>Amps AC</th>
<th>System Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>.56</td>
<td>60</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>347</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 Lumens where 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 L/R</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>B2 U9 G2</td>
<td>B1 U6 G1</td>
<td>B3 U6 G1</td>
<td>B1 U6 G1</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 L/R</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000K</td>
<td>N/A</td>
<td>3414</td>
<td>3376</td>
<td>3420</td>
<td>3403</td>
<td>3281</td>
</tr>
<tr>
<td>4000K</td>
<td>N/A</td>
<td>4163</td>
<td>4117</td>
<td>4100</td>
<td>4248</td>
<td>4091</td>
</tr>
</tbody>
</table>

*LED performance and lumen output continues to improve at a rapid pace. Log onto www.kimlighting.com to download the most current photometric files from Kim Lighting’s LED File Library for custom optics and color temperature configurations. Contact factory.

*Data is provided from 5000K NES files.

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Version 2.3.2014

Exterior Lighting and Installation
Pedestrian Poles and Fixture Datasheets
Form 10 Round LED

CP / MP Post Top Mount

The Philips Gardco post top mounted Round Form 10 LED products are cut-off luminaires featuring LED arrays. Round Form 10 LED luminaires 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 glow rings at post tops are available in (4) colors and are illuminated by the primary source. Luminaires 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>
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Enter the order code into the appropriate box above. Note: Philips Gardco reserves the right to change configurations. Not all combinations and configurations are valid. Refer to notes below for exclusions and qualifications. For questions or concerns, please consult the factory.

**Available in 70LA and 85LA LED Wattages Only**

**CP17L**
- 17" Cylindrical Luminaire LED - Constant Wattage
- 17" Cylindrical Luminaire LED - 0.10V Dimming

**MP17L**
- 17" Semi-Spherical Luminaire LED - Constant Wattage
- 17" Semi-Spherical Luminaire LED - 0.10V Dimming

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

**MOUNTING**

See Mounting Illustrations on Page 3 for more information.

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**DISTRIBUTION**

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

**LED WATTAGE AND LUMEN VALUES**

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<th>LED Current (mA)</th>
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**PHILIPS GARDCO**

1611 Cleois Barker Road, San Marcos, TX 78666
(800) 237-0798 (512) 753-1000 FAX: (512) 753-7855 siteled.com
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G200-215/1012
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 luminaries featuring LED arrays. Form 10 Round LED luminaries 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.

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 deformation.

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 post attachment. The yoke is electroplated and coated with satin black polyurethane or polyester powder coat.

LENSES: One piece, diecast aluminum door frame retains the optically clear, heat and impact resistant tempered flat glass, in a sealed manner using hollow section, high compliance, memory retentive extruded silicon rubber. Concealed stainless steel hinges and two (2) fasteners secure lens assembly to luminaire.

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>
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<tr>
<th>PREDICTED LUMEN DEPRECIATION DATA</th>
<th>Driver mA</th>
<th>L&lt;sub&gt;n&lt;/sub&gt; Hours&lt;sup&gt;a&lt;/sup&gt;</th>
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<td>530 mA</td>
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<td>530 mA</td>
<td>70,000</td>
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<sup>a</sup> Predicted performance derived from LED manufacturer's data and engineering design estimates, based on IESNA LM-80 methodology. Actual performance may vary due to field application conditions. L<sub>n</sub> is the predicted time when LED performance deprecates to 70% of initial lumen output.

FULL CUT-OFF PERFORMANCE: Full cut-off performance means a luminaire distribution where zero or negligible light occurs at an angle at or above 90° above nadir.

CUTOFF PERFORMANCE: Cutoff performance means a luminaire distribution where the candela per 1000 lumen luminous does not numerically exceed 100 (10 percent) at a vertical angle of 80° above nadir. This applies to all lateral angles around the luminaire.

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(800) 237-0758 (512) 753-1000 FAX (512) 753-7855 sticklighting.com
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G200-025/1015

Exterior Lighting and Installation
Pedestrian Poles and Fixture Datasheets
Page 51
# FGS – Federal Globe™ Small Housing Scale

- Two filter designs to accommodate architectural requirements
- Available with choice of three different optical systems, including patented ContraClinc®, internal and external Refractors and Bare Lamp
- Energy efficient light sources range from LED to 100MH up to 400PSMH, including induction lamp system
- Cut-off shield available to reduce uplight
- Integrated hinged cap allows tool-less access to lamp and ballast compartments
- Replaces the Pedestrian ContraClinc® families
- IP65 rated (SAL) IP69 rated (all others)
- Powder coat finish in 13 standard colors with a polymer primer sealer

## 1. LUMINAIRE

- GFS (Small Scale Housing - LED)
- GFS Short Scale Housing

## 2. DECORATIVE STYLE

- RG (Red-Green Filter Design)
- LF (Last Filter Design)

## 3. GLOBE STYLE

- LL3 Types 9
- LL5 Types 9
- STANDARD ACCORD GLOBE
- SAL (See price table Available with LED)

## 4. OPTICAL SYSTEM

- TEL (LED only)
- CONTRACTOR OPTIC
- COO
- GLASS REFRACTOR OPTIC Max 150PSMH (50Watts)
- GR3 (Type 9)
- GR5 (Type 9)
- BARE LAMP OPTIC
- BLO

## 5. LAMP/BALLAST

- LED 100W/32 wall fixture: 1 Watt white (5000K), 229 watts
- 35W LED 8W (4LEDs)
- METAL HALIDE (100/200/300 3007 with ballast)
  - Medium base E26 Lamp: 100MH
  - 200MH
  - 300MH
- PULSE START METAL HALIDE (100/200/300 3007 with ballast)
  - Medium base E26 Lamp: 100MH
  - 200MH
  - 300MH
- HIGH PRESSURE SODIUM (100/200/300 3007 with ballast)
  - Medium base E26 Lamp: 100MH
  - 200MH
  - 300MH
- INDUCTION LAMP (High frequency generator: 120/240, 200W at 277V, 380V)
  - 1.2W (55 watts)
  - 1.6W (60 watts)
- For all Pulse Start Ballasts: 1 in use lamps rated for vertical housing. All ballasts are factory wired 277 volts, unless specified. Lamps not included except 1 and 300MH.

## 6. COLOR

- CRT (Coral)
- MAL (Mar-A-Lago)
- MDG (Med-Grey)
- ATG (Antique Gold)
- LGY (Light Grey)
- RAL/PREMIUM COLOR (Provide RAL)
- CUSTOM COLOR (Provide color chip for matching)

## 7. OPTIONS

- FGS (Single Focus Holder for fixtures) LED only
- FS2 (Double Focus Holder for fixtures) WID only
- 347V (High voltage ballast) (100/200/300 740) 500, 1000, 1000W
- ASY (Asymmetric reflector - field installed. Only available with LID)
- HSS (Halo side shield), field installed. Includes asymmetric assembly. Only available with LID)
- TA3 (None adapter clips over a 3.5/35mm O.D. by 0.020mm)
- TA35 (None arthritis clips over a 3.5/35mm O.D. by 0.020mm)
- AC2 (Adapter box) over a 3.5/35mm O.D. packed and in 3/4x10mm long. Serves as the bullet with four stainless steel set screws
- ALF (Cell Migration Kit, for SAL grade only)
- COS (Cut-off shield – reduce weight! Factory installed. Not available with GR3 or GR5 and LED)
- PFC (Base control kit. Available in 700, 37W. Specify for wattage)

## 8. MOUNTING

### WALL MOUNT

- WMA 1M
- WMA 56
- WMA 57

### POLE MOUNT

- TRA 1M
- TRA 56
- TRA 57

## Specifications

### HOUSING

- Decorative, cast aluminum filter shall support the lamp base, reflector assembly and luminaire housing. The lamp holder shall be o.D. pol and sealed with four 5/16-18 stainless steel set screws. Lamp and ballast compartments shall be tool-less accessible through a hinged capital. The ballast is accessible by lifting ballast plate by handle.

### ELECTRICAL

- Fixture shall be EFL 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 ContraClinc® optical system is a multi-tiered reflector assembly composed of four reflective elements for Type 5 or six reflector elements for Type 3. Peak candela shall be at 70° and sharp cutoff at 80°. Lamp (by others) shall be in a vertical, base down, bottom position.

Other optical systems available consist of an internal glass reflector optic, which features a GR3 for Type 3 light distribution and GR5s for the Type 5 light distribution (up to 150PSMH and 150WRS), axially refractive globes in non-yellowing acrylic, as well as a bare lamp optic.

---

**Note:** See next page for additional information.
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.L. for outdoor, wet location use, in all mounting orientations, conforms to UL1598 and Can Canadian CSA Std. C22.2 no.200 standard. (Ref. 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:** 6902  
**EFFICACY:** 75.6

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<tr>
<th>B3 U4 G3</th>
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<td>FM</td>
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<td>FH</td>
<td>90°</td>
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<td>FVM</td>
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<tr>
<td>BL</td>
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<td>60°</td>
<td>6.4 %</td>
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<tr>
<td>BH</td>
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<td><strong>UP LIGHT</strong></td>
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**FGS TS 35LED BW**

**WATTAGE:** 32.9  
**LUMEN OUTPUT:** 2200  
**EFFICACY:** 66.9

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<td>BL</td>
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<td>UH</td>
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<td>4.5 %</td>
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*AAI reserves the right to change product specifications without notice.*

*FGS files can be found at www.aal.net*
**Historical Pedestrian and Heritage Lighting**

**Exterior Lighting and Installation**

**Pedestrian Poles and Fixture Datasheets**

---

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

**Luminaire Detail**

Scale: 1:12

**PROVISIONS FOR ANTENNA**

**Dark Sky Compliant**

**Color:** Bronze Custom

**POLE: CP12800**
- 5" Round Straight Flat Fluted Aluminum W/ 3/8" O.D. Tenon,
- 0.187" Wall Thickness,
- Cast Aluminum Base W/ Access Cover

**OUTLET FACTORY SUPPLIED AND INSTALLED**

Fasteners: Hex Head Bolts

Photo Control: None

**Philips LEDgine Specifications:**
- 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, Intellivolt 120-277 VAC, 50-60 Hz, RoHS compliant, additional 10kV/10kW surge suppression.

---

**Full Specification Drawing**

(Complete Assembly)

**Philips HADCO**

100 Craftway Drive
Lillington, NC 27540
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

**Pn.:**
14-D22

**By:**

---

Version 2.3.2014

Pedestrian Poles and Fixture Datasheets
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 I 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 TGIC polyster powdercoat or polyurethane. Luminaries provide full cutoff performance.

### LED WATTAGE AND LUMEN VALUES

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<thead>
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<th>Average System Watts'</th>
<th>LED Current (mA)</th>
<th>LED Selection</th>
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</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)

---

**Notes:**
1. Wattage may vary by ± 5% due to LED manufacturer's forward volt specification and ambient temperature. Wattage shown is average for 120V through 277V input. Actual wattage may vary by an additional ± 10% due to actual input ratings.
2. Watts shown are for luminaries without the HS external shied option. Data are for processes for luminaires with the HS option and WW luminaires. Contact Gardco at gardco.com for information on lampage estimates required for design purposes. Factor 3. Use with KHOS luminaires that provide an additional 0.10 lumens per watt when operated at 350 mA. Lumen values based on tests performed in compliance with IESNA LM-79. (g) Marked values are scaled from NW tests on the same luminaire.

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C200-02/1012
Form 10 Round LED
CW / MW Wall Mount

FINISH
- BRP: Bronze Paint
- BLP: Black Paint
- WP: White Paint
- NP: Natural Aluminum Paint
- BVA: Bronze Anodized 
- MLA: Natural Anodized
- OC: Optional Color Paint
- SC: Special Color

OPTIONS
- F*: Fusing
- PC*: Photocontrol and Recaptacles
- PCR*: Photocontrol Recaptacles only
- 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

OWLET

DIMENSIONS AND EPA

CW

MW

Wall Mounting Dimensions

1611 Clunis Barker Road, San Marcus, TX 78666
(800) 237-0758 (512) 753-1000 FAX: (512) 753-7855 sailighting.com
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Sterner Tapered Pole

### Ordering Example

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<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>
</tr>
</tbody>
</table>

### Ordering Sequence

- **RTA10**: See Pole Data Table Below
- **RTA20**: 0.125”
- **RTA25**: 0.135”
- **RTA30**: 0.188”

**Note**: 1) ‘T’ applies to both arm & pole mount fixtures. 2) ‘C’ style & ‘R’ style bases available 2’’ max. 3) 2.5” dia. base only.

### Pole Data

<table>
<thead>
<tr>
<th>Pole Col Ref</th>
<th>Standard (in.)</th>
<th>Wall Thickness (in.)</th>
<th>Pole Height (in.)</th>
<th>Wall Grade</th>
<th>Anchor Bolt</th>
<th>Anchor Bolt</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA10</td>
<td>4.5 x 0.189</td>
<td>0.25</td>
<td>10’</td>
<td>4.00’</td>
<td>0.025’’</td>
<td>0.025’’</td>
</tr>
<tr>
<td>RTA15</td>
<td>4.5 x 0.189</td>
<td>0.25</td>
<td>10’</td>
<td>4.00’</td>
<td>0.025’’</td>
<td>0.025’’</td>
</tr>
<tr>
<td>RTA20</td>
<td>5.0 x 0.25</td>
<td>0.25</td>
<td>10’</td>
<td>4.00’</td>
<td>0.025’’</td>
<td>0.025’’</td>
</tr>
<tr>
<td>RTA25</td>
<td>5.0 x 0.25</td>
<td>0.25</td>
<td>10’</td>
<td>4.00’</td>
<td>0.025’’</td>
<td>0.025’’</td>
</tr>
<tr>
<td>RTA30</td>
<td>5.0 x 0.25</td>
<td>0.25</td>
<td>10’</td>
<td>4.00’</td>
<td>0.025’’</td>
<td>0.025’’</td>
</tr>
</tbody>
</table>

### Powder Coats

- **BK**: Black
- **BZ**: Dark Bronze
- **WH**: White
- **AL**: Natural Aluminum
- **Anodized**: LBZ (Light Bronze 341) MBZ (Medium Bronze) DBZ (Dark Bronze) ABL (Black) AAL (Natural Aluminum) NS (Non-Standard Finish)
**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 I 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.

<table>
<thead>
<tr>
<th>FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRP</td>
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<tr>
<td>BLP</td>
</tr>
<tr>
<td>WP</td>
</tr>
<tr>
<td>NP</td>
</tr>
<tr>
<td><strong>BRA</strong></td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>OC</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>SC</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR</td>
</tr>
<tr>
<td>GFCI</td>
</tr>
<tr>
<td>VDA</td>
</tr>
</tbody>
</table>

**Nipples and Couplings**


**Single Mount Bullhorn Brackets**

Indicate height above base and orientation to hand hole. See Pole Orientation Information on Page 4.

<table>
<thead>
<tr>
<th>Bracket</th>
<th>Height</th>
<th>Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A15BH-19</td>
<td>Single</td>
<td>1.9&quot; OD</td>
</tr>
<tr>
<td>A15BH-24</td>
<td>Single</td>
<td>2.4&quot; OD</td>
</tr>
<tr>
<td>A215BH-19</td>
<td>2-Tenon</td>
<td>1.9&quot; OD</td>
</tr>
<tr>
<td>A215BH-24</td>
<td>2-Tenon</td>
<td>2.4&quot; OD</td>
</tr>
</tbody>
</table>

**Motion Response Provisions**

<table>
<thead>
<tr>
<th>GMR</th>
<th>Provision for Gardco HID Motion Response System</th>
</tr>
</thead>
<tbody>
<tr>
<td>NL</td>
<td>Nipple - External thread</td>
</tr>
<tr>
<td>CL</td>
<td>Coupling - Internal thread</td>
</tr>
<tr>
<td>MSM</td>
<td>Motion Sensor Mounting Provision for LED Luminaires available with Motion Response</td>
</tr>
</tbody>
</table>

Minimum Pole Height is 18'. Includes a 1/2" coupling placed 180° to the hand hole, 12" above the pole base.

Minimum Pole Height is 18'. Includes a special hand hole with 1/2" coupling placed in the cover plate, 180° to the hand hole, 15" above the pole base.

---

1611 Clovis Barber Road, San Marcos, TX 78666
(800) 227-0758  (512) 753-1000  FAX: (512) 753-7855  sitelighting.com
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79415-240611

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**Version 2.3.2014**

Exterior Lighting and Installation
Roadway / Parking Poles and Fixture Datasheets

Page 58
Kim Tapered Pole

LTRA
Round Aluminum Tapered Pole

Type: Kim Lighting

Standard Features

NOTE: All allowable pole and fixture EPAs are derived from the AASHTO standard. Responsibility lies with the specifier for correct pole selection based on local codes and standards for the job location. (See page 4).

<table>
<thead>
<tr>
<th>Pole Catalog Number</th>
<th>Pole Diameter (in)</th>
<th>Pole Height (ft)</th>
<th>Allowable Pole EPA (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTRA16-6156</td>
<td>6&quot; x 1.56</td>
<td>16</td>
<td>19.36</td>
</tr>
<tr>
<td>LTRA16-6188</td>
<td>6&quot; x 1.88</td>
<td>16</td>
<td>23.58</td>
</tr>
<tr>
<td>LTRA20-6156</td>
<td>5&quot; x 1.56</td>
<td>20</td>
<td>12.01</td>
</tr>
<tr>
<td>LTRA20-6188</td>
<td>5&quot; x 1.88</td>
<td>20</td>
<td>15.25</td>
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<tr>
<td>LTRA25-6156</td>
<td>6&quot; x 1.56</td>
<td>25</td>
<td>10.73</td>
</tr>
<tr>
<td>LTRA25-6188</td>
<td>6&quot; x 1.88</td>
<td>25</td>
<td>14.30</td>
</tr>
<tr>
<td>LTRA30-7156</td>
<td>7&quot; x 1.56</td>
<td>30</td>
<td>8.17</td>
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</tbody>
</table>

48" and 50" poles are 2-piece assemblies

Anchor Base and Bolt Detail

<table>
<thead>
<tr>
<th>Pole Height (ft)</th>
<th>Y Pole Diameter (in)</th>
<th>Bolt Circle Dia. (in)</th>
<th>Anchor Bolt Projection (in)</th>
<th>Anchor Bolt Size (in)</th>
<th>Base Size (in)</th>
<th>Conduit Opening (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5&quot;</td>
<td>.925</td>
<td>.375</td>
<td>.375 x .300 + .4&quot;</td>
<td>.925 sq.</td>
<td>.437 DIA</td>
</tr>
<tr>
<td>16-25</td>
<td>6&quot;</td>
<td>.925</td>
<td>.375</td>
<td>.375 x .300 + .4&quot;</td>
<td>.925 sq.</td>
<td>.5 DIA</td>
</tr>
<tr>
<td>25'-30</td>
<td>7&quot;</td>
<td>1&quot;</td>
<td>.375</td>
<td>.375 x .300 + .4&quot;</td>
<td>1.0 sq.</td>
<td>.625 DIA</td>
</tr>
<tr>
<td>25'-39</td>
<td>8&quot;</td>
<td>1.125</td>
<td>.375</td>
<td>1.0 x .36 + .4&quot;</td>
<td>1.125 sq.</td>
<td>.75 DIA</td>
</tr>
<tr>
<td>35'-48</td>
<td>10&quot;</td>
<td>1.437</td>
<td>.375</td>
<td>1.0 x .48 + .4&quot;</td>
<td>1.437 sq.</td>
<td>.925 DIA</td>
</tr>
<tr>
<td>50</td>
<td>10&quot;</td>
<td>1.437</td>
<td>.375</td>
<td>1.0 x .42 + .6&quot;</td>
<td>1.437 sq.</td>
<td>.925 DIA</td>
</tr>
</tbody>
</table>
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.

**PREFIX**
- EH19L

**MOUNTING**
- Single Pole Mount

**DISTRIBUTION**
- 1: Single Pole Mount
- 2: Type II
- 3: Type III
- 4: Type IV
- 5: Type V

**LEADING 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>Luminaire Initial Absolute Lumen (Lm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70LA</td>
<td>70</td>
<td>350</td>
<td>CW</td>
<td>6,517 / 6,735 / 6,545 / 6,382</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NW</td>
<td>5,938 / 6,124 / 5,999 / 5,874</td>
</tr>
<tr>
<td>85LA</td>
<td>85</td>
<td>350</td>
<td>CW</td>
<td>7,660 / 7,841 / 7,604 / 7,242</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NW</td>
<td>7,164 / 7,372 / 7,241 / 6,922</td>
</tr>
<tr>
<td>110LA</td>
<td>110</td>
<td>350</td>
<td>CW</td>
<td>9,126 / 9,360 / 9,016 / 8,903</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>NW</td>
<td>9,016 / 9,305 / 9,016 / 8,903</td>
</tr>
<tr>
<td>160LA</td>
<td>160</td>
<td>350</td>
<td>CW</td>
<td>13,170 / 13,690 / 12,724 / 12,100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NW</td>
<td>12,308 / 12,802 / 12,370 / 12,111</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)
Specifications

Housing: Fabricated from a one-piece extruded aluminum side panel with flared corners that are internally welded and sealed for weathertightness. A press-formed 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 PMN sockets are porcelain 4kV pulse rated mogul bases. All reflector modules are factory premounted 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 tightly seals 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. Fast field 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 tin-coated zinc conversion coating. 2500 hour salt spray test endurance rating. Standard colors are Black, Dark Bronze, Platinum Silver, Stahlelv C152, 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 polish.

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.

<table>
<thead>
<tr>
<th>Listings and Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL cUL 1598 standards</td>
</tr>
<tr>
<td>IP66 Rated</td>
</tr>
<tr>
<td>25C Ambient</td>
</tr>
</tbody>
</table>

Suitable for wet locations.

Kim Lighting reserves the right to change specifications without notice.

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Version 2.3.2014

Exterior Lighting and Installation
Roadway / Parking Poles and Fixture Datasheets

Page 61
# Standard Features

<table>
<thead>
<tr>
<th>Mounting</th>
<th>Plan View:</th>
<th>Wall Mount:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="#" alt="Diagram" /></td>
<td><img src="#" alt="Diagram" /></td>
</tr>
</tbody>
</table>

EPA:
- 2.1
- 4.2
- 3.5
- 4.5
- 5.0
- n/a

Cat. No.:
- 1A
- 2B
- 2L
- 3T
- 4C
- 1W

### 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 Type Volts
  - 400 HPS 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
- **Cat. No.**
  - 1W
  - No Option
- 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.

#### Polycarbonate Shield
- **Cat. No.**
  - LS
  - No Option
- May ONLY be used with 400HPS in outdoor locations where ambient air temperature during fixture operation will not exceed 85°F.
  - Optional 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.
  - **CAUTION:** Use only when vandalism is anticipated to be high. Useful life is limited by discoloration caused by UV from sunlight and metal halide lamps.

#### Houseside Shield
- **Cat. No.**
  - HS
  - No Option
- 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.

#### Photocell Receptacle
- **Cat. No.**
  - A-25
  - No Option
- 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.

#### Poles
- See Kim Arms and Poles Selection Guide for a complete selection of square and round poles in aluminum or steel.
Bollard Fixture Datasheets

Gardco Bollard

**LED BOLLARD**

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

Featuring  
Motion Response

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 gaskets assure years of trouble free service. The BRM830 and BRM834 are complete assemblies with an aluminum base. BRM831 and BRM835 head only units ship to custom architectural elements. BRM833 and BRM837 luminaries include a concrete base assembly. Gardco’s advanced stack-louver LED technology and Motion Response provide maximized light output and maximum energy savings.

<table>
<thead>
<tr>
<th>PREFIX</th>
<th>HEIGHT</th>
<th>LED CONTROL</th>
<th>LED SELECTION</th>
<th>LIGHTED COVERAGE</th>
<th>VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRM830</td>
<td>42</td>
<td>DR</td>
<td>BRM834</td>
<td>360</td>
<td>347</td>
</tr>
<tr>
<td>BRM831</td>
<td>36</td>
<td>NW</td>
<td>BRM835</td>
<td>360</td>
<td>11&quot;</td>
</tr>
<tr>
<td>BRM833</td>
<td>36</td>
<td>Head Only</td>
<td>BRM837</td>
<td>42&quot;</td>
<td>347</td>
</tr>
<tr>
<td>BRM834</td>
<td>42</td>
<td>11&quot;</td>
<td>BRM838</td>
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<td>BRM835</td>
<td>36</td>
<td></td>
<td>BRM839C</td>
<td>42&quot;</td>
<td>347</td>
</tr>
<tr>
<td>BRM836</td>
<td>36</td>
<td></td>
<td>BRM837C</td>
<td>42&quot;</td>
<td>347</td>
</tr>
</tbody>
</table>

Dome Top  
Bevel Top

LEDs stay at Low Level (9 watts) when no motion is present; LEDs 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 variation of LED voltage (±10%) may occur due to LED manufacturer’s normal variation from specification and ambient temperature.)

**FINISH**

BRP  Bronze Paint  
BLP  Black Paint  
WP  White Paint  
NP  Natural Aluminum Paint  
BGP  Beige Paint  
VP  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 240V through 480V Input meeting ANSI C62.41.2

Gardco保留修改或变更其产品的权利。
## 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 units affix to custom architectural elements. BRM833 and BRM837 luminaries include a concrete base assembly. Gardco's advanced shock-proof LED technology and Motion Response provide maximum light output and maximum energy savings.

### LED CONTROL

- **MR**: Motion Response  
  LEDs stay on Low Level (8 watts) when no motion is present. LEDs increase to full light output (41 watts) when motion detected.

- **CWL**: Constant Wattage Full Light Output  
  Full light output only (41 watts). No motion sensor included.

(Note: A variation of LED wattages (+/- 1%) may occur due to LED manufacturer's forward volt specification and ambient temperature.)

### LED SELECTION

<table>
<thead>
<tr>
<th>Color</th>
<th>Temperature</th>
<th>SCR</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW</td>
<td>6,500K</td>
<td>75CRI</td>
<td></td>
</tr>
<tr>
<td>NW</td>
<td>4,300K</td>
<td>75CRI</td>
<td></td>
</tr>
<tr>
<td>WW</td>
<td>3,000K</td>
<td>75CRI</td>
<td></td>
</tr>
</tbody>
</table>

### LIGHTED COVERAGE

- 360° 180° lighted louvers (Provide reduced backside light)

### VOLTAGE

- **UNIV**: 120V through 277V, 50Hz to 60Hz input

### 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
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 1¼" depth, a 65° 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 III) three 5-LED boards for a total of 15-LED. (Type V) four 5-LED boards for a total of 20-LED. Available in 3500K and 5100K color temperatures.

**Anchor Bolts**: Four ¾" 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 coated zinc immersion 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>Listings and Ratings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>UL or ETL to UL Standards 1598 &amp; 6750*</td>
<td>25C Ambient</td>
</tr>
<tr>
<td>IP46 Rated</td>
<td>FS = Fully Shielded*</td>
</tr>
</tbody>
</table>

*Suitable for wet locations.

**Dark Sky Legislation Compliant**: KIM LIGHTING RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

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### Standard and Optional Features

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Cat. No.</th>
<th>VRB1 Single Function, Aluminum Shaft, Domed Top</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Module</strong></td>
<td><strong>LED – Light Emitting Diode</strong></td>
<td><strong>Source:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ 10L – 10 LED (IES Type I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ 15L – 15 LED (IES Type II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ 20L – 20 LED (IES Type V)</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>0.10 / 0.05 / 0.05 / 0.04</td>
</tr>
<tr>
<td>VRB1 – 15 LED</td>
<td>18</td>
<td>120 / 208 / 240 / 277</td>
<td>0.15 / 0.08 / 0.08 / 0.07</td>
</tr>
<tr>
<td>VRB1 – 20 LED</td>
<td>24</td>
<td>120 / 208 / 240 / 277</td>
<td>0.20 / 0.12 / 0.10 / 0.09</td>
</tr>
</tbody>
</table>

**Finish**
TGIC thermoset polyester powder coat paint applied over a titanated zirconium conversion coating on fixture and shaft.

**Color:** Back Dark Bronze Light Gray Stealth Gray Platinum Silver White Custom Color
**Cat. No.:** □ 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

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**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, alkalis 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><strong>Apache web server</strong>&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>MySQL database</td>
<td><strong>MySQL</strong>&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>PHP</td>
<td><strong>PHP</strong>&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>JavaScript</td>
<td><strong>JavaScript</strong>&lt;br&gt;JavaScript is a scripting language for automating websites.</td>
</tr>
<tr>
<td>Segment controller</td>
<td><strong>Python</strong>&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>Wireless network</td>
<td><strong>ZigBee</strong>&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. <a href="http://www.zigbee.org">www.zigbee.org</a> 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></td>
<td></td>
</tr>
<tr>
<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></td>
<td></td>
</tr>
<tr>
<td>A controller, which controls the lamps, is integrated into every lamp. There are different shapes and designs available.</td>
<td></td>
<td></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>
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<tr>
<td></td>
<td>EN 61347-2-11:2001</td>
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<td></td>
<td>EN 61347-1:2008</td>
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<td></td>
<td>EN60950-1:2006+A11:2009</td>
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<tr>
<td></td>
<td>EMC</td>
</tr>
<tr>
<td></td>
<td>EN 301 489-1 V1.8.1:2008-04</td>
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<tr>
<td></td>
<td>EN 301 489-17 V2.1.1:2009-05</td>
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<tr>
<td></td>
<td>RADIO:</td>
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<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 Luminaires 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 ballasts such as magnetic ballasts and bipolar ballasts as well as electronic ballasts and LED drivers with 1-10V interface or the DALI standard. Each output is able to switch a 1000W load at 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, ensuring security through a VPN. The connection to the Internet is done either to ADSL, GPRS or 3G. Equipped with 2 Digital and 2 Analog In/Outputs 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 actuators, 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.

CoCo (FU/SI/DA) for installing in the pole.

LuCo NX for installing in the lamp.

LuCo PD / LuCo PN for installing on the lamp.

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 fail-safe 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 luminaire 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.
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 idle 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 fallback scenario can be extended to dusk/dawn switching based on ambient light conditions.

2. Energy Saving
   The LuCo firmware has two built-in remote configurable energy savings algorithms:
   Constant Lumen Output CLO compensates the luminance depreciation over time according to the maintenance 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 Information

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
   Horizontal
   Vertical
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 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.

Operating conditions
- Ambient temperature: 0°C to +40°C / -40°F to 104°F
- Relative humidity: 10% to 90%
- Max. housing temp.: 0°C to 85°C

Non-operating conditions
- Temperature: -30°C to +80°C
- Relative humidity: 5% to 90%

Mains connection
- Mains voltage: 230/277VAC ±10%
- Mains frequency: 50/60 Hz ± 5%
- Maximum load current of 8 A
- Required external fuse: ≤ 10 A

Power consumption
- Stand-by wattage: ≤ 0.7 W
- Operating wattage: ≤ 0.9 W
- Accuracy Integrated powermeter: 1% (between 0% and 100% dimming)

Installation terminal
- Tension clamp connection with a 135° outlet direction
- Lever for simple opening of terminal point
- Solid, flexible 0.13-2.5mm² (ECQ/26-14AWG/0.6)
  with wire end ferrule DIN 46228 pt. 1 min 0.25mm² – 1.5mm²
  stripping length 6mm

DALI output Interface
- DALI Compliant to IEC62386 part 101/102
- Load capacity: # DALI lampdrivers
- Protection: Interface is short circuit proof
- DALI voltage: 11.5 to 20.5Vdc
- DALI current: 8 to 20mA

1-10V interface
- Compliant to 1-10VDC IEC60929 (Annex I)
- Load capacity: eight 1-10V lampdrivers
- Load current: Interface is current sinking, max 16mA

Radio Frequency
- Protocol: IEEE802.15.4 / Zigbee Pro Meshnet
- Frequency band: 2.4 GHz (2400.0...2483.5 MHz)
- Range open field (at an installation height of 1.5 m)
  - 300m/1060 ft from controller (to be confirmed at site location)

Housing
- Material: Toyolac® T884-1 ABS RESIN
- Protection class: IP20 (installed condition)
- Standards & Legislation
- Approvals:
  - R&TTE directive 1999/5/EC
  - EMC directive 2004/108/EC
  - LV directive 2006/95/EC
  - RoHS directive 2002/95/EC
  - UL 916
  - Conducted emission: FCC Part 15
  - Radiated emission: FCC Part 15
  - Safety: EN60950-1 / EN 61347-2-11

OWLET Datasheets
Mounting information

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

2. Luminaire Controller Installation
ZigBee/IEEE address
The Luceo-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 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>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>-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% to 80°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-operating conditions</th>
<th>Values</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>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains voltage</td>
<td>110-227VAC ±10%</td>
</tr>
<tr>
<td>Mains Frequency</td>
<td>50/60 Hz ± 5%</td>
</tr>
<tr>
<td>Maximum load current</td>
<td>8 A (880VA@110V, 1,590VA@240V, 2,250VA@277V)</td>
</tr>
<tr>
<td>Required external fuse</td>
<td>10A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power consumption</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand-by wattage</td>
<td>&lt; 0.7W</td>
</tr>
<tr>
<td>Operating wattage</td>
<td>&lt; 0.8W</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>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension clamp connection</td>
<td>with a 135° outlet direction</td>
</tr>
<tr>
<td></td>
<td>for simple opening of terminal point</td>
</tr>
<tr>
<td>Solid, flexible 0.13-2.5mm²(IEC)/26-14AWG(U.S.)</td>
<td>with wire and ferrule DIN 46228 pt 1 min 0.25mm² = 1,5mm² stripping length 5mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DALI output Interface</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>DALI Compliant to IEC62386 part 101/102</td>
<td>8 DALI lampdrivers</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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<tr>
<th>1-10V interface</th>
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<tr>
<td>Compliant to 1-10VDC IEC60929 (Annex E)</td>
<td>8-light 1-10V lampdrivers</td>
</tr>
<tr>
<td>Load capacity</td>
<td>Light current is current sinking max 16mA</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Radio Frequency</th>
<th>Values</th>
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<tbody>
<tr>
<td>Protocol</td>
<td>IEEE802.15.4 / Zigbee Pro Meshnet</td>
</tr>
<tr>
<td>Frequency band</td>
<td>2,4 GHz (2,400,0...2,483,5 MHz)</td>
</tr>
<tr>
<td>Range open field (at an install site height of 5.1 m)</td>
<td>&gt; 300m/1000 ft from controller to controller (to be confirmed at Kalemuch)</td>
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<table>
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<th>Housing</th>
<th>Values</th>
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<td>Material</td>
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<tr>
<td>Protection class</td>
<td>IP20 (installed condition) provides Insulation Class II</td>
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<table>
<thead>
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<th>Standards &amp; Legislation</th>
<th>Values</th>
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<tr>
<td>Approvals</td>
<td>EN301489-17 / EN61000-4 / EN55022</td>
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<table>
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<tr>
<th>Conducted emission</th>
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</thead>
<tbody>
<tr>
<td>FCC Part 15</td>
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<th>Radiated emission</th>
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<td>FCC Part 15</td>
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<th>Safety</th>
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</thead>
<tbody>
<tr>
<td>EN60950-1 / EN 61347-2 / 11</td>
<td></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.
PART 6 OVERHEAD POLES WITH TRANSFORMERS

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

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

40' CLASS 2 POLE

FINISHED GRADE

5/8 X 8' GROUND ROD

GROUNDED GROUND

RIDGE PIN

15KV PIN INSULATOR

8' CROSSARM

WOOD CROSSARM BRACE

44' TYP

18' TYP

15' TYP

50' CLASS 2 POLE

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.
Design Standard

Hydronic Piping in Buildings

Detailed specifications follow.

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

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 & 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 Prysium
   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.

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**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). Busses 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 °C average winding temperature rise over a 30 °C average, 40 °C 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 ethelene 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.
 Replace or repair wet or damaged insulation as directed by Engineer or product installation requirements.

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.

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

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.

Restore all finished grades and improvements as detailed.

PART 3 TYPE OF CONSTRUCTION

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

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.

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.

The insulation shall have a thermal coefficient of heat conductivity (K factor) of no more than 0.60 BTU/hr./ft²/°F/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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</thead>
<tbody>
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<td></td>
<td></td>
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</tr>
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</table>

Based on thermal conductivities (K factors) of Gilsulate 500xr 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

Overall Design Criteria

The FibreShield 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”)

UTILITIES
McGARD

SANITARY

UTILITIES
McGARD

ELECTRICAL

UTILITIES
McGARD

UPPER INSERT

CENTER INSERT

McGARD

THERMALS

UTILITIES
McGARD

STORM

UTILITIES
McGARD
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: 8705TSAxxxC1W0N0Q4D1 (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 cablesTSX 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: 3051SFP2S015A3SXXXXD52DA1A5WDQC7Q4E5 (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