DIVISION 16

ELECTRICAL

SECTION 16050: BASIC ELECTRICAL MATERIALS AND METHODS STANDARDS

I. GENERAL

A. Basic Electrical Design shall insure that the building power factor is 0.9 or greater.

II. MATERIALS

A. All light switches and receptacles shall be specification grade, 20 Amp. Back or side wired with tightening screws only. No push-on type connectors.

B. Aluminum wiring is not allowed on campus.

C. Electrical Panels:

1. Panel number shall be identified by an engraved plastic nameplate attached to the outside of the panel with screws.

2. Panel legends shall be typed with exact locations of areas fed.

3. Panels shall be 42 circuit with bolt-on circuit breakers unless otherwise approved by the UCSC Electrical Engineer.

4. Panelboards serving multiple areas shall not be located in private offices, labs., etc.

5. Panelboards located in storage closets shall be located in areas likely to remain accessible (e.g., behind the door).

6. Panelboards that exceed 3 feet in length shall have the cover hinged for easy access.

7. Switchboards, panelboards, and motor control centers shall utilize circuit breakers, not fusible switches.

D. Conduit:

1. Non-Residential Areas: EMT (electrical metal tubing) concealed in walls shall be utilized for all power, communications, fire alarm, lighting, cable TV, etc., wiring. 3/4" minimum.

2. Residential Areas: Conduit may be deleted at the direction of the Project Manager.

3. Insulated throats shall be used for all conduit connectors. Insulating bushings shall be used for all conduit ends.

4. EMT fittings shall be steel, compression type. As an alternative, compression screw-type with self-locking screws that activate a steel compression ring may be used.

5. Flex conduit shall be allowed only for vibrating equipment, expansion joints, or for final connections to recessed light fixtures.

6. All ends of conduits shall be cut square and reamed.

7. All communications conduit that passes through firewalls shall be sealed with fire stop putty after all station wire has been installed.

E. Wire Colors

1. 120 / 208 V

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

2. 277 / 480 V

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	White or gray
Ground	Green

3. 12 KV

Phase A	Yellow
Phase B	Red
Phase C	Blue

F. Transformers shall be low temperature rise "energy efficient type".

G. Wire shall be copper, THHN/THWN.

H. Outlet boxes:

1. Shall be minimum 4" square with appropriate rings.

2. Boxes installed on the inside channel of metal studs shall be adequately braced to avoid twisting.

3. Note provisions concerning outlet boxes in Part II E, Acoustic Privacy.

I. Disconnect switches shall be provided at all mechanical equipment not visible from panelboards, MCCs, etc. Do not rely on ability to padlock circuit breakers.

J. Motor Controls

1. All motor controls to have NEMA rated starter with HOA switch, running light, EMS interlock, and smoke detector interlock.

2. Provide a detail on the drawings showing this wiring and specifying responsibility for each component.

3. For mechanical equipment intended to be manually switched, provisions for manually switching should be called out on the electrical drawings.

4. Electrical engineer should confirm early in design, mechanical equipment not being furnished with integral starters and provide required motor starters under the electrical section of work. Equipment intended to be automatically controlled should be provided with magnetic starters.

5. VFD's should be specified in the electrical section of work, not mechanical. We continue to run into situations where the VFD's are not well integrated into the electrical motor controls and power wiring design when the mechanical section attempts to cover VFD's. Required motor torque characteristics and controls interface should be coordinated between Electrical and Mechanical (It is almost always variable torque with 4-20 ma speed control signal for HVAC applications.)

6. VARIABLE FREQUENCY DRIVES

    a. Start up by factory trained technician with startup documentation provided to the University's Rep.
    b. Interlock with local motor disconnect switch. (To shut down drive in event that someone pulls the disconnect without first shutting down the drive.)
    c. Three contractor manual bypass with overload protection.
    d. Input circuit breaker.
    e. Input line reactor
    f. 4-20 MA speed input, run and fault contacts to signal back to DDC
    g. Drives need to be placed under cover in dry location.
    h. Insure compatible motor is specified.
    i. Saftronics or equal.
    j. VFD rated motors with minimum insulation rating or 2500 V.
    k. Provide adequate ventilation for the internal transistors and enclosure.
    l. locate the drive as close as possible to the motor but in no case more then 200 feet without designing additional line reactors into the system.
    m. Control circuits to be isolated from the same source as drive input via isolation.
    n. Use PWM type drives.
    o. Use IGBT transistors.
    p. Power factor for the drive to be unity.
    q. Drive should have it's own internal PID control capabilities.

K. Surface Raceway for Communications

1. Surface raceway shall be secured at 2'-0" intervals (raceway wider than 2" shall be secured with 2 screws at each attachment point) with wood screws into wooden framing or molly bolts into sheetrock or plastic inserts with pre-assembled drive screw for concrete (ITT-HOLUB "HI-DRIVE" nail anchors, no known equal) Powder driven anchors are not acceptable. The use of adhesives for fastening to any surface is not allowed.

2 Screws used in fastening surface raceway shall be no less than 1" in length.

3. The proper support and joiner clips, as called for by the manufacturer, for securing surface raceway to walls or floors are to be used per the manufacturer's instructions.

L. Control wiring shall be NEC Class 2 cabling. Coordinate with University's representative if conduit is required. Coordinate with Division 15.

III. EXECUTION

A. Interruption of Services:

1. Before making any high voltage connections, notify Owner in writing at least two weeks in advance. Such work shall be performed at such times as designated by Owner.

2. Before making any low voltage connections that require power interruption to existing facilities, notify Owner at least one week in advance.

3. All service interruptions shall be performed by the Campus Electrical Department.

B. Underground cables shall be looped and racked in all pull boxes.

C. Receptacles dedicated for custodial equipment use shall be installed in appropriate areas and shall be provided with power from a panelboard as far away as possible from panelboards serving electronic equipment. Each receptacle will be labeled "custodial use only".

D. Splicing of wires #10 and smaller use plastic insulated caps Buchanan, 3-M Scotch-Lok, or equal. Larger size conductors use approved compression connectors. Do not use split bolt type. All splices shall be made in outlet or pull boxes. All splices in underground wiring system shall be epoxy encapsulated with Scotch splice kit, flooded shrink tubing, or equal.

E. Office power receptacles shall be 4 plex and shall be located on all 4 walls.

F. Emergency Power panel-boards shall have cover painted yellow; receptacles shall be yellow.

G. Panelboards shall have a 2" conduit stubbed above ceiling level for future expansion.

H. Provide 4" high concrete equipment pad beneath switchboards, motor control centers, transformers, etc.

I. Receptacles shall be marked with Panel and circuit # of origin via a transparent tape lettering machine such as Kroy or Merlin.

J. Receptacles in areas likely to serve copy machines, laser printers, coffeemakers, etc. shall be served by dedicated circuits.

K. Hallway receptacles shall be spaced 50 feet max. On center.

L. Provide receptacles at all elevator lobbies and at every other stair landing.

M. Where cable trays are being installed, provide coordination between the mechanical systems installation and cable tray space requirements such that the cable tray is accessible from below

and a minimum of 12” clear is provided over top and at least one side of the cable tray to allow for future cables to be set in place.

SECTION 16100: UNDERGROUND DISTRIBUTION STANDARDS

All power and communications site wiring shall be routed underground in conduit. Refer to Part III Site Requirements and Specification Section 01530 Tree Protection for other requirements affecting underground distribution.

1. UNDERGROUND DUCT BANK

A. The underground service conduits shall be installed in a concrete envelope, or sand with a concrete cap. See Appendix detail sheets 16-5 & 16-6. Verify choice of methods with Project Manager.

B. All conduits shall be 4" schedule 40 PVC or P&C duct rated for concrete encasement. Risers from below grade shall be rigid wrapped galvanized steel or schedule 80 PVC.

C. Electrical and Communications Duct:

1. All electrical power and communication s ducts shall be constructed with cast in place concrete encasement around 4" non-metallic conduit (no direct burial). Optionally for secondary power and communications systems (see project manager) a concrete cap may be installed over sand encased conduits.

2. Concrete for encasement shall be class B with 28 day compressive strength of 2000 P.S.I. and colored with red pigment.

3. Ducts shall terminate with bell ends.

4. All underground conduits shall have yellow warning tape stating: "Warning Electrical Wiring" or similar buried 12" below grade in the same trench as the conduit.

5. All splices shall be sealed in epoxy encapsulated splice kits.

C. The number of conduits in each duct bank shall be determined by the requirements and approved by the Project Manager.

D. Provide one spare power and one spare communication conduit in each duct bank. Communications conduits will include three 4" conduits minimum as follows:

1. Telephone (T).
2. Computer / data (C) and cable TV (TV).
3. Fire alarm (FA).

E. Conduits shall be sloped to drain to pullboxes.

F. All conduits, including those with new cables installed, shall have a nylon pull rope installed.

2. CONCRETE PULLBOXES

A. Provide separate precast concrete pullboxes, with lids labeled "communications" (for TV, telephone, data, fire alarm) or "power".

B. Pullboxes for site power and communications shall be inside dimensions 30" x 60" x 36” deep, minimum. This dimension shall be increased if high voltage junctions are installed. Install on gravel pad and provide drain. Pullboxes shall have concrete bottoms and galvanized steel lids.

C. Pullboxes in traffic areas and along roads shall be designed and installed for H20-44 loading.

D. Pullboxes shall be located and provided with grade rings as necessary to ensure that water is drained from conduits.

E. Pullboxes shall be installed to minimize surface drainage entry as follows:

1. Pullboxes should not be located in paths or streets. If such location cannot be avoided, pullboxes should not be located in low spots or drainage channels.

2. Pullboxes not located in paths or streets should be installed so that the top is approximately 2" above final grade.

F. All cables in manholes and pullboxes shall be formed around the sides of the pullbox and tie-wrapped to racks with rack arms and ceramic insulators attached to the sides of the pullbox.

G. All underground conduit shall have a correctly sized mandrel pulled through it before cables are installed.

H. Non-slip lids shall be provided for pullboxes in sidewalk areas. Use concrete or fiberglass-no metal lids in sidewalks.

I. Electrical and Communication Manholes:

1. Manholes shall be sized to accommodate all feeders, wiring, switching, and extensions to future buildings.

2. Manholes shall be reinforced concrete, cast-in-place or precast, and designed for H2O-44 wheel loading. Provide knockouts for future duct connections.

3. Electrical manholes shall be 8-sided/octagon design. Minimum inside clear width shall be 8'-0", minimum inside clear height 8'-0", length will vary depending on present and future switching requirements of the manhole but minimum inside net length shall be 9'-0". Manhole covers shall conform to drawings in Part VI.

4. Manholes shall be provided with pulling eyes, Unistrut inserts for support materials, and a ladder.

5. Provide gravity drains where possible for all manholes. Provide sump pumps where gravity drains are not possible.

3. Work in existing campus manholes:

A. Contractor shall protect from damage existing UCSC and utility company cables and facilities that are present underground and at cable closets. Damage to such cables shall be promptly reported and repaired at no cost to the University. Splice cases shall not be used as steps to enter/exit manholes. Contractor shall provide ladder for manhole access.

B. Contractor shall follow OSHA guidelines in working in manholes including taking air samples of manhole air quality before entry and at regular intervals. Contractor shall provide a person to observe the work from outside the manhole at all times. This person shall carry a radio or telephone to summon emergency assistance. This work shall be coordinated by the University's Representative with the campus Environmental Health and Safety office.

C. Contractor shall provide barricades and traffic control as necessary to protect persons and vehicles in the vicinity of open manholes.

SECTION 16300: HIGH VOLTAGE DISTRIBUTION STANDARDS

I. GENERAL

A. Electrical Distribution System

1. The campus primary electrical distribution system is a primary selective radial system, 12,000 volts, 3 phase, ungrounded neutral with three separate campus distribution feeders (derived from a single source). Loop feed building substation switches are used to switch feeders without power interruptions. The primary system is underground and no aerial distribution is permitted on campus.

2. Building electrical systems should be 480-277 volt, 3 phase, 4 wire and/or 208/120 volt, 3 phase, 4 wire for lighting and power unless otherwise directed by the Office of Campus Facilities.

3. Connection to the existing campus electrical system shall be coordinated with the Project Manager. Note that connection may not take place at the closest manhole. Generally, two feeders are available in the vicinity of the project, and these two feeders will be brought to each building via sectionalizing switches.

4. Contractor shall submit high voltage cable splicer experience 30 days before splices or terminations are made in high voltage cables. Experience during the past 3 years shall include at least 3 projects that include performance of splicing and terminating cables of the type and classification provided under this contract.

5. The secondary main circuit breaker of all substations and pad-mounted transformers (or alternatively the main switchboard circuit breaker) shall be able to be opened and closed by the energy management system.

6. Transformer size shall be limited to 1000 KVA maximum for proper coordination with primary protection.

II. MATERIALS

A. High Voltage Cable and Connectors:

1. All high voltage cable shall be shielded single conductor rated MV-90, 15 KV, ungrounded neutral. The conductor shall be copper size 4/0 AWG. Class B concentric stranding and shall have a semi-conducting layer between conductor and insulation. The insulation shall be ethylene propylene rubber, 220-mil thickness, which shall be ozone, moisture and heat resistant. Insulation shielding shall consist of a layer of semi-conducting material with either drain wire or copper shielding tape overall. The outer jacket shall be PVC and be water, oil, alkali, and sunlight resistant.

2. All cable shall be copper conductor and shall be manufactured, factory tested, and field tested in full compliance with all applicable sections of I.P.C.E.A., N.E.M.A., A.S.T.M., U.S.A.S.I., I.E.E.E. and A.E.I.C. standards.

3. High Voltage Separable Connectors: Provide 600 amp ESNA-type connectors with insulated bushings General Electric "Suremake", Elastimold or equal. Provide

capacitance test point. Connectors shall satisfy requirements of IEEE 386 and shall be designed for use with the specific cable and type of installation required. The manufacturer shall provide all components and at least two copies of complete directions for assembling, and putting the unit into service, (one of which shall be submitted for record). All switch 600A terminations shall be provided with a capacitance tap for voltage testing and a 200A grounding terminal 15KV kits from Elastimold 656ETP-WOX-DRG-SG2 or SG3.

B. Building Substation:

1. The building substation will generally consist of: load interrupter switches, transition bay, transformer, secondary junction box.

2. Load interrupter switches shall be outdoor (or indoor) type, metal clad, rated 13.8 KV (95 KV BIL) for use on a 12,000 volt, 3 phase primary service. The apparatus shall consist of two air interrupter switches, a duplex switch arrangement, and each switch shall consist of a stationary, 3 pole, group-operated air switch mounted within a free-standing, weatherproof (indoor) enclosure. There shall be mounted in the bottom compartment of one switch a set of three current limiting fuses connected common to the load side of the switches. Each complete assembly shall be rated 13,800 volts, 600 amperes continuous, 600 amps load interrupting, not less than 40,000 amps momentary at 12,000 volts, and shall be rated to close in on a fault of 40,000 amps asymmetrical at 12,000 volts. Provide a spare set of fuses. Each section of outdoor switches shall be supplied with a 250 watt strip heater to reduce condensation. Incoming high voltage terminations at these switches shall utilize stress cones.

3. Each switch shall be three-pole, single-throw, and shall be assembled using NEMA standard components, spacing, arrangement and mounting. Live parts, except contacts, shall be copper alloy totally free of aluminum. Contacts shall be silver, silver coated, or silver alloy.

4. Each switch shall be group operated by a handle external to the switch compartment. The operating handle shall have a spring-assisted mechanism that provides quick-make, quick-break contact action totally independent of manipulation by the individual actuating the mechanism.

5. Each switch operating mechanism shall be fitted with a Kirk-key interlock. The key interlocks shall function to retain the key when the switch is closed, thereby permitting switch operation, and shall release the key when the switch is open, thereby preventing switch operating. The intent of this provision is that under normal circumstances, only one switch can be operated at a time. A spare Kirk-key shall be provided. The fuse compartment door will be Kirk-key interlocked with each switch such that both switches must be opened before the fuse compartment door can be opened.

6. The transformer shall be *mineral oil filled* 3 phase, 60 cycle, KVA rating as required with a 12000 volt delta primary winding having two 2-1/2% taps above and below normal voltage. The secondary winding will be 3 phase, 4 wire, wye grounded. Provide accessories as listed for Pad Mounted Transformer.

7. Provide a set of 3 spare fuses to the Campus Facilities Electrical Department.

8. Provide flexible braid connection between transformer secondary connections and secondary distribution section.

9. Provide factory tests including the following: ratio, polarity, phase relation, no-load loss, excitation current, impedance voltage, load loss, applied potential, induced potential, leak, resistance measurement.

C. Pad Mounted Transformers:

1. A pad-mounted transformer may be used instead of a building substation for residential areas. Such a unit shall contain the transformer, primary switch, current limiting fusing, secondary circuit breaker, and separate compartments in a weather resistant, tamper resistant enclosure, arranged for padlocking. Transformer shall conform to ANSI C57.12.26. High voltage and low voltage compartments shall be isolated from each other in a manner to require a separate unlatching or unbolting action to give access to the high voltage compartment. Manufacturer shall be Balteau Standard, ABB or G.E.

2. Transformer: Dead front, three phase, two winding, 60 Hz, 65 degree C rise, oil insulated, self-cooled type rated as shown on drawings, with two 2-1/2% full capacity taps above and below rated primary voltage. Basic Insulation Level shall be 95 KV. High voltage winding shall be 12,000 volts delta. Low voltage shall be 120/208 or 277/480 grounded wye, 4-wire. Transformer tank shall be sealed except for bolted handhole access. Provide lifting lugs. Provide external tap changing for de-energized operation only. Locate the changer control handle within the high voltage compartment and provide position indicator and method of securing the control handle against unintentional operation. Tank construction: liquid immersed transformer shall have a totally bolted gasket cover. Liquid shall have sampling valve, accessible while energized.

3. The transformer tank and compartment shall be assembled as an integral unit for mounting on a pad. There shall be no exposed screws, bolts, or other fastening devices that are externally removable. There shall be no openings through which foreign objects such as sticks, rods, or wires might contact live parts. The construction shall limit the entry of water (other than floodwater) into the compartment so as not to impair the operation of the transformer.

4. Full-height, air-filled high voltage and low voltage terminal compartments with hinged door shall be located side-by-side separated by a steel barrier, with the high voltage compartment on the left. To facilitate making connections and permit cable pulling, the doors and compartment hood shall be removable. Removable doorsill on compartments shall be provided to permit rolling or skidding of unit into place over conduit studs in foundation. A 250-watt strip heater shall be mounted in the primary and secondary compartments to reduce condensation.

5. Mineral Oil: ASTM D 3487, Type II tested in accordance with ASTM D 117. Minimum Impedance 5%.

6. Transformer: Provide the accessories listed below:

   a. Drain and sampling valves, accessible while energized.
   b. Filter press connections.
   c. Ground pads.
   d. Provision for lifting and jacking.

e. Top liquid dial-type thermometer without alarm contacts.
f. Pressure vacuum gauge, readable while energized.
g. Pressure relief device.
h. Fill plug, accessible while energized.
i. Liquid level gauge, accessible while energized.

7. Circuit breakers: Provide molded case circuit breakers conforming to UL 489:

    a. Breaker must be thermal-magnetic type common trip with one operating handle and solid state 7 or 9 function trip unit, General Electric Versa-Trip, Westinghouse Seltronic, or equal.
    b. Adjacent poles must be connected to phases A, B, C, respectively.
    c. Minimum symmetrical interrupting current rating shall be as indicated.
    d. Connectors must be designed for use with copper, copper clad, or aluminum conductors.
    e. Mounting shall be "bolt-on" type, removable without disturbing any other breaker.

8. Primary Switching: Provide internal, oil-immersed, (2) 2-position selector load break switches, mounted internally in the transformer tank. The switches shall consist of two 2-position (on-off) switches. Minimum switch ratings shall be load-break and make, 400 A; make and latch, 10,000 A symmetrical. Provide current limiting fusing in dry well, air-insulated, non-load break fuse holders inserted in the transformer tank. Provide an integral warning notice and safety baffle mechanically interlocked with the high voltage switch to prevent fuse removal unless the transformer is de-energized. Fuse values shall be 150 percent of full load circuit. Provide spare set of fuses. Provide apparatus bushings for connection of incoming cables via 600 amp separable connectors.

    a. "Weak-link" primary fusing is not acceptable in lieu of current limiting primary fusing.

9. Provide factory tests including the following: ratio, polarity, phase relation, no-load loss, excitation current, impedance voltage, load loss, applied potential, induced potential, leak, resistance measurement.

D. Underground Sectionalizing Switch

1. Primary Sectionalizing Switches: The sectionalizing switches shall be SF6 filled type rated 15,000 volts, 600 amperes, load-break 30,000 amperes momentary. Switch shall be 3 or 4-way type, and each way shall be 3-pole, 3-position, "on-off ground" position. Cable entrances shall be through the bottom of the tank and shall be apparatus bushings with ESNA type 600 amp elbow connectors for single-conductor #4/0 AWG cables. Handle on each way of each switch shall be fitted with a spring operator with Cock-N-Trip mechanism: Nelson Arc-Whipper, no known equal.

2. The switch shall be mounted on a 48" frame, and shall be complete with SF6 gas. The inside of the tank shall be painted white. The switch shall be fitted with pressure gauge and valve for filling.

3. The switch shall be furnished with provisions for Kirk key interlock on the outside ways of the switch and shall prevent motion of this way to the "ground" position without the key (which will be released only when existing sectionalizing switch on the supply side is locked in "off" or "ground" position.)

4. In addition to Kirk key interlocks and provisions for future interlocks, all ways of the switches shall be capable of padlocking in any position: "on", "off", or "ground".

5. A new shop drawing is to be submitted to the University (as per Section 01300) for approval prior to manufacture.

E. Above Ground Switches

1. Pad mounted air insulated switches shall be deadfront, 600 Amp continuous current on switch side, 200 Amp on fuse side. 12,000 Amps asymmetrical; 19,000 Amps asymmetrical momentary current. 600 Amp apparatus bushings. Side operated external operating mechanism. Oversized viewing windows so that break is easily visible. Coal tar undercoating. Chance AIS Series, S&C Electrical Equipment Co. or equal.

2. Alternatively, use SF6 puffer switches. Joslyn, G &W, or equal.

F. Faulted circuit Indicators- submersible, mechanical indicating disc, cable mounted, stainless steel, manually resettable. Kearney/Horstmann #H317570-04-300 (no known equal). Where used: On all 3 phases of the load side of all splices or multiway switches.

III. EXECUTION

A. High Potential Tests:

After cables are installed, a high potential test shall be performed on each conductor. An initial voltage shall be applied and increased in no less than 5 uniform steps up to the maximum test voltage. The minimum time at each step shall be no less than required for test current to stabilize. The high potential test shall be AC or DC. If an AC test is performed, the applied voltage shall be 60 Hz. If the applied voltage is interrupted at any time during the test on a conductor, the test shall be started again from the beginning.

Test potentials shall be as follows:

	Nominal Cable Rating	DC Test
Initial Voltage	15 KV	15 KV
Final	15 KV	63 KV
Hold final voltage for (minutes)		5

Report of Test Results: Reports of voltage test results shall be submitted for review with three copies of each report prepared in the following format and detail:

1. A separate 8-1/2 by 11 inch report sheet shall be prepared for each separately tested section of high voltage cable.

2. Each report shall be headed with the project identification.

3. The following additional data shall appear on each report sheet:

   Date
   Name of operator performing test
   Company operator is employed by
   Section of cable tested
   Type of cable insulation
   Cable length
   Nominal rating of cable
   Cable manufacturer and product identification
   Size of conductor
   Identification of test equipment
   Whether AC or DC test

4. The test results shall be plotted on a log-log graph and shall have microamperes on the left and kilovolts across the bottom. The graph shall also provide a current vs. time test to be recorded in 1-minute intervals after final test voltage has been reached.

5. Each test report shall be signed by the operator of the test equipment.

6. Each report sheet shall be endorsed by the contractor or his authorized representative.

B. Insulation Resistance Tests: Electrical insulation resistance tests shall be made by the Contractor in the presence of the Architect for all new sectionalizing switches using a constant voltage magneto generator capable of measuring 2,000 megohms. Tests shall be made between phase conductors and grounded phase conductors. Insulation resistance shall not be less than 750 megohms. The Contractor shall furnish the Project Manager with a record of all insulation resistance measurements for distribution to UCSC Utilities Dept.

C. Cable shall be looped and racked in all pull boxes and manholes.

D. All outdoor terminations shall be covered with high-voltage silicone tape.

E. Grounding

1. A #2 AWG copper ground wire shall be installed with each of the feeders and it shall be connected to the existing grounding system in the manhole, the grounding system at the pad mounted switches and the building grounding system. All cable shields shall be connected to this ground.

F. Field testing of transformer and switches

Shall be conducted according to NETA Acceptance Testing Specifications 1995. Test shall include, but not be limited to, the following: insulation resistance tests, turns ratio test, insulation power-factor/dissipation factor test, excitation current, resistance of each high voltage winding in each load tap-changer position, core insulation resistance, oxygen in nitrogen blanket, oil sample (dielectric breakdown, specific gravity, color, visual condition, ppm water, dissipation or power factor)

SECTION 16430: METERING STANDARDS

I. GENERAL

A. Electric Metering

1. All buildings shall be provided with a separate power/power quality meter at the service entrance on the low voltage system.

2. Provide area metering at each building for the following building classifications: (Verify with Project Manager.)

a. Academic Buildings
b. Housing
c. Food Service
d. Parking lots (verify with Project Manager)
e. Other areas as determined for specific projects.

3. Provide separate metering for path and street lighting.

4. It is desirable to have the KWH meters grouped at the main distribution panel within a building or building complex.

5. Current transformers will be verified as to direction and polarity before being energized so that necessary values will be positive.

6. Test switch should be directly above or below meter.

7. Potential transformer for the meter power source shall be fused, switched and derived from the source being measured.

8. Design and specify Lantronix serial to Ethernet converter with power source, preferably on generator power. Connection to campus SCADA via the closest ITS data network closet shall be provided.

9. Meters shall be programmed to trend KW, KWH, Volts, Amps, KVA.

II. MATERIALS

A. All hardware, power, terminations and programming shall be provided to fully commission the power meter including it’s communication to the SCADA front end.

B. The meter constant shall be printed on the faceplate (it shall include the effects of potential and current transformers).

C. The meter shall be a multi-function electronic meter Power Measurement Co. #7350 to match existing networked metering equipment. Meter functions shall include: voltage, current, KW, KVAR, PF, Frequency. Provide SCADA network connection using Lantronix:

UDS1100 device server, US domestic power 120 VAC power supply
Part Number: UD1100001-01

DB25M to RS485 and 9-30 VDC power input screw terminal adapter
Part Number: 500-171-R

III. EXECUTION (not used)

SECTION 16500 - LIGHTING STANDARDS

I. GENERAL

A. All interior lighting shall utilize fluorescent or high intensity discharge sources. Incandescent lighting may only be used if written justification is approved by the Assistant Vice Chancellor.

B. Exterior Building Lights shall be fluorescent or high pressure sodium and shall be controlled by the campus Energy Management System (EMS).

C. Self-powered exit signs relying on radioactive elements are not allowed.

D. Minimal lighting with keyless fixtures and switching at the access opening should be provided at those parts of crawl spaces where fire sprinklers are required or clear height exceeds four feet.

E. Details shall be provided on the drawings to show seismic requirements for pendant mounted light fixtures.

F. Light fixtures shall be chosen and located to allow easy maintenance.

II. MATERIALS

A. Electronic high frequency ballasts shall be utilized for all classroom, office, living areas, etc. to minimize noise and reduce energy consumption. Noise from the lighting system in these areas shall not exceed 24 dbA for an installation with 50 footcandles nominal light levels, 20 dbA background noise levels and enclosed fixtures.

B. Fluorescent lamps shall be energy saving type T-8, SP-35.

C. Use L.E.D. type exit signs.

D. Lighting control panels that sweep interior lights off to comply with Title 24 energy regulations shall use a BMS contact input to enable the start of the sweep off period and to disable the end of this period. Wattstopper SWS panel with BMS interface option. NO INTERNAL CLOCKS.

III. EXECUTION (not used)

SECTION 16530: EXTERIOR LIGHTING STANDARDS

I. GENERAL

A. Lighting shall be provided for safety only. Decorative lighting shall be used only upon approval by the Campus Architect of a written justification submitted early in the design process. Such justification may include: lighting is necessary for public performances (in this case, lights shall be switched separately from safety lighting) or to achieve a limited effect at the building entrance. Refer to LRDP for lighting considerations and wildlife. Emergency egress lighting with required backup power source shall be provided to major roadways.

B. Path and Street Lighting:

1. 70 watt, 120 volt, high pressure sodium lamps shall be used in path lights and 150 watt, 277 volt, high pressure sodium lamps shall be used in street lamps.

2. Each fixture shall be fused with a time delay fuse in a weatherproof holder. Fuse shall be located in the base or in the base pull box.

3. Street and path light assignment numbers (based on sector map location) shall be stenciled on the base of path and street lights. Numbers shall be determined by the Project Manager and shall match the campus standard.

4. Lighting control circuits shall be on a circuit separate from the lighting branch circuits to minimize lighting disruptions.

5. Site lighting shall be scheduled on and off by the campus energy management system (EMS).

6. Site lighting shall be metered separately from other power.

7. Street lights shall have a concrete pull box installed adjacent to each fixture with conduits and wiring terminating in this pullbox.

8. No tree mounted lights allowed.

9. Site lighting pullboxes shall include a concrete bottom with drain hole.

II. MATERIALS

A. Refer to Standard Details in Part VI of this Handbook for standard campus path and street lights, including bases. Note that specific projects may specify lower level path lighting or other special requirements at particular projects. Verify with the Project Manager.

B. Street, and parking lot lights shall be die cast aluminum, 150 high pressure sodium, bronze finish, glass lens, aluminum 4" x 4" x 20' pole, RUUD PR2515M to match existing. Path light fixtures shall utilize globe type fixture as shown on attached detail or 70 watt version of RUUD fixture above.

C. Fluorescent fixtures shall utilize F40 or PL type lamps.

III. EXECUTION

A. Underground splices shall be insulated with epoxy encapsulation splicing kits.

B. Space parking lot light fixtures 30" from curbs or wheel stops to avoid car bumper damage.

SECTION 16600: EMERGENCY AND STANDBY POWER UNITS

A. EMERGENCY POWER UNITS shall be natural gas and propane/air fueled, four cycle, naturally aspirated, designed to operate at 1800 rpm. STANDBY POWER UNITS shall be natural gas, four cycle, naturally aspirated, designed to operate at 1800 rpm. An internal combustion engine >25 bhp, regardless of fuel type, must be certified in accordance with 40 CFR Part 60, §60.1 - §60.5430 and labeled with the EPA Engine Family Name that corresponds to the year of engine manufacture. In lieu of EPA certification, engines less than 500 bhp may demonstrate compliance with emissions standards by meeting EPA and local Air District performance criteria through an initial source test.

B. Provide auxiliary contacts on the transfer switch and utilize the EMS to monitor *and control* switch operation.

C. Provide emergency power to the following equipment as a minimum:

EMS (Repeaters and Excel Plus panels at a minimum) & FA Panels
Telephone switch and associated air conditioning (if present)
Egress lights including exterior stairs.
Mech/electrical room lights and receptacles
Exterior substation lights and receptacles
Selected equipment and fume hood fans as identified in the program

D. Provide two position maintained contact switch on the automatic transfer switch: "Test" and "Automatic". The "Test" position simulates power failure with transfer to "emergency" position. To prevent the unauthorized operation of exterior mounted switches, test switch shall be either key operated or contained in a locked area.

E. Exterior mounted automatic transfer switches shall contain a thermostatically controlled strip heater.

F. Provide a four-hour full load field test of generator.

G. Coordinate with mechanical engineer to provide required natural gas inlet pressure of approximately 11" w.c. and gas meter.

H. Provide seismic rated spring isolators at base attachment to pad.

I. Provide remote start with status connection from the campus energy management system.

J. Submit heat rate, fuel consumption, and emissions data necessary for the university to apply for and receive Authority to Construct and Permit to Operate from Monterey Bay Unified Air Pollution Control District. Generator must include BACT as determined by MBAPCD.

K. Provide automatic transfer switch with a switched neutral and ground neutral as required for "separately derived system".

L. Contractor to schedule with Project Manager load testing and training. After successful operational test, Contractor shall schedule with Project Manager and campus EH&S representative an inspection by Monterey Bay Air Pollution Control District.

SECTION 16720: FIRE ALARM SYSTEMS STANDARDS

Typical specification follows:

I. GENERAL

A. All new construction is to conform to the Siemens XLS system on campus as described in the following Attachment to this Section.

B. Note that the following Attachment is to be reviewed and modified on a project by project basis. All panels, etc. required may not be applicable to some remodels or additions.

C. All buildings built with the older (obsolete) fire alarm system (all Larse and Gamewell panels) will not be allowed to expand or remodel using such equipment unless specifically approved by the Project Manager and the Campus Fire Marshal.

D. Smoke detectors and heat detectors may be non-addressable, zoned by building wing and by floor through a TRI module.

E. It is desirable to include provisions for connecting the fire alarm system to the HVAC system so that smoke and fire can be contained.

F. Dormitories shall utilize smoke detectors in the bedrooms, corridors and stairwells. In the student rooms, the intent is to minimize false alarms by utilizing a combination smoke detector/heat detector. When activated, the smoke detector would sound an internal siren only. The heat detector portion would be monitored by the campus fire alarm system. Reverse polarity will be applied to bedroom smoke detectors to sound internal siren when a system alarm is received. Power *to detectors* will be supervised *independently* by an end of line relay. *For ADA rooms, provide TRI connected to smoke detector contacts as supervisory alarm. Provide strobe controlled by ICP.*

G. Smoke detectors in areas that are difficult to access (e.g. Dining Hall ceiling) and duct smoke detectors should be addressable.

H. Connections to existing fire alarm system shall be performed in the presence of a University Fire Alarm Technician. One week prior written notification of such connection shall be supplied.

I. Design of the fire alarm system should generally be based on current regulations of CCR Title 24 or current edition of NFPA National Fire Code, whichever is more restrictive. Additionally, the requirements of the Americans with Disabilities Act (ADA) shall be implemented.

J. Provide smoke detectors in exit corridors and stairwells for non-residential buildings without sprinklers. In non-residential buildings with sprinklers, the Fire Marshal may require smoke detectors in these areas to serve as alternate means of protection. Have the UCSC project manager check with the Fire Marshal early in the design process.

K. Duct detectors shall be addressable and shall be supplied with a relay base to shut down fan operation. Do not use EMS to control fans based on smoke detection.

L. Configure elevator recall for alternate floor recall per Section 14000 of these standards.

M. Consultant providing plans for design/build fire alarm bid shall provide floor plans showing devices and riser diagrams showing interconnection of devices. For retrofit installations, raceway means and methods shall also be shown.

N. Designer shall be aware that horn audibility in interior suites and similar spaces has been a problem in past designs. The installation shall fully comply with NFPA audibility requirements.

O. Strobe locations to comply with ADA shall include classrooms, hallways, lounges, and conference rooms.

P. Kitchen hood suppression systems are to be monitored by the fire alarm system.

Q. Provide smoke detectors in elevator machine rooms and electrical rooms with transformers.

R. Fire/smoke dampers in corridor walls shall be activated by corridor smoke detectors.

S. Fire/smoke detectors and door holders shall be powered by 24 *VAC* provided by a power supply at the fire alarm panel.

T. Provide fixed temperature heat detectors in boiler rooms.

U. Provide remote annunciator panel at entry locations designated by Fire Marshall.

V. For interior halls with smoke detectors locate manual station at bottom of stairs only- not on each floor.

W. Exterior stairs shall have manual station only at bottom of stairs.

SECTION 16720 - FIRE ALARM SYSTEM

PART 1.00 - GENERAL

1.01 SCOPE

A. The fire alarm system shall be a Siemens XLS system to be fully compatible with the existing XLS systems installed on campus and the existing monitoring system at the Dispatch Center. The panels shall be fully capable of being controlled and monitored by the existing system in place at the UCSC Dispatch Center.

1.02 REQUIREMENTS

This installation shall be made in accordance with the drawings, specifications, and the following standards:

N.E.C. Article 760
N.F.P.A. Standard 72E
N.F.P.A. Standard 72B
N.F.P.A. Standard 72H

1.03 RELATED WORK DESCRIBED ELSEWHERE

Coordinate with related sections as required, including, but not limited to:

Division 14 - Elevators
Division 15 - Sprinkler System
Division 15 - Controls
Division 16 - Basic Electrical Materials and Methods
Division 16 - Telephone
Division 16 - Motor Control Centers
Division 16 - Miscellaneous Mechanical Equipment

1.04 FIRE DETECTION SYSTEM DESCRIPTION

A. Supervised non-coded 24 VDC (limited energy) system.

B. Provide devices as per the Drawings and Specifications.

C. Each detector or manual station shall be supervised as an individual point or as indicated on the drawings. Voltage settings shall be available for printing on the existing printer for a permanent record.

D. Initiate the signal to the HVAC system and shut down the system (in that HVAC system area), or by the duct-sampling unit for that HVAC system.

E. Transmit signal to the existing system in the Dispatch Center.

F. Sound an audible alarm to indicate alarm or trouble, as indicated on Drawings.

1.05 QUALITY ASSURANCE

A. All equipment supplied shall be listed by a nationally recognized fire test laboratory (U.L. and/or F.M.) and if required, listed by the jurisdiction having authority.

B. The Contractor shall have experience in installing three addressable Siemens systems in the last three years and shall submit description of experience, contact person familiar with work and telephone numbers.

C. The program shall be supplied and installed by an authorized Siemens distributor.

1.06 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1 and below.

B. Indicate system components, location, addresses, and provide wiring of the system. Show building floor plans, conductor routing, quantities and connection details. Provide riser diagram with device addresses. Plans shall be clearly drafted and shall not be photocopies of bid set plans.

C. Submit manufacturer's installation instructions including outlet box or black box requirements for each piece of equipment.

D. Submit manufacturer's descriptive literature, operating instructions and maintenance data.

E. Submit control panel assembly points authorized by the manufacturer.

F. Submit C.S.G. printout for approval prior to "burning" the program.

G. Submittals shall comply with CSFM guidelines as shown in Table 1.

1.07 COORDINATION

A. Contractor shall coordinate location of flow and tamper switches with approved fire sprinkler shop drawings.

B. Additions to existing Siemens MXL/XL3 systems shall be coordinated with the existing software license holder. This may involve utilizing the programming services of the license holder or the owner will arrange to have the program license transferred to the contractor.

PART 2.00 - PRODUCTS

2.01 PRODUCTS FIRE DETECTION SYSTEM

A. The control panel will supervise, receive alarm and trouble signals from the detectors, manual stations and interface devices listed below. The control panel shall be capable of reading and displaying the sensitivity of remote addressable ionization detectors and photoelectric detectors, at the control panel. The control panel shall be Siemens Model XLS with current software revision.

l. The detection system shall remain 100% operational and capable of responding to an alarm condition while in the routine maintenance mode. Any quantity of addressable detection devices shall be in alarm at any time up to the total number connected to the system.

2. Dynamic supervision of system electronics, wiring, detection devices, and software shall be provided by the control panel. Failure of the system hardware of wiring shall be indicated by type and location on the alphanumeric annunciator and the printer Software and process operation shall be monitored by an independent hardware watchdog circuit, which will indicate their failure.

3. The control panel shall provide fail-safe operation, i.e., incoming alarms shall automatically override all other modes of operation, and the panel shall automatically return to normal operating mode from any operator-initiated mode.

4. Addressable dual-chamber ionization detectors and photoelectric detectors' sensitivity shall be reported to the control panel when requested. It shall be possible to change the detector sensitivity from the control panel within maximum and minimum values as defined by the U.L. listings of the detectors.

5. The panel annunciator shall be a 80-character alphanumeric display, which shall provide optional user definable messages associated with each detection device or zone. It shall be possible to display up to (127) alarms and up to (127) trouble indications, one at a time, on the digital annunciator and as a list on the printer.

6. A Thermal Printer shall be provided in the XLS panel for event logging. Siemens TSP-40.

7. Addressable/programmable initiating circuits shall be provided in the quantity as indicated on the Drawings. There shall be four (4) circuits on each module. The module shall be system interconnected by a card edge connector, and shall be operated by the control panel. Each initiating circuit shall allow multiple T-taps and not require any end-of-line devices. Each initiating circuit shall accommodate up to (60) addressable devices. Each circuit shall be capable of Class "A" or Class"B" wiring. The module shall be Siemens Model ALD.

8. An output circuit for operation of DC audible devices shall be provided in the quantity as indicated on the Drawings. The module shall be system interconnected by a card edge connector, and shall be operated by the control panel. The module shall be capable of operating audible devices, supervised extinguishing circuits, and lease line auxiliary trip. Each circuit shall be programmed to operate as the system requires. The module shall be Siemens Model CSM.

9. Programmable relay modules shall be provided to perform functions as indicated in Specifications and Drawings. The module shall be system interconnected by a card edge connector, and shall be operated by the control panel. The module shall be Siemens Model CRM.

10. The power supply/battery charger shall provide power to operate the system as specified and be capable of keeping the back-up batteries at their full potential. The battery charger shall be a microprocessor controlled variable rate device. The power supply/battery charger shall be Siemens Model MPS with battery pack.

11. Provide and install CXM-1 communications card in the CXL panel in the Communications Building so that the XLS panel can be remotely controlled and monitored. Twisted pair wiring between two panels will be provided by UCSC. Provide and install a CMI-300 card in each XLS panel so that it can communicate with the CXL panel. Provide a PIM module in the panel so that a printer or VDT can be connected to it.

12. Software shall be provided by the Contractor so that a functional and operational system results that meets the requirements of the UCSC Fire Department. Based on direction by UCSC, the following minimum information shall be entered into the system: Descriptors, setpoints, sequence of operation, etc. Smoke detectors shall be configured so those 10 polls occur before an alarm occurs.

    a. Descriptors shall be created in the following format: Univ. Bldg. # abbreviation for common building name if panel serves more than one building (e.g. DINING), General Location on the floor (e.g. NE), floor or room #'s if applicable, further location information if room # not provided, device type abbreviation. The abbreviation O/S (outside) and a room number is often used for a hall location.(Floor # not needed if room # is provided)

       Device type abbreviations:

HD	Heat detector
WFS	Water flow
MS	Manual station
TS	Tamper
SD	Smoke detector
DD	Duct smoke detector

       Examples (include spaces shown)

       766, ACAD, 2ND, SW STAIR, MS
       COMMONS, BSMT, MECH, HD
       SCI LIBE, O/S RM 241, SD

    b. Separate audible, door release, smoke damper*, elevator recall,* and air handler shutdown override keyed switches shall be installed at the XLS panel per University requirements to allow these functions to be bypassed during testing. Alternatively, the panel function keys shall be configured to disarm outputs for fire alarm system maintenance; with constant logic after soft reset. Program the panel Function and Alt Function keys to disarm/re-arm outputs for audibles, air handler shutdown, door release, etc. employing the bi-stable control function, mode 3.

    c. Contractor shall submit programming worksheets for review by University's representative and the Fire Marshal before creating the program and shall submit the program for review before *"program instillation"*.

    d. Sequence of operation - In general, all notification appliances will be activated by an alarm in that building only. Fire/smoke dampers shall be closed when smoke is detected by the associated duct detector by hallway smoke detectors. For non-fume hood equipped buildings, fans will be shutdown when smoke is detected by any smoke detector in the building.

13. The system shall be capable of being programmed in the field via a laptop computer. All programmed information shall be stored in non-volatile memory. System programming shall be password protected and shall include full upload and download capability.

14. Provide a RCC-1 remote annunciatior at building entry locations shown on plans.

B. The system shall be capable of providing a hard copy written record consisting of: all alarms, troubles, system activity and to print detection device designations, as well as, location messages by means of a full carriage width printer capable of a single line of up to (128) characters, wherein (32) are reserved for device or zone custom identification. New unacknowledged alarms and troubles shall be distinctively displayed on both visual display as well as the printer and differentiated from previous alarms and troubles. The printer is located in the communication center and is part of the CXL.

C. The addressable ionization detector shall be dual chamber type, shall be dynamically supervised, indicating a trouble at the control panel when the detector is unable to sense a fire condition due to both internal and external operating conditions or malfunctions. The detector relay shall be capable of operating from either the detectors or from the control panel. Sensitivity shall be monitored and charged from the control panel without special tools or meters. The detector shall be Siemens ID-60I with base Model DB-3S or relay base Model DBX-3RS.

D. The addressable photoelectric smoke detector shall be U.L. listed. The automatic gain control circuit is capable of maintaining correct sensitivity by compensating for detector aging and dirt accumulation. It is possible to adjust and/or electronically measure the sensitivity of the addressable detectors from the control panel. The addressable photoelectric detectors will provide complete supervision of the detector optics. The detector shall be capable of comparing the fire characteristics with pre-programmmed profiles to assist in rapid identification of a fire. The detectors shall be supervised for any critical reduction in the light output of the LED, or complete failure of the LED light source. This condition may be caused by excessive dirt which would not be compensated for by the automatic gain control circuit. The detector relay shall be capable of operating from the detector or from the control panel. The detector shall be Siemens Model *Fire Print FP-11* with base Model DB-*11* or relay base Model DBX-*11RS*.

E. The addressable thermal fire detector shall be of the 135 ^{O}F rate compensation/fixed temperature type. The detector shall plug into a standard base and have a lamp to indicate alarm initiation. The detector shall also be capable of operating one remote lamp or auxiliary relay. This detector shall be capable of being mixed on the same circuit as addressable ionization, photoelectric detectors, addressable manual stations and addressable interface modules. The detector shall be Siemens Model ID-60T-135.

F. The manual fire station shall be U.L. listed and shall be die-cast aluminum with an actuating action that requires a lever to be pulled forward (not down). Gamewell M46-29 (no known equal). A CZM module shall be used to interface the manual station to the system.

G. The remote conventional zone module shall be U.L. listed. This unit is designed to provide interface for direct shorting contact devices to the system. This unit is used for water flow switches, OS&Y tamper switches, low profile heat detectors, manual stations, kitchen hood, and duct systems. The interface module shall be Siemens Model CZM or TRI.

H. The air duct detector shall be U.L. listed. The air duct detector shall operate on a cross-sectional air sampling principle to overcome stratification and the "skin effect." The air duct

detector shall consist of a standard addressable detector mounted in an air duct sampling assembly and sampling tube that protrudes across the duct of the ventilating system. The air duct detector features of the addressable (ionization/photoelectric detector, choose one) and be installed in the ducts as indicated by the manufacturer's instructions. The duct detector shall be Siemens Model *ADB-11XPR* with addressable detector *FP-11*, and sampling tubes Model STA-2, 3, 6 or 10 (size to fit duct). The detector shall be interlocked with the associated fan starter so that it shuts down when smoke is detected. For exterior locations use EAD-3 weatherproof housing.

I. Non-addressable combination photoelectric smoke detectors with separate 135 degree F heat detector, integral test switch, plug connector, *temporal 3 sounder,* reverse polarity siren shall be Gentex *8243 PHY*, or equal (no known equal) connected to a TRI module. Power to the smoke detectors shall be monitored with a power supervision relay at the end of line location *separately monitored from other circuts*.

J. Non-addressable heat detectors shall be rate of rise, low profile, 135 degrees, Siemens Model DT - 135R, Gamewell, or equal. Mechanical rooms shall utilize fixed temperature 200-degree type. They shall be connected to a TRI module.

K. Waterflow detector shall be furnished and installed as indicated on the Drawings. Switches shall be sized per sprinkler pipe sizes, have two dry contacts and shall have a 0 to 1 minute retard control. OS&Y tamper switches shall be provided by the mechanical contractor as indicated on Drawings, and installed by fire alarm contractor. A TRI-B6D shall be used to indicate flow alarm and tamper switches. (See mechanical specifications and Drawings.)

L. The audio/visual device shall provide an indication of a fire condition. The horn shall be an electronic type. The highest sound level shall produce 90 DB UL SPL at 10'. The strobe shall produce light intensity to meet ADA requirements. The strobe shall provide polar distribution complying with UL 1971 of at least 15 cd *and at least 110 cd in sleeping areas.*.

Audible devices shall provide temporal coded output as required by NFPA 72. Coded audible signals shall be synchronized within a building.

Visual notification devices shall be synchronized when two or more can be seen from a single location. *Provide synch modules with matching audibles.*

Provide separate silenceable (audibles) and non-silenceable (strobes) notification circuits.

For A 1,2,2.1 occupancies and other required locations provide an approved prerecorded message announcement using an approved supervised voice communication system. Siemens Voice Com or equal. No known equal.

M. Addressable manual fire station shall be U.L listed, non-coded, and shall operate on any addressable detection circuit. The addressable manual station shall be individually annunciated at the panel. It shall be Siemens *MSI-10B*. Addressable manual stations exposed to rain shall be protected by a weatherproof cover such as Safety Technology International, Inc. Weatherstopper II or equal.

N. Power Supply - Provide 10 amp power supply and batteries to provide power to the standalone smoke detectors in "alarm" condition. Power supply to be 24 vdc output, with less than 2 volts ripple. La Marche (no known equal). *Must be SFM approved. Power limited. Monitor power supply trouble contacts with a TRI.*

O. Door holders shall be 24 VDC.

2.02 MULTI-CONDUCTOR CABLE

A. Underground cables shall be solid copper conductors with a polyethylene jacket. ALD cables shall have an overall copper tape shield with twisted pair conductors - IMSA spec. No. 20-2-1984. Other cables shall be IMSA spec. No. 20-1-1984. Alternately type TC cables may be used.

B. Above ground cables shall be Power Limited Fire Protection Signaling cable in accordance with NEC Article 760. Conductors shall be solid copper. ALD cables *and monitored contact wiring for TRI's* shall be shielded and twisted. Cables shall consist of 2 or more conductors in an overall red jacket.

PART 3 - EXECUTION

3.01 Refer to Section 16050 for execution requirements.

3.02 INSTALLATION

A. All equipment, terminals, sensors, etc. shall be located and installed readily accessible for operation and maintenance. Manufacturer's instructions shall be followed in all cases.

B. The building fire alarm panel shall be installed adjacent to the electric metering panel that serves the fire alarm panel. The AC power required for the system shall be obtained from the emergency power system. Connection to the power source shall be made via separate locked fused safety disconnect switch with a "Fire Alarm" nameplate on the cover. The power disconnect switch shall be painted red. AC power writing and installation shall confirm to the appropriate portions of Division 16 of this specification.

C. Insulated bushings shall be installed on all conduits entering panels, control cabinets, terminal cabinets, outlet and junction boxes. Bushings shall be O.Z. Type B for rigid conduit, or Type A for EMT; T & B; or equal.

D. Residential areas shall utilize a Gentex Co. combination smoke/heat detector. A reverse polarity relay shall be used to cause all internal sounders to activate.

3.03 WIRING

A. Wiring between addressable devices and the XLS panel shall be 2 or 4 conductor #16AWG solid shielded cable. For lengths greater than 500 feet, #14 AWG shall be used. Wiring shall be a Class B supervisory system. Notification signal circuit wiring shall be #14 AWG solid, minimum. Wiring between contact closure devices and TRI modules shall be #16 AWG, solid, 2 or 4 conductor cable.

B. Multi-conductor cable shall be installed in 3/4" minimum EMT conduit and shall be installed concealed in walls and ceilings. Underground wiring shall be installed in PVC conduit as

specified in the appropriate portions of Division 16 of this specification. The minimum size of underground conduit shall be 4". All other alarm system wiring shall be installed in minimum 3/4" EMT conduit raceways. Conduits shall be sized to provide 25% room for future cables (beyond 40% NEC maximum fill). All wiring not terminating in a control panel shall be routed via wiring gutters, junction boxes and/or conduit as appropriate.

C. Wiring shall be continuous from device to device; splicing shall be accomplished by use of terminal blocks, or, in non-terminal locations with permission of Project manager, shall be soldered splices with wire nuts in locked cabinets or junction boxes (keyed Corbin Cat. 60). Provide separate terminal strips for notification and activation wiring. No splices in the underground system. If the voltage loss at the last device on a loop exceeds 4V DC, a larger size wire will be required.

D. All conduits containing fire alarm wiring shall be dedicated fire alarm conduits and shall not contain wiring for any other purpose.

E. Coordinate connection of the communication cable between the XLS panel and the CXL panel in the Communications Building. Connection will be by others.

3.04 LABELING

A. Cable labeling shall be the ALD or CSM number and XLS number or device description. The numbering and color-coding shall be continuous for each circuit wire. Wiring shall be numbered at each connection, termination, and junction point.

B. Each group of wires shall be tagged with its destination at each panel, terminal box, or junction box with an engraved plastic tag. Attach the tag to each group of wires as they enter and leave the panel, terminal box, or junction box.

C. All conduits entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner. Upon completion, a riser diagram shall be supplied by the Contractor showing all conduit, junction boxes, terminal cabinets, and devices, with all conduit numbers indicated.

D. Print the address on the back of all devices with a felt-marking pen.

E. For TRI's, install an engraved red nameplate with the loop and address number.

3.05 SUPERVISION AND TESTING

A. After "rough-in" prior to connection of equipment, the manufacturer's representative shall meet with the Contractor to review the installation and connection requirements. Upon completion of the installation, the Contractor shall have the manufacturer's engineer and the University fire official assist the Contractor on final testing and inspection and shall certify that the entire installation was tested and performed satisfactorily.

1. Contractor shall provide a printer to the XLS panel that is capable of printing alarm / trouble information on-site during checkout.

2. Contractor shall provide his own personal computer to initially enter the program into the panel.

3. Contractor shall provide his own FPI-32 for programming intelligent devices.

B. Connection to the campus system shall be made by the contractor under the supervision of the manufacturer's representative and the University fire official.

C. Prior to connecting and testing, the Contractor shall perform a clearance test of all systems to insure that the systems are clear of opens, grounds, and defects.

D. Prior to scheduling testing with the University Fire Official, Contractor shall supply a completed matrix form to the Owner's Representative. This matrix will list all devices and provide a check-off box for contractor to indicate successful pre-testing of the device including confirmation of correct descriptor wording. Contractor shall schedule operations with adequate time to accommodate the availability of the Fire Marshal to witness the acceptance test. 48 hours minimum notices after receipt of pre-test documentation.

E. Contractor shall provide sound meter, chemical smoke, ladder, extensions devices, printer , CSGM listing and the services of at least two technicians for the Fire Marshal test.

3.06 TESTS AND REPORTS

A. Contractor shall have system tests performed only by an individual who has attended a manufacturer's seminar for testing the systems as specified above. Testing of the system shall be performed with the test instruments as required by the manufacturer. Testing by means other than the manufacturer's procedures will not be acceptable unless agreed to by the Owner, Owner's Representative and the manufacturer.

B. Reports shall include, but not be limited to:

1. A complete list of equipment installed.

2. Indication that all equipment is properly installed and functions and conforms with these specifications.

3. Test of individual zones as applicable.

4. List serial numbers, locations by zone and device number, and model number for each detector installed.

5. A hard copy printout of the voltage (sensitivity) settings for each ionization and photoelectric detectors measured in place with the HVAC system operating.

6. List method of testing thermal and flame detectors, as well as manual stations.

7. Technician's name, company represented, and date.

C. Final acceptance will require the Contractor to deliver three copies of the following in a manual type binder:

1. Operating and maintenance manuals.

2. A statement of guarantee including date of termination and the name and phone number of the person to be called in the event of an equipment failure.

3. Complete record drawings of wiring and conduits.

4. Detailed catalog data on all installed system components.

5. Copy of the test reports described in paragraph 3.07B.

6. A current hard and disk copy of the complete C.S.G. program. The electronic version of the program, sufficient for the University to change sequences of operation if desired, shall be provided. Consultant shall verify with Project Manager that the University has obtained the required licenses and certifications to obtain this program.

7. A completed NFPA 72 certification form.

D. One hundred percent (100%) of the devices shall be field-tested. Testing from the system keyboard is not acceptable. Battery test as described- NFRA 72 (10 minutes/24 hours) will be required.

Table 1 - CALIFORNIA STATE FIRE MARSHAL
FIRE ALARM SYSTEM SUBMITTAL CHECKLIST

The following information is to be provided in the fire alarm shop drawings submitted to the Fire Marshal for review.

		REFERENCE
I. A D M I N I S T R A T I V E		
A.	Installing contractors name, address, phone number.	UFC 1001.3
B.	Basis for system installation / Building code occupancy classification.	UFC 1001.3
C.	Building owner and/or tenant.	UFC 1001.3
II. FIRE ALARM EQUIPMENT		
A.	Manufacturer's specification sheet.	UFC 1001.3,1007.3.4.3
B.	Equipment application per fisting/approvals.	UFC 1001.3, 1007.3.2
C.	CSFM building materials listing sheet/numbers.	UFC 1001.3 & T19
Ill. GENERAL INFORMATION		
A.	Appropriate codes & standards, including edition.	UFC 1001.3, CBC Section 3505.1.3
B.	Type of system or service involved.	NFPA 72, 1993
C.	Voice evacuation message/language(s), if involved.	NFPA 72, 3-2.4.1
D.	Written sequence of operation or matrix table.	U FC 1007.3.4.3
E .	Combination systems specific additional uses.	U FC 1007.3.3.4, NFPA 72, 3-8.14
F.	HVAC locations > 2000 cfm.	CMC, Section 608
G.	Special system features/operations.	UFC 1007.3.4.3
H .	Required placarding.	UFC 1007.3.4.2 & NFPA 72, 1993
IV. PLANS & DRAWINGS		
A.	Scaled floor plans, including north reference.	UFC 1001.3
B.	Completed title block with site address and issuing contractor's business address.	UFC 1001.3
C.	Identification of each room's use.	UFC 1001.3
D.	Location of all components, including, end-of-line devices, if involved.	UFC 1001.3
E.	Symbol legend, including quantities, mfg name, model, etc.	UFC 1001.3
F.	Identification of circuit styles, designations and methods.	UFC 1001.3
G.	Description of zone assignments/device addresses.	UFC 1001.3,1007.3.3.7
H.	Complete building cross-section, include attic, soffit, or ceiling details.	UFC 1001.3
I.	Location of sprinkler system test valve.	UFC 1001.3
J.	Specifications and details of through-penetration fire stopping, if required.	U.L. Fire Resistance Directories
K.	Device Mounting heights for manual boxes and visible notification appliances.	NFPA 72, 3-8.1.1, 5-9.1.1 & 6-4.1.1
L.	Primary power supply details.	NFPA 72, 1-5.2.4,.2.8
M.	Secondary power supply calculations.	NFPA 72, 1-5.2.5
N.	Voltage drop calculations.	UFC 1001.3

V. SINGLE LINE (RISER) DIAGRAM

A.	Conductor information, including size, stranding, insulation type, etc.	CEC, Article 760
B.	Conduit fill calculations or NEC reference.	CEC, Table #4
C.	Location of end-of-line devices.	UFC 1001.3

SECTION 16780: TELEVISION SYSTEMS STANDARDS

I. GENERAL

A. CATV Coaxial Cable

1. The existing trunk cable TV system shall be extended to the main cable closet of all new buildings or complexes.

2. Contractor Qualifications - The contractor shall have experience in 3 similar installations in the last 3 years and shall submit description of experience, contact person familiar with the work, and telephone numbers.

3. Extension of the existing CATV system to the project must be designed and installed by a contractor qualified to do such work. The CATV system is a sub-split design that operates from 0 to *750* MHZ. Path loss is 44 db + or - 3 db both directions and for both systems. Distribution to buildings is via bridge amplifiers (the trunk is not tapped.) CATV design shall be coordinated with TCI Co., the local provider.

4. Each building, or group of buildings, shall have the distribution leg from the trunk terminated in a two port tap for the CATV system located in the main cable closet. All extensions shall comply with the trunk system specifications.

II. MATERIALS

A. Trunk Cable - Aluminum Jacketed Coaxial Cable

1. Physical Construction:

a. The inner conductor of the cable shall be copperclad aluminum wire. The cable shall be Times Fiber Communications, Inc. 565 or 840 series semiflex flooded cable TX 10 to match existing TCI co. standard..

b. The inner conductor of the cable shall be surrounded by a foamed or cellular polyethylene dielectric.

c. The dielectric shall be surrounded by a seamless aluminum shield.

d. The outside diameter of the aluminum shield shall be 0.840 inches for trunk cable and 0.565 inches for distribution cable.

e. The aluminum shield shall be covered by an extruded high molecular weight polyethylene jacket specifically made for underground duct use where the cable will be exposed to standing water.

f. The cable shall have a flooding compound injected between the aluminum shield and the outer jacket. This flooding compound shall remain 'tacky' and flow to fill pinholes or other minor installation damage to the outer jacket.

2. Electrical Characteristics:

a. Impedance: The impedance of the cable shall be 75 ohms +/-2 ohms.

b. Attenuation: The cable shall have an attenuation of no more than 1.10 decibels (db) of loss per 100 feet at 300 megahertz, measured at 68 degrees Fahrenheit for .565 cable and 0.75 db of loss per 100 feet at 300 megahertz for 0.840 cable.

c. Capacitance: The capacitance of the cable shall be no greater than 20 picofarads/foot.

d. Velocity of propagation: The velocity of propagation of the cable shall be no less than 75 percent.

e. D.C. resistance: The D.C. loop resistance of the cable inner conductor shall be no greater than 2.00 ohms per 1000 feet, measures at 68 degrees Fahrenheit.

3. Testing and Inspection: All cable shall be inspected and tested in accordance with standard procedures used by the manufacturer and certificates showing compliance by the cable manufacturer shall be provided at the time of delivery. This testing shall include a sweep test for structural return loss. The reflected wave shall be at least 20 decibels down from the incident wave over the entire frequency range from 5 megahertz to 550 megahertz. The manufacturer shall provide a characteristics graph, plotting the attenuation loss (in db per 100 feet at 68 degrees Fahrenheit) versus signal frequency (in megahertz). This graph shall cover the frequency range of 5 megahertz to 550 megahertz. The attenuation scale shall show markings at each 0.1 db per 100 feet and the frequency shall show markings at the frequencies of 5, 10, 20, 30, 40, 50, 100, 200, 300, 400 and 550 megahertz.

4. Pulling Tension: The vendor shall specify the maximum recommended pulling tension of the cable, in pounds.

5. Shipping Package: The cable shall be delivered on round reels with each reel containing not less than the lesser of 2000 feet of cable or the amount of cable required on this project divided by two (2). Each reel shall contain no more than 4000 feet of cable.

6. Markings: Linear distance markings imprinted on the outer jacket shall be provided. CATV cables shall be color-coded, either by factory applied markings or colored markings applied at the time of installation with a blue stripe. LAN cables shall not be color-coded.

7. Grounding: The outer shield of each cable shall be grounded to building ground at the building entrance.

8. Connectors to aluminum jacketed cable shall be aluminum, pin type (i.e. cable center conductor is not fed through the connector) LRC, Gilbert or equal.

9. Passive devices (splitters, directional couplers, etc.) located on the feeder shall be designed for 0 to 1 GHz operation. These devices shall be power passing (but with all fuses removed), be waterproof, and have center conductor seizure mechanisms. General Instrument SSP series, CCOR or equal.

10. Termination of the coaxial cable at the main cable closet shall occur via a gas discharge surge arrestor (Gilbert G-TA/SP or equal). Tap value to be determined by Project

Manager. The cable shield shall be grounded at this entrance point to building ground with a #8 AWG wire.

11. All underground cable terminations/splices shall be waterproofed with shrink boots.

12. The TV cable shall terminate at each building with a split band tap unit (Jerrold FFT2, CCOR or equal). All tap, equalizer and pad values shall be chosen by the contractor to insure specified performance.

B. Distribution Cable - Cables within the building or within a college site shall be 100% coverage, quad shielded, inner shield bonded to the dielectric, MaCom Super Shield or equal. RG-11 shall be used for distribution and riser cables. RG-6 shall be used to outlets, RG-11 for feeders. Underground cable shall be flooded. Connectors shall be tamperproof snap-on Augat SNS series or equal - no known equal.

C. Cable television system distribution amplifiers shall be 2 way wide band (50 - 550 MHz. forward) *Blonder Tongue 750 MHz BIDA 750-30 (#5400-73)* or equal with return amplifier. Inline taps shall be -80 db shielding, cast housing, brass output connection, miniature directional coupler, Blonder-Tongue, no known equal. Provide pads, equalizers, terminations, filters, splitters, directional couplers, etc., as required. Splitters shall have 5-*1 GHz* band width, packaged in a cast housing, providing better than 80dB shielding. Minimum return loss shall be 14 dB and minimum isolation between outputs shall be 18 dB. Maximum insertion loss shall be 4.0 dB for two outputs and 8.4 dB for four outputs. All components shall be manufactured by General Instrument, Blonder-Tongue or equal. Entire system shall be compatible with cable television system existing on the Campus. Connectors to aluminum jacketed cable shall be aluminum, pin type. Other connectors shall be F type Augat/LRC Snap-n-seal SNS-6QS (607-739-3844) to match existing used by TCI company. Available thru Toner (800-523-5947).

D. Underground devices (splitters, directions couplers, equalizers, etc.) shall be waterproof and shall have center conductor seizure mechanism. General Electric SSP, CCOR or equal.

III. EXECUTION

A. Provide and install any and all additional fittings, pads, terminations, filters, etc. as needed to provide best performance possible at present state of the art at no additional charge to the Owner.

B. Mount all outlets on 4" square junction box (if conduit system is used) or on plaster ring (if conduit not installed). See Drawings for locations where conduit is required.

C. All wiring in conduits or otherwise concealed shall be continuous. Splices are allowed in pull boxes and at terminal boards only.

D. Signal level at any outlet shall be between +5 dB mv and +*15* dB mv from 50 to 550 MHz.

E. Provide and install equalizers and attenuators as required.

F. Amplifiers shall be padded down as required to balance the system.

G. Identify each branch cable at splitter with room number or terminal backboard served using plastic engraved wire tags.

H. The final tap on each branch rise or run shall be terminated with a 75 ohm resistor.

I. Television outlets may be wired in series (coaxial cable looped from outlet to outlet) with a maximum of five outlets per circuit. Each circuit shall be wired separately to the building terminal board. Coaxial cable shall be continuous from outlet box to the terminal panel.

J. In certain buildings the conductors from each outlet to the first terminal board need not be installed in conduit. All other conductors shall be installed in conduit. Verify with Project Manager.

K. For dedicated wiring from terminal board to outlet, utilize self-terminating outlets, LRC TF-81, or equal.

L. Underground cable shall be continuous from terminal board to terminal board. (i.e., no splices in pullboxes)

M. RF leakage shall comply with FCC and FAA requirements. (i.e., less than 20 microvolts/meter at ten feet.)

N. Underground Cable Installation: Installation procedure must meet or exceed requirements listed below:

1. All cables routed through manholes and pullboxes shall be supported at a maximum of every four (4) feet. Cables shall be routed in such a manner as to allow other maintenance activities to occur within manholes without damage to the cable. All cables should be routed as close to walls as possible in vaults to reduce accidental damage. Cables in manholes shall be routed as close to the tope of the vault as possible to allow maximum area for telephone cable splice cases. In no case shall cables be routed less than 12" from manhole floor.

2. All cables supplied for the entire project shall be tested before installation to validate the cable electrical integrity. All cable reels shall be swept for structural return loss and bandwidth continuity.

3. The contractor shall exercise due care in handling rigid coaxial cable in order not to damage the cable. In particular, the cable shall be left uncut, and fastened securely to its shipping reel until immediately prior to its installation. Correct tooling shall be used in making all bends in order to ensure that the minimum safe bending radius is not exceeded.

4. Minimum bending radius for all solid sheathed aluminum cables is fourteen (14) times the cable diameter. Manufacturer's recommended pulling tensions shall be observed.

5. The Contractor shall be responsible for scheduling and coordinating the coaxial cable placement with other activities so as to avoid damage to the cable by other activities which may take place subsequent to cable placement. Notice is given that the cable construction is such that relatively minor physical damage, such as dents and kinks, can have major impact on system performance.

6. All spare cables shall be weatherproof with end cap heat shrinkable tubing with sealant compound and shrunk to maximum shrinkage.

7. All equipment shall have expansion loops at the input and output connectors of each device.

8. All equipment shall be installed so as to be readily accessible for maintenance and shall be located so as not to interfere with servicing of other utilities or services.

9. All active and passive equipment shall be securely fastened to concrete manhole/vault walls or to internal building structures using adequate support hardware. Equipment suspended by the coaxial cable and connectors will not be accepted. All electronic equipment installed in manholes or pull vaults shall be physically attached at the top of manhole/vault walls. Equipment attached using tie wraps or wire is not acceptable.

10. All connectors and equipment covers shall be torqued to manufacturer's specifications.

11. All connectors and splices shall be fully sealed against moisture in tunnels, manholes, vaults, pullboxes or locations where jacketed flooded cable has been installed. All connectors shall have shrink boots with sealant compound installed and shrunk at each connector. Shrink tubing shall extend over the cable jacket a minimum of six inches. All shrink tubing shall be shrunk at time of connector installation and initial splicing.

12. All connections to equipment are to be of the center conductor seizure set screw type and not the mating pressure contact type.

13. All connectors shall be installed in such a manner that the cable center conductor shall adequately pas through the set screw to prevent any possible suck-outs. The set screws shall be tightened per manufacturer's specifications.

14. All cable connections shall have the dielectric removed using an approved CPT coring tool. The center conductor shall be free of all dielectric material bonded to it by scraping or by use of a plastic dielectric removal tool.

15. All splicing must be accomplished using a utility cable cutting tool. Tubing cutters shall not be allowed. Cables which have had their aluminum shield scored during jacket removal shall be replaced.

16. All passive equipment, taps, splitters, or directional couplers installed in manholes or vaults shall be factory protected for underground installation.

17. Equipment-to-equipment connection shall be accomplished using an LRC 625-R housing-to-housing connector or equal wherever possible. All 625-R connectors or equal installed in vaults shall be weather proofed with electrical rubber shrink tape.

18. At all distribution termination points, a power blocking connector terminator shall be used.

19. All directional couplers taps shall be spliced within two inches of the output of amplifiers whenever applicable using LRC 625-R connectors or equal.

20. The trunk lines shall have a maximum of one splice between amplifiers. No trunk splice shall be allowed within 400 feet of the output of any amplifier.

21. Contractor shall pass cable through manholes (without a splice) in such a manner that would allow installation of an active or passive component at a later date.

22. All unused tap ports must be terminated into 75 ohms.

23. All input and output cables of all active or passive devices shall be identified with a taped color band around the cable using the above color code.

24. Each amplifier shall be identified with the amplifier number stenciled on is cover. A minimum of one-inch high stencils shall be used, using black lettering on a white background patch.

25. Each power supply shall be stenciled on the front cover with the power supply number using one-inch high black letters.

26. Placement of all amplifiers and distribution taps shall be in locations where they are readily accessible for future connection or maintenance without the use of special ladders or lifts. All equipment and taps shall be permanently mounted to structures so access to unused tap ports or normal maintenance operations with amplifiers can be accomplished without damaging the distribution or trunk cables.

O. SAFETY

1. All construction and installation shall be designed and accomplished with safety as a primary consideration. The objective is to protect equally the public, the university, and the contracting employees.

2. The contractor shall at all times exercise extreme care to reduce to a minimum the hazard of accidental injury to themselves and the public due to the presence and installation of wires and equipment particular to their trade.

3. All work performed on public streets, alleyways, highways, private property and inside buildings, shall be done in such A manner that the convenience of the general public shall be interfered with as little as possible and no conditions unusually dangerous to workmen, pedestrians or others shall be established at anytime.

P. TESTING

1. CATV coaxial cable: After installation, provide sweep tests from 0 - 550 MHZ for cable from point of connection to the existing system to the tap at the main cable closet. Tests shall be photographically recorded and submitted to the Campus Engineer. The reflected wave shall be at least 25 db down from the incident wave over the entire spectrum.

2. Provide measurement equipment and measure path loss from the campus head end to the building tap over the entire bandwidth and for both systems. Adjustment of the trunk system is beyond the scope of this project.

3. Test each outlet and record level at Channel 4 and Channel 70. Submit written documentation of test results.