

## **DIVISION 26 - ELECTRICAL**

### **TABLE OF CONTENTS**

#### **26-1 INTRODUCTION**

#### **26-2 ELECTRICAL OVERVIEW**

- A. Parnassus Campus Electrical System Overview
- B. Moffitt/Long Hospital Electrical System Overview
- C. Ambulatory Care Center (ACC) Building Electrical System Overview
- D. Mt. Zion Hospital Buildings “A”, “B”, “C”, “D”, and “R” Electrical System Overview
- E. Other Sites
- F. Normal Power Load Shed Systems
- G. Emergency Load Control System

#### **26-3 BASIS OF DESIGN ANALYSIS AND DOCUMENTATION**

- A. Design Analysis Report
- B. Exceptions to Design Criteria
- C. Design Analysis
- D. Voltage Drop Calculation
- E. Phase Balance Calculation
- F. Power-Factor Correction Calculation
- G. Power System Study
- H. Report Contents
- I. Luminaire Schedule
- J. Drawings
- K. Electrical Single Line
- L. Branch Circuit Panel Schedules
- M. Lighting System
- N. Signal System

- O. Nurse Call System
- P. Sound System
- Q. Fire Alarm System
- R. Electrical Commissioning and Operation and Maintenance Manual

**26-4 GENERAL DESIGN CRITERIA**

- A. New Utilities and Extensions
- B. Electrical Service Requirements
- C. Electrical Equipment Location
- D. Medium Voltage Distribution System
- E. Service from Pacific Gas and Electric (PG&E) Company
- F. Low Voltage Systems
- G. Lighting Systems
- H. Lighting Controls
- I. Normal Power Distribution System
- J. Emergency Power
- K. Power
- L. Telephone/Data
- M. Radiology Equipment

**26-5 SPECIFIC DESIGN GUIDELINES**

- A. Medium Voltage Conductors (26 05 13)
- B. Low Voltage Conductors (26 05 19)
- C. Conduit Hangers and Supports, Penetrations (26 05 29)
- D. Grounding and Bonding (26 05 26)
- E. Raceway and Boxes (26 05 33)
- F. Underground Electrical Distribution (26 05 43)
- G. Identification (26 05 53)
- H. Power Monitoring and Control (26 09 13)

- I. Lighting Controls (26 09 23, 33, 36)
- J. Unit Substations (26 11 16)
- K. Medium Voltage Switchgear (26 13 00)
- L. Low Voltage Transformers (26 22 00)
- M. Low Voltage Switchgear (26 23 00)
- N. Switchboards (26 24 13)
- O. Distribution Panels (26 24 16A)
- P. Branch Circuit Panelboards (26 24 16B)
- Q. Motor Control Centers (26 24 19)
- R. Enclosed Bus Assemblies (26 25 00)
- S. Wiring Devices (26 27 26)
- T. Fuses (26 28 13)
- U. Enclosed Switches and Circuit Breakers (26 28 16)
- V. Enclosed Controllers (26 29 13)
- W. Engine Generator Assemblies (26 32 13)
- X. Automatic Transfer Switches (26 36 00)
- Y. Testing Requirements
- Z. Interior Lighting (26 51 00)
- AA. Exterior Lighting (26 56 00)
- BB. Emergency Lighting (25 52 00)
- CC. UPS and Batteries
- DD. Surge Protection
- EE. Power Filter/Conditioner

## **26-6 LOW VOLTAGE SYSTEM**

- A. Communication (27 00 00)
- B. Communication Horizontal Cabling (27 15 00)
- C. Patient Monitoring and Telemetry Communication (27 15 01)

- D. Paging Communication System (27 15 02)
- E. Interior Communication (27 15 43)
- F. Data and Voice Communication (27 20 00)
- G. Audio-Video Communication (27 40 00)
- H. Health Care Communication and Monitoring System (27 52 00)
- I. Telemedicine System (27 52 16)
- J. Healthcare Imaging System (27 52 19)
- K. Nurse Call / Code Blue System (27 52 23)
- L. Clock System (27 53 13)
- M. MATV System
- N. Electronic Safety and Security System (28 00 00)
- O. Electronic Access Control and Intrusion Detection (28 10 00)
- P. Electronic Surveillance (28 20 00)
- Q. Fire Detection and Alarm (28 31 00)

## **26-1 INTRODUCTION**

- A. The following electrical guidelines shall be utilized to design and document new construction and renovation projects for the University. All designs are subject to review and approval by the University and appropriate authorities having jurisdiction.
- B. In the following text, UCSF Medical Center shall be referred to as the “University” which includes: UCSF Medical Center Facilities, referred to as "Facilities" and UCSF Medical Center Office of Design and Construction, referred to as "D&C".
- C. The guidelines describe criteria, performance, and materials requirements for electrical systems. Design professionals can recommend changes to specific guidelines as appropriate to meet the project program and goals, but shall not incorporate changes without the University’s written approval. Recommended changes that reduce quality, utility, flexibility, and energy efficiency criteria described herein shall be submitted with cost/benefit analyses.
- D. This document was prepared prior to the opening of the new Mission Bay Hospital, and does not address guidelines for renovations or future development at the UCSF Medical Center at Mission Bay.

## **26-2 ELECTRICAL OVERVIEW**

- A. Parnassus Campus Electrical System Overview: This portion is specific to the Parnassus Campus and has an impact on the Moffitt/Long Hospital and the Ambulatory Care Center (ACC).
  - 1. The Parnassus campus is served from Pacific Gas and Electric Company (PG&E) at 12kV. The campus is served by three primary service cables two of which are normally carrying campus load with the third service cable providing redundancy as a standby service. The main 12kV distribution equipment for the campus is located at the Parnassus Central Utilities Plant (PCUP). The PCUP 12kV distribution equipment is arranged as a double bus system for complete redundancy. Each bus has two utility services and utility interconnect breakers. Each bus also has two connections to the cogeneration system at the PCUP. Each bus has a number of feeder circuit breakers with feeders serving campus buildings.
  - 2. The PCUP has a combined cycle cogeneration plan that provides much of the electricity used by the campus. The cogeneration system consists of two 5MW combustion turbine generators and one 3.75MW steam turbine generator. Power is generated at 4.16kV and stepped up to 12kV for interconnection to the campus 12kV distribution service and the 12kV PG&E services. The cogeneration plant is capable of operating in “island mode”, disconnected from PG&E. The cogeneration plant provides backup power to the campus during utility company power outages and functions as an Optional Standby system per California Electrical Code (CEC) Article 702. Power from the cogeneration plant is distributed to the campus buildings using the 12kV normal power distribution feeders.

3. The PCUP also has three 2MW Emergency Diesel Generators (EDGs) generating power at 12kV. The EDGs provide Emergency power to the PCUP, Health Sciences Instruction and Research (HSIR) buildings, and the Medical Science Building (MSB) through dedicated 12kV Emergency power feeders and Emergency power substations to step the voltage down from 12kV to 480 volts. The EDGs also provide Standby power to various campus buildings through 12kV automatic transfer equipment located at the CUP. The Standby power from the EDGs is distributed to the campus buildings using the 12kV normal power feeders. The EDGs are capable of operating in parallel with the cogeneration plant to supply the campus with power in island mode operation.
  4. The Parnassus campus has a small 4.16kV medium voltage distribution system. This 4.16kV system serves the cogeneration plant at the PCUP, a 1200 ton electric centrifugal chiller at the PCUP, and unit substations serving the PCUP itself. There is one 4.16kV distribution feeder (Feeder 4F7) that leaves the PCUP and serves the Laboratory of Radiobiology Building.
  5. The Parnassus campus is primarily served by a 12kV, medium voltage distribution system. 12kV feeders are routed throughout the campus in underground concrete encased duct banks. The system is arranged as a dual primary system with primary selective switchgear at campus buildings. Typically each building on campus is served by two 12kV feeders, with one feeder from each of the two main busses at the PCUP. This arrangement provides a high level of redundancy, reliability, and operating flexibility. New utilities and extensions shall be coordinated with and be consistent with the University's Campus master plans. Additions to 12kV system may be approved after completion of load studies, coordination studies and short circuit studies to determine impact on the existing system configuration.
  6. The larger buildings at Parnassus campus have secondary selective double-ended substations for redundancy and a high level of reliability and operating flexibility. These buildings include Ambulatory Care Center (ACC), and Long/Moffitt Hospitals, Health Sciences Instruction and Research (HSIR), Medical Sciences Building (MSB), Regeneration Medicine Building (RMB), Clinical Science Building (CSB), Parnassus Service Building (PSB), and School of Dentistry. All other buildings served from the campus medium voltage system have single-ended substations. All buildings have dual primary feeders with primary selective switchgear except for Koret Vision Research, and the Laboratory of Radiobiology.
- B. Moffitt/Long Hospital Electrical System Overview:
1. Moffitt/Long Hospital is served from two dedicated 12kV feeders from the Central Utility Plant (CUP) 12kV distribution system. The two 12kV feeders which serve Moffitt/Long Hospital primary switch station (PSS-ML1-SS1) (Section A & B) are 12F110 and 12F211. The feeder 12F110 is connected to the CUP 12kV switchgear 12S11 and feeder 12F211 connected to CUP 12kV switchgear 12S22.
  2. In Moffitt/Long Hospital primary switch station PSS-ML1-SS1 consists of two sections "A" and "B". Section "A" is connected to 12kV feeder 12F110, and section "B" is connected to 12F211. Primary switch station (PSS-ML1-SS1) (Section A & B) consists of main vacuum breaker and six (6) vacuum breakers which serve Moffitt/Long

substations. There is a control interface between section “A” and “B” which allows each feeder load to be transferred from one section to the other section.

3. Each section (section A and B) of primary switch station PSS-ML1-SS1 serves Moffitt/Long double ended substation HCM-H, HCM-H2 and HCM-L.
4. There are three double ended substations in Moffitt/Long Hospital:
  - a. Substation HCM-H consists of two 2000/2300kVA transformers. 12kV primary – 277/480V-3 $\Phi$  secondary. Transformers T100 and T102 with main-tie-main switchgear, and all feeders serve from draw out circuit breaker. This substation was installed under the original Long Hospital construction approximately in 1979.
  - b. Substation HCM-L consists of two 750/863kVA transformers. 12kV primary, 120/208V-3 $\Phi$  secondary. Transformer T200 and T201 with main-tie-main switchgear, and all feeders serve from draw out circuit breaker. Substation HCM-L was installed under the original Long Hospital Construction approximately in 1979.
  - c. Substation HCM-H2 consists of two 1500/1995kV transformer – 12kV primary, 277/480-3 $\Phi$  secondary. Transformer T300 and T301 with main-tie-main switchgear, and all feeders serve from electronically operated draw out circuit breaker. Substation HCM-H2 was installed approximately in 1998.
5. Essential Systems in Moffitt/Long Hospital:
  - a. Essential System in Moffitt/Long Hospital serves from two 1500KW-277/480V-3 $\Phi$ -4WSN generator which serves a paralleling switchgear. The paralleling switchgear consists of generators paralleling controlling section and distribution section which includes main circuit breaker and feeder circuit breaker. All circuit breakers are draw out electrically operated.
  - b. Essential system in Moffitt/Long Hospital is a segregated system per NEC and CEC, which provides life safety branch, critical branch, and equipment systems.
  - c. Essential system in Moffitt/Long consists of multiple automatic bypass transfer switches for each system.
  - d. There is one life safety automatic bypass transfer switch which serves all code required life safety components.
  - e. There are multiple critical branch automatic transfer bypass switches. Some of the critical branch automatic transfer bypass switches are assigned to Long Hospital operating rooms, some to Moffitt operating rooms, Intensive Care Unit (ICU), Critical Care Unit (CCU), radiology and cardiac cath lab, patient floors and others are assigned to serve critical loads in hospital.
  - f. There are multiple equipment system automatic bypass transfer switches. Long Hospital elevators and Moffitt elevators are served from independent automatic transfer bypass switch, and other HVAC and other related loads required to be

connected to the equipment system are served from multiple automatic transfer bypass switches.

C. Ambulatory Care Center (ACC) Building Electrical System Overview:

1. ACC Building is served from three 12kV feeders from the Central Utility Plant (CUP) 12kVA distribution system. These feeders are designated as 12F210, 12F212, and 12F111. These feeders, in addition to ACC Building, serve other buildings at the Parnassus campus such as LPPI and Campus Library.
2. Two feeders, 12F210 and 12F111, serve the primary switching station PSS-ACC-SS1 (Section A and Section B), which serves transformer ACC-TDA and TDB a double ended substation ACC-H1. Each section of the primary switch station (A and B) have control capability to serve substation ACC-H1 from either 12kV feeder.
3. Feeder 12F212 serves H.V. fused which serves a single end substation ACC-H2 which serves MRI equipment at P3 level (old "C" Level).
4. Feeders 12F211 and 12F212 serve H.V. fused switches 3A1, 3A2, 3B1, and 3B2. The H.V. fuse switch feeds transformer TH3A and TH3B double ended substation ACC-H3. H.V. fused switch has the capability to transfer load to either feeder.
5. Substation ACC-H1 consists of two 1500/1932kV transformers 12kV primary – 277/480V-3Φ-4wsn secondary. Transformer TDA and TDB with main-tie-main switchgear, and all feeders serve from electrically operated draw out circuit breaker. This substation was installed in 2009.
6. Substation ACC-H2 consists of 500kVA transformer – 12kV primary – 277/480V-3Φ-4wsn secondary with draw out main circuit breaker which serves distribution panel to serve MRI equipment at P3 Level (C Level). In addition, there is a molded case circuit breaker with kirk key interlock which is connected to substation ACC-H1. This allows load on substation ACC-H2 to transfer to substation ACC-H1. This substation was installed in 1989.
7. Substation ACC-H3 consists of 1000/1288kVA transformer – 12kV primary – 277/480V-3Φ secondary which serves switchgear with main-tie-main and all feeders serve from electrically operated draw out circuit breaker. This substation was installed in 1999.
8. Emergency System in ACC Building:
  - a. We have recently replaced all of the existing generators with two 550kW-277/480-3Φ generators with paralleling switchgear which will serve emergency loads. The previous transfer by-pass switch will remain to serve the existing emergency load. In addition, multiple automatic transfer bypass switches will be provided to serve the existing load other loads from the standby system.
    - 1) There were three existing generators– EPU#1, EPU#2, and EPU#3. These generators have been replaced with two new generators with paralleling switchgears.



- 2) EPU#1 is rated at 75kw-277/480-3 $\Phi$  generator which serves ACC life safety load, limited to emergency lighting and limited load on each floor. These loads are being served from ATBS "E" which is connected to generator EPU#1 and normal side is connected to distribution equipment which serves from ACC-H1 substation distribution system.
- 3) EPU#2 is rated as 200kW-277/480-3 $\Phi$  generator which serves ACC surgery center load, mechanical load which serves surgery center at Plaza Level. In addition to surgery center, EPU#2 serves some other floors such as 1<sup>st</sup> Floor Dialysis. These loads are being served from ATBS "B" which is connected to generator EPU#2 and normal side is connected to distribution equipment which is served from ACC-H3 substation distribution system.
- 4) EPU#3 is rated as 25kW-277/480-3 $\Phi$  generator which serves ACC MRI at P3 Level (Old C Level) emergency load. These loads are being served from ATBS which is connected to generator EPU#3 and normal side is connected to distribution system which is served from ACC-H2 substation distribution system.

D. Mount Zion Building "A", "B", "C", "D" and "R" Electrical System Overview:

1. The Mt. Zion Building "A", "B", "C", "D" and "R" are served from three separate PG&E services. These services serve from PG&E underground transformer. Each service feeds separate switchgear and/or switchboard. The following are PG&E service ratings.
  - a. 4000Amp-120/208-3 $\Phi$ -4w serves switchgear "A" in Building "A". Installed in the original 1948 construction of Mt. Zion. The circuit breakers in existing switchgear were retrofitted in 1995.
  - b. 1600Amp-120/208-3 $\Phi$ -4w serves switchgear "EXAN" in Building "A". Installed in 1994.
  - c. 2000Amp-277/480-3 $\Phi$ -4w serves switchboard "C" in Building "B". Installed in 1965.
  - d. 1200Amp-277/480-3 $\Phi$ -4w serves switchboard "BR" outside of Building "B" northeast corner. Installed in 1994.
2. The main switchgear "A" located in basement of Building "A" consists of distribution section with draw out insulated case circuit breaker. This switchgear was installed under original Mt. Zion building in 1948 and circuit breakers were retrofitted in 1995.
3. The main switchboard "EXAN" serves 277/480V load in Building "A" including radiology equipment.
4. The main switchboard "C" located at basement of Building "B" serves normal load in Building "B" and "R". Switchboard "C" was installed under original building "B" construction.

5. The switchboard “BR” serves chillers and cooling towers on the rooftop of Building “B”, and the gas fired/driven chiller in courtyard “F” site.
  6. Building “C”, “D”, and “R” serve from distribution equipment in building “A” and “B”.
  7. Essential system in Mt. Zion Building “A”, “B”, “C”, “D” and “R” is served from three generators: Gen#1, Gen#2, and Gen#3.
    - a. Gen#1 is 260kw-120/208V-3 $\Phi$ -4wsn
    - b. Gen#2 is 260kw-120/208V-3 $\Phi$ -4wsn
    - c. Gen#3 is 350kw-120/208V-3 $\Phi$ -4wsn
    - d. Gen#1, Gen#2, and Gen#3 are connected to emergency paralleling switchboard ETA, which serves essential system in multiple buildings. The emergency generator paralleling switchgear is constructed with multiple automatic bypass switches integral to switchgears. These transfers bypass switches are critical and equipment system.
    - e. There are other transfer bypass switches within Building “A” which serve equipment and critical branches. The essential system in Building “A” serves multiple distribution equipment in Building “B”, “C”, “D” and “R”.
    - f. Generator GEN#1, GEN#2, and GEN#3 serve essential system loads in Building “A”, “B”, “C”, “D”, and “R”.
- E. Other Sites:
1. The University has many other smaller buildings and leased spaces. These other sites are served from PG&E with secondary service at 120/208 volts or 277/480 volts depending on the building. The electrical distribution system for each site must be evaluated.
- F. Normal Power Load Shed Systems:
1. Parnassus Campus and Moffitt/Long Hospital:
    - a. The majority of building substations and 12kV distribution equipment is connected to campus SCADA system which provides control and monitoring of vacuum breaker in 12kV switchgear and substation draw out circuit breaker which includes high speed load shedding capability. If PG&E services failed the entire campus shall be served from CUP co-generation. Since the total campus load is larger than co-generation capacity, the load on the existing campus building will be shed based on priority and amount of power needed to keep co-generation within load capacity.
    - b. In addition to campus SCADA system, there is a CCMS system which provides monitoring of metering and digitrip of circuit breaker and interface with SCADA system to provide load information needed for shedding.

2. Moffitt/Long Hospital:
    - a. Moffitt Long Hospital 12kV primary switch station PSS-ML-SS1 is fully connected to campus SCADA system and CCMS system.
    - b. Moffitt/Long Hospital substation HCM-H1, HCM-L does not have electrically operated circuit breaker. It is not connected to SCADA for control. However, main circuit breakers and some of the breakers are connected to SCADA and CCMS for monitoring such as circuit breaker position.
    - c. Moffitt/Long Hospital substation HCM-H2 is fully connected to campus SCADA system and CCMS system. Under the load shed program, Moffitt/Long hospital is on high priority list.
  3. ACC Building:
    - a. ACC Building 12kVA primary switch station PSS-ACC-SS1 is fully connected to SCADA system and CCMS system.
    - b. ACC substation ACC-H1 and ACC-H3 is fully connected to SCADA system and CCMS system. Each electrically operated breaker remotely can be monitored and/or controlled through SCADA system from Central Utility Plant control room.
    - c. ACC substation ACC-H2 does not have electrically operated circuit breaker and is not controlled via the SCADA system. However the main circuit breaker position is monitored through SCADA and CCMS system.
  4. Mt. Zion Hospital:
    - a. Mt. Zion Hospital normal power system does not have any load shed or monitoring system.
- G. Emergency Load Control System:
1. Moffitt/Long Hospital:
    - a. Essential systems in Moffitt Hospital are connected to two levels of emergency load shed system. The life safety and critical branch are not part of the load shed system. Equipment system has load shed in case one generator does not operate.
    - b. There is emergency load control system which controls approximately all loads being served from equipment system. Each load has been programmed to shut down and operate based on time sequence and load to be shed upon failure of one generator. Some of the equipment system load which serves critical areas such as the ICU, CCU, operating rooms, and some specific areas may be programmed to operate on the delay if one generator fails. This control provides more flexibility of load selection to be shed.

- c. In addition to emergency load control system, there is load shed which will be done by opening circuit breaker in paralleling generator switchgear, which serves equipment system automatic transfer bypass switch one at a time. The load shed occurs through paralleling switchgear interface. If load exceeds a certain threshold the load shed will occur. This load shed is provided as a redundancy if emergency load control system does not operate properly.
  - d. All circuit breakers in the emergency paralleling switchgear are connected to campus SCADA system and CCMS system.
2. ACC Building:
    - a. The emergency paralleling switchgear will have load shed capability to shed transfer switch load by opening circuit breaker that serves standby power if one generator failed. The load shed will be programmed through paralleling switchgear.
  3. Mt. Zion Hospital:
    - a. Currently there is load shed as part of the emergency paralleling switchgear which is connected to automatic bypass switch emergency circuit breaker feeder.
    - b. There are three emergency load sequences that are identified as sequence #1, #2, and #3. These sequences are based on priority, and generator availability, if one, two or three generators are available.

### **26-3 DESIGN ANALYSIS AND DOCUMENTATION**

- A. Submit a complete design analysis report for review with every submittal. Analysis shall list design criteria, assumptions, calculations and equipment selections. Provide as back-up data manufacturer's catalog data showing equipment dimensions, weights, capacities, electrical requirements, and maintenance and operating clearance dimensions.
- B. The project program or design analysis shall document any specific exception and compliance to the criteria herein. Generalized exceptions are not acceptable. Submit exception to design criteria to University's Representative for review and approval. Include all supporting documentation and other related items required for exception to design criteria.
- C. The design analysis shall include:
  1. Lighting calculations showing required and designed footcandles. For simple spaces, a zonal cavity calculation can be provided. For complex spaces, a point-by-point calculation shall be provided.
  2. Site lighting photometric analysis using point-by-point calculation. Maximum 5 feet on center point spacing for exterior areas. Provide emergency lighting at site area for pathway to the public street.

3. A projection/summation of the electrical loads to the electrical distribution system to justify the sizing of the building transformers, utility service, and building generator for emergency system.
4. Voltage drop calculation, phase balance calculation, power-factor correction calculation, power system study, short circuit study, coordination study, and arc-flash study.

D. Voltage Drop Calculation:

1. Size feeder conductors to limit voltage drop to two percent (2%). Size branch circuit conductors for a voltage drop of not more than three percent (3%). Provide voltage drop calculations of longest circuits for each wire size under maximum load conditions to demonstrate proper circuit sizing.

E. Phase Balance Calculation:

1. Proper balancing of single-phase loads among the three phases on branch circuits and feeders is necessary to keep the load unbalance and the corresponding phase voltage unbalance within reasonable limits. An unbalance will affect three-phase motors and sensitive electronic equipment and shall not exceed two percent (2%). Single-phase loads shall not be connected to three-phase circuits that are supplying equipment that would be sensitive to phase voltage unbalance. Motors and lights shall not be on the same circuit or panelboard.

F. Power-Factor Correction Calculation:

1. Power-factor correction shall be required at individual inductive loads with PF less than 85 percent. Correction to 90% is required.
2. Power-factor correction shall be required at building service entrance equipment where PF is less than 90 percent under every loading condition.

G. Power System Study:

1. General
  - a. Short Circuit, Coordination, and Arc Flash Studies shall be performed. Submit studies prior to final acceptance of distribution equipment Shop Drawings and prior to release of equipment for manufacture. If formal completion of studies may cause delay in equipment manufacture, acceptance from the University's Representative may be obtained for preliminary submittal of sufficient study data to ensure that selection of device ratings and characteristics will be satisfactory. Provide for both normal and emergency systems.
  - b. Arc flash study for equipment shall be performed. Include arc flash label on equipment based on short circuit study. Determine arc flash boundary and incident energy per NFPA 70E. Determine the required personal protective equipment (PPE) required on each equipment based on arc flash boundary.

- c. Report shall include portions of electrical distribution system from primary of service transformers down to and including 480V and 208V distribution system. Normal and emergency system connections and those that result in maximum fault condition shall be adequately covered in the study.
  - d. Perform studies in accordance with ANSI C37, ANSI C57, and IEEE Standards 320, 141, 242 and 399.
  - e. The University shall provide the most recent short circuit and arc flash study to design professional to assist in the studies.
2. Short Circuit Study:
- a. Perform study with the aid of a digital computer program, such as OTI's ETAP or SKM's DAPPER.
  - b. Include data on power source's short circuit contribution, resistance and reactance components of branch impedance, X/R ratios, base quantities selected and other source impedance.
  - c. Calculate short circuit momentary duty values and interrupting duty values on the basis of three-phase bolted short circuits at each switchgear bus, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, list the total duty on the bus, as well as the individual contribution from each connected branch, with its respective X/R ratio.
  - d. Perform protective device evaluation study to determine adequacy of circuit breakers, molded case switches, automatic transfer switches and fuses by tabulating and comparing short circuit ratings of these devices with calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards.
  - e. Include recommended settings for system ground fault devices. The settings shall provide coordination so that downstream feeder devices will trip before upstream devices.
3. Coordination Study:
- a. Perform study with the aid of digital computer program, such as SKM's Captor or equal.
  - b. Include system protective devices from utility company devices feeding the building down to distribution panelboard branch breakers.
  - c. Plot device curves on log-log paper, grouping appropriate devices together.

- d. Study shall show selective coordination so that the device closest to the fault will trip before any other device trips. Recommend settings of devices to achieve this coordination.
4. Arc-Flash Study:
    - a. Perform study with the aid of digital computer program, such as SKM's Captor or equal.
    - b. Include system protective devices from utility company devices feeding the building down to distribution panelboard branch breakers.
    - c. Provide stickers for equipment indicating the arc flash hazard, personnel protective equipment required, etc. to place on electrical equipment.

#### H. Report Contents

1. Summarize results of system study in a final report. Submit five bound copies of final report.
  2. Include the following sections in the report:
    - a. Description, purpose, basis and scope of study and single line diagram of that portion of power system which is included within scope of study.
    - b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same.
    - c. Protective device time versus current coordination curves, tabulations or relay and circuit breaker trip settings, fuse selection and commentary regarding same.
    - d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
    - e. Other sections as appropriate.
    - f. Protective Device Testing, Calibration and Adjustment: Equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system study.
    - g. Provide arc-flash labels on equipment and determine arc-flash boundaries and incident energy per NFPA 70E. Determine the required personal protective equipment (PPE) required on each equipment.
- I. Luminaire Schedule: Each luminaire type utilized shall be included on a luminaire schedule on the drawings with a detailed description, manufacturer's basic catalog number, mounting

- type, total wattage, lamp type, voltage and quantity. Provide details for special mounting or installation conditions, pole types and bases, etc. Provide energy efficient luminaire in each space. The luminaire in all patient care areas must be completely sealed. In operating rooms luminaire must be listed for surgery rooms. For other special areas such as ICU, CCU, cath labs, radiology, Magnetic Resonance Imaging (MRI), kitchen, cafeteria, laboratories, pharmacy, etc. provide luminaire suitable for the space. All recessed, surface mounted fixture housings must be completely sealed. Pendant, wall mounted direct/indirect fixtures must have cover lens with cleanable capability. Recessed fixtures with direct/indirect or basket must have dust cover.
- J. Drawings: Drawings shall symbolize each luminaire location, luminaire controls, associated branch circuit conduit, outlet boxes and wires, on the electrical lighting floor plans. Luminaires shall be identified on the electrical lighting plans as to type and total wattage and cross-reference to the luminaire schedule. The emergency lighting shall be identified on floor plan and branch circuit must be completely independent.
- K. Electrical Single Line: The electrical power distribution system shall be defined by an electrical single-line drawing showing significant electrical equipment, available fault currents at each equipment location, equipment ratings, identification numbers, circuit protection ratings, feeder conduit and wire sizes, lengths and voltage drops. A load summary shall be provided for each switchboard, panelboard, and Motor Control Center (MCC).
- L. Branch Circuit Panel Schedules:
1. Provide complete branch circuit wiring for all devices, identify branch circuit number for each device.
  2. Provide separate branch circuit for each system, normal, life safety branch, critical branch, equipment system. Each system must be installed in independent raceway system.
  3. Provide separate neutral for each branch circuit in patient care area, nurse station, ICU, CCU, operating room, Pediatric Acute Care unit (PACU), recovery, radiology, laboratory, pharmacy, kitchen, cafeteria, and other supporting spaces to meet CEC.
  4. The quantity of branch circuits in the same raceway is limited per California electrical code without derating factor for conductors.
- M. Lighting System:
1. Lighting Fixtures:
    - a. Lighting system includes street lighting, parking area lighting, parking structure lighting, ground lighting, landscape lighting, building interior lighting, building exterior lighting, emergency lighting, and other special area lighting.
    - b. For lighting levels, refer to the Illuminating Engineering Society of North America (IESNA) publication for illumination quantity and quality guidelines.



- c. Specific areas, such as patient care areas, require lighting fixtures that have completely sealed housings and are easily cleaned.
- d. Lighting levels in corridors in areas such as patient care area, nurse station, ICU, CCU, radiology, laboratory, pharmacy, kitchen, cafeteria, and other supporting spaces shall be per IESNA on high side. Provide with multiple lighting controls.

2. Lighting Controls:

- a. Provide automatic lighting controls for luminaires as required by code and to minimize lighting energy usage.
- b. Provide local dimming and/or dimming system as required to minimize lighting energy usage or meet space requirements.
- c. Provide daylight harvesting and other energy efficiency light control methods to suit project requirements.
- d. Automatic control consists of local occupancy sensors, centralized time clock with the capability to blink warning functions, exterior photo cell, or astronomic time clock, and the capability to connect to network to allow for remote access.

N. Signal System:

1. Where project calls for telecommunication, sound system, public address, and/or security system, define by showing device arrangement, wiring arrangement, head end location, equipment rack, riser diagram, cable schedule, show all major components, short description, identification and interconnection of major components, conduit and wire sizes.
2. Provide all pathways (conduit, cable tray, and/or cable management system) and coordinate all power requirements.
3. Provide riser diagram for signal system (telecommunication, sound system, security, etc.). Riser diagram for each signal system shall be defined by a riser showing major components, short description, identification number, and interconnection of major components, conduit, and wire size.
4. Provide complete design for sound system and public paging, and clock system to suit each project and each building facility.
5. Coordinate with University's Representative to confirm the scope of design for telecommunications (telephone/data) and security and provide accordingly per University telecommunication standards.

O. Nurse Call System:

1. Provide audio/visual nurse call system for all patient care areas, ICU, CCU, operating rooms, emergency department, and other areas as required by code and/or University.

2. Provide visual system and/or audio/visual for areas such as radiology, cath labs, and other areas where code allows visual system. However, this shall be reviewed with the University.
3. Provide code blue and staff emergency station in all operating rooms, Cath labs, CT scans, ICU, CCU, emergency department, radiology, and critical patient care area.
4. At UCSF Parnassus Campus at Moffitt/Long the Nurse Call system is Rauland System. Some limited areas such as the emergency department, PACU, are Intercall. Coordinate with University and provide nurse call system accordingly. Coordinate any upgrades and/or additions to standardize with the University. The new nurse call system must be compatible with the existing system. Any nurse call upgrade shall be reviewed with the University.
5. UCSF Parnassus ACC building has visual and audio/visual. The Nurse Call system is manufactured by different companies. Currently the University utilizes Rauland system to match with Moffitt/Long Hospital. Coordinate with University's Representative and provide nurse call system accordingly. Coordinate any upgrades and/or additions to standardize with the University.
6. UCSF Mt. Zion Building "A", "B", "C", "D" and "R" has visual and audio visual nurse call system manufactured by different companies. Currently Mt. Zion utilizes Rauland System. To match with building standard, coordinate with the University and provide nurse call system accordingly. Coordinate any upgrades and/or additions to standardize with the University.

P. Sound System:

1. Moffitt/Long Hospital:
  - a. Sound system throughout Moffitt/Long Hospital buildings.
  - b. Provide speaker in all corridors and in areas where there is not adequate coverage.
  - c. Provide volume control in areas such as nurse station, labs, offices, and other supporting spaces.
  - d. Sound system in Moffitt and Long Hospital operates on two different voltages. Moffitt Hospital operates at 70.7 Volt and Long Hospital operates at 25 Volts. Do not interconnect systems together.
  - e. There are two sound risers in Moffitt and one in Long Hospital. There is wiring interconnections between head end equipment at 1<sup>st</sup> Floor which allows these two systems to operate together.
  - f. The sound system speaker for each building must be connected independently. Do not interconnect between buildings.

2. ACC Building:
  - a. There is not a separate sound/paging system in ACC. There is a speaker system which is connected as part of the fire alarm system.
  - b. Locate devices to allow for sound coverage throughout the building.
3. Mt. Zion Building “A”, “B”, “C”, “D” and “R”:
  - a. Provide speakers in all corridors and in areas where there is not adequate coverage.
  - b. Provide volume control in areas such as nurse stations, labs, offices, and other supporting spaces.
  - c. There is paging system head end equipment that is located at the “B” Building which serves speaker system in buildings “A”, “B”, “D”, and “R”.

Q. Fire Alarm System:

1. Moffitt/Long Fire Alarm System:
  - a. Provide ceiling mounted smoke detector in each patient room, nurse station, corridors, and supporting spaces with hold open doors.
  - b. Provide manual pull, audio/visual, and visual fire alarm devices in all corridors and areas required by code, and all supporting spaces.
  - c. Provide ceiling smoke detector, duct smoke detector, and/or in-duct smoke detector for all fire smoke dampers. Provide fire alarm control module and interposing relay to interface for fire/smoke damper. Provide with remote indicator light and damper control mounted below ceiling to allow for damper testing with key switch.
  - d. Provide ceiling smoke detector, duct smoke detector, and/or in-duct smoke detector for all fans required to be shutdown and provide fire alarm control module, monitor module, and interposing relay to allow fan fire shutdown.
  - e. Provide complete design of fire alarm system including fire alarm device arrangement, all fire alarm interface, riser diagram, fire alarm zone arrangement, zone schedule, and sequence of operation. Include device and circuit identification, and flashing candela for visual devices.
  - f. Moffitt and Long Hospital serves from separate fire alarm system with interconnection at 1<sup>st</sup> Floor which allows both systems to operate together.
  - g. Design all fire alarm systems at Parnassus campus (Moffitt/Long) as described above. Send documentation to the University’s Campus Life Services Facility to prepare fire alarm shop drawing for submission to Agency Having Jurisdiction.



- d. Provide ceiling smoke detector, duct smoke detector, and/or in-duct smoke detector for all fans required to be shutdown. Provide control module, monitor module, and interposing relay to allow fan fire shutdown.
  - e. Provide complete design of fire alarm system including fire alarm device arrangement, all fire alarm interfacing, riser diagram, fire alarm zone arrangement, zone schedule, and sequence of operation. Include device and circuit identification, and flashing candela for visual devices.
  - f. Mt. Zion fire alarm system control panel for Buildings “A”, “B”, “D” and “R” is located at Building “A” basement, and 1<sup>st</sup> Floor of “Building “A” with interface to Building “C” fire alarm system. Building “C” fire alarm control panel is located at the 1<sup>st</sup> Floor of Building “C”.
  - g. Fire alarm in Mt. Zion Building “A”, “B”, “C”, “D”, and “R” is a Notifier system. All modifications and additions must match with existing fire alarm system.
  - h. Coordinate fire alarm submittal preparation with the University’s Representative.
- R. Electrical Commissioning and Operation and Maintenance Manual:
- 1. All electrical equipment must be tested and started up in field.
  - 2. Commissioning of all electrical equipment includes medium voltage distribution system, low voltage electrical distribution switchgear, substations, transformers, distribution switchboards, motor control centers, panelboards, lighting, lighting control, nurse call, sound system, and other signal systems.
  - 3. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include submittals, instruction leaflets, instruction bulletins, and renewal parts lists when applicable, for the complete assembly of each major component. The following items shall be part of the operation and maintenance manual:
    - a. As-built drawings.
    - b. Catalog data sheet of equipment and related items.
    - c. Test reports from field testing.
    - d. Complete operating instructions, maintenance manual, and parts list.
    - e. Coordination curve for protective relay and other current protection.
    - f. Complete point-to-point wiring diagram, control interface showing all wiring connections, terminal blocks, terminal locations, and cable type.
- S. Branch circuit panel schedules shall be provided for each panelboard. Schedule shall show each phase, circuit number, breaker size, and connected circuit load in volt-amps, type of load (i.e., lighting, receptacle, etc.), main circuit breaker or main lugs only, surface or recessed

mounting, and top feed or bottom feed. Show summary calculations for panel at bottom of each panel schedule. Equipment AIC rating requirements shall be placed in appropriate schedules on the drawings.

#### **26-4 GENERAL DESIGN CRITERIA**

- A. **New Utilities and Extensions:** New utilities and extensions shall be coordinated with and be consistent with the University's Campus Utility Master Plan (UMP) and Long Range Development Plan (LRDP). Additions to 12kV systems at Parnassus and Mt. Zion shall be approved after completion of load studies, coordination studies and short circuit studies to determine impact on the existing system configuration. Electrical service requirements, additions, and modifications must be determined while the project is in the preliminary or early design phase.
- B. **Electrical Service Requirements:** Electrical service for a building must be determined while the project is in the preliminary or early design development phase. This includes establishing dual or single feed requirements, the tie-in points and location of service equipment and the magnitude of new power requirements. Where the design is to utilize an existing building service, establish the net increase in electrical power requirements to evaluate whether the existing service capacity can accommodate existing and new loads. The University will perform demand load surveys on affected portions of the existing system when requested.
- C. **Electrical Equipment Location:**
  - 1. Locate electrical equipment in dedicated electrical rooms accessible to authorized personal only. The location shall be a secure location.
  - 2. The location of the main switchgear and the low-voltage distribution system shall take into account voltage drop and material cost. To achieve a high efficiency power delivery design, the power supply point shall be as close as possible to the center of the building electrical load. That will keep feeder lengths short and achieve a minimum voltage drop without resorting to increased copper conductor sizes. The cost for locating the power supply point near the center of building load shall be compared with the cost for any alternate location.
  - 3. **Space.** Place utilities in electrical room with access from each floor. Provide space for future utilities equal in area to one-half the space required for the initial installation. Where load conditions justify, use busways for riser and floor distribution as an economic alternative to conduit and wire.
  - 4. **Unacceptable Locations and Connections.** The following design locations are unacceptable:
    - a. Electrical equipment requiring periodic inspection, maintenance, or adjustment with access via ladders or crawl space.
    - b. Electrical substations or switchboards with only one access door, or located below mechanical equipment rooms, kitchens, toilets, or other "wet" rooms without waterproof floors.

- c. Electrical panels located in or requiring access through private offices or narrow, heavily used passage ways.
- d. Electric panels or telephone cabinets in doorways, behind doors, or in narrow passageways.
- e. Electrical panels located in public space. Exception: Where necessary coordinate location with the project manager.

5. Special Locations

- a. Basements and below grade: Secure electrical equipment located in basements or below grade against flooding.
- b. Wet Areas (Spaces Cleaned with Water or Steam, and Exterior Areas):
  - 1) Make electrical work in these spaces waterproof.
  - 2) Provide NEMA 4X enclosures for electrical equipment.
  - 3) Seal conduits entering or leaving the area.
  - 4) Where possible, locate items like switches and programmed clock for lighting outside the space.
  - 5) Install large equipment like switchgear and motor control centers located on roofs or outside in walk-in electrical equipment enclosures that have double walls with insulation, fully gasketed doors, dual redundant heat pumps for interior heating and cooling to eliminate the possibility of condensation inside the equipment or enclosure. Exterior walls shall be constructed of stainless steel or aluminum.
  - 6) Finish enclosures with a heavy-duty maintenance coating of ultraviolet-inhibited isocyanate/acrylic resin coating system of a high solids polyamide or amine cured (catalyzed) epoxy.

D. Medium Voltage Distribution System:

- 1. Electrical service is taken from Pacific Gas and Electric Company's Distribution System at 69kV and transformed to 12kV. With the exception of a few areas served by PG&E, most of the campus is served by University's own 12KV system. The system voltage is a nominal 12,000 volts, three-wire and solidly grounded. No single-phase connections are permitted. Campus distribution is underground via conduit duct banks, manholes, and tunnel utility systems. New systems will be routed underground. Overhead distribution is prohibited. Duct bank routing and depths shall be coordinated with existing utilities.
- 2. The University has standardized on 500 thousand circular mils (KCM) as the preferred size for the 12 kV cable. The load carrying capability of 500 KCM is much higher, at 12

kV, than is needed for most of the building loads on campus. The 500 KCM size has been chosen as a standard size to simplify fault calculations and to reduce the amount of stock cable for replacement purposes. The large size allows for future expansion without replacing feeders. Building feeders shall have the following minimum conductor sizes:

<b>CIRCUIT RATING</b>	<b>MINIMUM CONDUCTOR SIZE AND TYPE</b>
12kV 200A Feeders	No. 4/0 Copper
12kV 400A Feeders	500 kcmil Copper
Loop conductors	500 kcmil copper

3. Above grade distribution equipment includes metal-clad switchgear, pad-mount transformers, SF6 sectionalizing switches, air-break pad-mount switches, and air- break load interrupter switches at unit substations. Below grade and tunnel equipment is subject to being submersed and shall be designed accordingly.
  4. New building loads shall be supplied from the 12kV system when the load exceeds 150kVA. Generally, two new SF6 sectionalizing switches with a minimum of six switched ways are required for new connections to the 12kV system. Connections to the existing circuits may be provided from existing spare 12kV SF6 sectionalizing switches, each fed from a separate circuit where available. Where G&W type RA oil switches exist at the point of connection, they shall be replaced with new SF6 switches having a minimum of two spare ways available after new switch installation. Dual selective radial feeders shall always be provided under one of the following conditions:
    - a. For new major building loads and research or state facilities.
    - b. For new 12kV feeder extensions from the “ring” loops.
    - c. For continuation of existing dual connections of the existing loop circuits.
  5. Connections to the existing loop shall be provided from the existing vaults in the campus ring tunnel where possible. The University’s representative will determine availability of existing switch positions and need for new SF6 sectionalizing switches.
  6. Single radial feeders may be provided under one of the following conditions:
    - a. Temporary facilities.
    - b. Special buildings as directed by the University.
- E. Where the project design only allows for one 12kV circuit initially installed to a building, provisions shall be made for the future installation of the second sectionalizing switch and second feeder providing a dual selective system. An existing single radial feeder may also be extended to a new building but provisions shall be made for a second feeder and circuit extension. Building 12kV to 480V transformers shall have dual primary switches for dual feed.



- F. Minimum conduit size for 12kV shall be 5” diameter. Provide at least one spare 5” conduit for the service to a building. Conduits extending the campus loop service shall include a minimum of two spare 5” conduits.
- G. Where motor loads exceed 250 HP, provide 4,160V rated equipment and service. Motor starters shall limit inrush currents and have vacuum-type switching devices. 4,160V is appropriate for Central Plant and other installations with similar load conditions. Variable frequency drives (VFD) shall be required to limit inrush, voltage dip and control power factor.
- H. Service from Pacific Gas and Electric (PG&E) Company:
  - 1. Pacific Gas and Electric (PG&E) provides 12 kV underground primary service to some areas of Parnassus campus. This service is intended to supply selected individual buildings with individual metered service, independent of the main Campus 12kV system. PG&E will provide transformers and meters. This type of service is a special circumstance, and shall be reviewed with the University on an individual basis for the following types of projects:
    - a. Temporary structures where connection to the Campus 12kV system is not economically feasible.
    - b. Privately funded and operated facilities located on Campus property.
    - c. Special buildings as directed by the University.
  - 2. PG&E requires five-foot easement on each side of underground service. Any digging near PG&E lines requires notification to the power company.
  - 3. The Campus 12kV Distribution System shall be the first choice for electrical service.
  - 4. The existing PG&E services at Mt. Zion are 277/480V and 120/208V services. Any major modifications to the campus requires the evaluating of existing service, and the provision of a multiple design approach with consideration of the existing utility services for review by the University.
- I. Low Voltage Systems:
  - 1. Power
    - a. Electrical system within the buildings shall be three-phase 480Y/277V, solidly grounded and can be provided by 12KV to 480Y/277V transformation. Liquid filled transformers shall be provided at each building with either an outdoor pad mounted or indoor unit substation. Transformation from 480V to 208Y/120V or other voltage will be accomplished in electrical rooms with dry-type transformers. Provide separate transformers for each building’s service.

- b. The University requires separate dedicated feeders for panelboards. A tapped feeder serving more than one panelboard is not acceptable. Provide a dedicated feeder breaker and feeder for each panelboard.
  - c. New construction or additions to facilities may be connected to existing secondary distribution systems where the electrical system has adequate spare capacity. Calculate that voltage levels for existing and new loads will be acceptable (not more than 5% drop from nominal) after connection of new load.
  - d. Main electric rooms shall be sized large enough to accommodate switchboards, panelboards, transformers, MCC's, or other system cabinets. At least one of the entrances to the main electrical room shall be two 3'-0" doors for an opening size of 6'-0". Install FACP, EMS, and other control related items in a separate room.
  - e. Provide one electrical room on each floor of a building and locate electrical rooms in vertical alignment. Feeders to panelboards on the same floor shall not exceed 250 feet. Where feeders exceed 250 feet provide an additional electric room. Provide an outdoor motor control center if needed on roof where mechanical equipment is located on roof.
  - f. Conductors shall be selected to provide a quality installation. The choice of conductor size and construction shall be made incorporating factors that affect power delivery, reliability and quality. Conductor ratings shall be based on the highest ambient temperature encountered and de-rating as required by NEC for the number of conductors in a raceway. Where underground duct bank is utilized, duct bank heating and cable de-rating requirements shall be determined. Determine the voltage drop is within allowable limits or increase wire size accordingly. Voltage drop shall not exceed 2 percent for feeders and 3 percent for branch circuits. Circuit harmonic content may require over-sizing neutral conductors or additional measures, except where standards require installation of 200% neutrals.
2. The preferred voltages for supply of power to motors, lighting, and general loads shall be as follows:

Motors 1/2 HP and larger	480 volts, 3 phase
Motors smaller than 1/2 HP	120 volts, 1 phase and/or 208 volts, 1 phase
Lighting, interior fluorescent, LED and HID	277 volts, 1 phase
Lighting, exterior (attached to building)	480/277 volts, 1 phase and/or 277 volts, 1 phase
Lighting parking lot, street and pathways	480 volts, 1 phase
Convenience receptacles	120 volts, 1 phase
Vender equipment	208 volts, 3 phase only when 480volt, 3 phase equipment is not available

J. Lighting Systems

1. Systems included in lighting category include parking area lighting, parking structure lighting, grounds lighting, building interior lighting, and emergency lighting.
2. Lighting circuits shall be loaded to maximum of 15 amps.
3. Lighting levels shall be based on task and location. Refer to the Illuminating Engineering Society of North America (IESNA) publications for illumination quantity and quality guidelines.
4. Luminaires that are 45 feet above finished floor cannot be re-lamped by present University equipment. Provide alternate means of re-lamping luminaires by either lowering luminaires, catwalks, or other approved method acceptable to University's Representative.
5. All major renovations shall utilize LED type fixtures where possible. For smaller projects, fixtures shall match existing adjacent areas. Coordinate with the University for specific fixture types.
6. Exit signs shall match adjacent areas.
7. Provide LED type fixtures for all exteriors, parking lots, parking structures, and other similar areas to the extent possible. All LED light fixtures shall have dimming capability.
8. Provide sensor for each parking lot light fixture. To allow lighting control provide LED fixture with dimming capability.

#### K. Lighting Controls

1. Provide automatic lighting controls for all luminaires as required by Code and to minimize lighting energy usage. Automatic controls consist of local occupancy sensors, centralized time-clock based relay panels, and exterior photocells.
2. Automatic controls shall not be provided for the following areas:
  - a. Emergency life safety lighting circuits.
  - b. Patient care lighting circuits.
  - c. Lighting provided for enhanced security.
  - d. Luminaires and circuits specifically authorized by the University, on a project by project basis.
3. Centralized lighting controls shall be provided which are capable of interfacing with a building Energy Management System (EMS), where such a system is provided. Lighting controls shall have expansion capability.
4. Occupancy sensors shall be provided to save energy in bathrooms, private offices, lecture halls, classrooms, enclosed stairwells, storage rooms, janitor's closets, and other spaces

with intermittent occupancy. Occupancy sensors shall not to be used in patient rooms, nurse stations, radiology rooms, operating rooms, kitchen, exam room, procedure rooms.

5. Provide dual switching strategies to control inboard/outboard lamps in luminaires where applicable. Do not switch alternate luminaires unless the luminaires have two lamps or less, and uniformity of lighting levels is maintained when alternate luminaires are so switched. Provide dimming switch where it complies to provide multi level lighting control.
  6. Provide dimming switch for LED light fixtures to provide multi-level lighting control.
  7. Provide automatic daylighting control override of occupancy sensors in rooms that have windows, skylights, or clerestories.
  8. Provide automatic dimming with a photocell of lobbies, atrium, and other spaces that have daylighting, but is not otherwise controlled to save energy.
  9. In enclosed stairwells with adequate daylighting for emergency egress, provide photocell in the stairwell to control the lighting. Lighting in stairwells can be dimmed up to 50%, photocell shall control light in stair 50% or 100%.
  10. Each exterior stairwell shall have the lighting controlled by a respective photocell.
  11. Provide centralized or distributed lighting control. Coordinate lighting control method with the University.
  12. Provide occupancy sensors for each light fixture in the parking garage area to allow each fixture to be controlled independently. Coordinate control with the University.
- L. Normal Power Distribution System:
1. Provide normal and emergency power in all patient care areas as required by code.
  2. Provide normal and emergency power to various equipment in patient care areas per code and/or as required by University's Representative. Provide additional normal or emergency power for all fixed equipment.
  3. Moffitt/Long Hospital:
    - a. Moffitt/Long Hospital normal power distribution are 277/408V-3 $\Phi$ -4wsn and 120/208V-3 $\Phi$ -4wsn which is distributed through bus riser, distribution switchboard, motor control center, distribution panels, and panelboards throughout building. Each feeder, bus riser, and electrical distribution equipment have specific designation which refers to origination of power floor designation. All designations must follow building standards and be reviewed with the University's Representative.
    - b. Provide normal power for all components per code. Provide normal power in all patient care areas and supporting spaces.

- c. Provide normal power for specific medical equipment as required by University's Representative.
  - d. Provide normal power for HVAC equipment as required by code. HVAC equipment shall be served from motor control center.
4. ACC Building:
- a. ACC Building Normal power distribution are 277/408V-3 $\Phi$ -4wsn and 120/208V-3 $\Phi$ -4wsn which is distributed through cable-tap riser, distribution switchboard, motor control center, distribution panel and panelboards throughout the building. Each feeder, cable-tap riser, and electrical distribution equipment has specific designation which refers to the origination of power, floor designation. All designations must follow building standard and be reviewed with University's Representative.
  - b. Provide normal power for all components per code. Provide normal power in all patient care areas, and supporting spaces.
  - c. Provide normal power for specific medical equipment as required by University's Representative.
  - d. Provide normal power for HVAC equipment as required by code. HVAC equipment serves from motor control center.
  - e. All HVAC equipment shall be served from motor control center. Individual enclosed starter is not acceptable unless it is approved by University's Representative.
5. Mt. Zion Building "A", "B", "C", "D" and "R":
- a. Mt. Zion normal power distribution for buildings "A", "B", "C", "D" and "R" are 277/408V-3 $\Phi$ -4wsn and 120/208V-3 $\Phi$ -4wsn which is distributed through distribution switchboard, motor control center, distribution panels, and panelboards throughout building. Each feeder, switchboard, motor control center, distribution panelboard, and panelboard have specific designation which refers to origination of power floor designation. All designations must follow building standards and be reviewed with the University's Representative.
  - b. Provide normal power for all components per code. Provide normal power in all patient care areas and supporting spaces.
  - c. Provide normal power for specific medical equipment as required by the University's Representative.
  - d. Provide normal power for HVAC equipment as required by code.
  - e. All HVAC equipment shall be served from motor control center. Individual enclosed starter is not acceptable unless it is approved by University's Representative.

M. Emergency Power:

1. IEEE Standard 446 shall be used as the basis for Emergency System design. Emergency generators shall be provided at buildings identified in this Standard or the Detailed Project Program (DPP) or as directed by the University.
2. Where emergency power is only required for emergency lighting and exit signs, LED exit signs and normally-off unit LED emergency luminaires with battery packs and chargers can be provided in lieu of a generator.
3. Where emergency power is required for special items not including lighting, an uninterruptible power supply (inverter system) shall be provided. Central inverter back-up systems will be evaluated on a case-by-case basis. Central A.C. inverter battery units shall provide 60Hz AC power output and automatic battery charging. Units shall have output load and voltmeters, line and load status lights, charge light and disarrangement alarm signal.
4. In Moffitt Long Hospital, provide segregated emergency power as required by code. Provide life safety branch, critical branch, and equipment system to various components.
5. In ACC Building, provide emergency power for selected equipment at each area as required to be functional in addition to other equipment that requires service from emergency power. The ACC Building has separate stand-by power that serves lighting, power, and HVAC equipment.
6. In Mt. Zion Building “A”, “B”, “C”, “D” and “R”, provide segregated emergency power as required by code. Provide life safety branch, critical branch, and equipment system to various components.
7. Emergency system must comply with all requirements of Bay Area Air Quality Management District (BAAQMD) emissions, Federal, and State environmental services.
8. Fuel storage system for generator shall be provided per joint commission NFPA and University requirements.

N. Power:

1. Outlets shall be provided as required to serve both normal and emergency loads.
2. Outlets serving patient care areas and in hospital shall be hospital grade illuminated.
3. Outlets serving pediatric patient areas shall be hospital grade tamper proof.
4. The basis for providing outlets and their circuiting requirements for 120 volt branch circuits shall be as follows unless otherwise directed by the University:
  - a. Convenience outlets, which per NEC are calculated at 180 W each – maximum four (4) per circuit, except otherwise noted.

- b. Single person staff offices - dedicated circuit for convenience outlets. Provide a minimum of five outlets. (Calculate at one outlet for 800 watt printer and others at 180 watts each.)
  - c. Printer outlets – maximum one (1) per circuit (calculated at minimum 800 W each). Provide one outlet per 500 square feet of administrative area per floor.
  - d. Copy machine outlet – maximum one (1) per circuit (calculated at minimum 1500 W each). Provide one outlet per 2,000 square feet of administrative area per floor.
  - e. Pyxis – one (1) per circuit.
  - f. Refrigerators/freezers – one (1) per circuit.
  - g. Outlets in Storage/Utility Areas shall be on dedicated circuits, separate from other circuits.
  - h. Provide receptacles with control designation for all spaces required per California Energy Code (Title 24).
  - i. Other medical or specific equipment – one (1) per circuit.
  - j. Patient rooms – dedicated receptacles connected to critical branch and normal source. Provide a minimum of four (4) dedicated receptacles served from critical branch power. Provide a minimum of two (2) dedicated receptacles served from normal power.
  - k. ICU/CCU/NICU patient rooms – each receptacle shall be dedicated with LED indicator. Critical branch power shall come from two separate critical branch automatic transfer switches, the Critical Branch I and Critical Branch II source. Each bed shall be served from a patient service console (headwall) with integral panel.
  - l. Operating rooms – each receptacle shall be connected to a dedicated branch circuit. Each operating room shall be served from two dedicated ground isolation panels served from two separate critical branch automatic bypass switches, Critical Branch I or Critical Branch II.
  - m. All receptacles and duplex receptacles in I occupancy shall be hospital grade, as well as in outpatient clinic, all clinic spaces, and supporting spaces.
  - n. University furnished equipment – provide power as required.
  - o. Provide special outlets for equipment and/or as required by University’s Representative.
5. Provide disconnect switch within 10 feet of every motor. Disconnect switches shall be within sight of motor.

O. Telephone/Data

1. Telephone/data outlets shall be provided as required.
2. The basis for providing telephone/data shall be as follows unless otherwise directed by the University:
  - a. Single person staff offices – Provide a minimum of two telephone/data outlets.
  - b. Printer outlets – Provide one data outlet per 500 square feet of administrative area per foot.
  - c. Copy machine outlet – Provide one data outlet per 2,000 square feet of administrative area per floor.
  - d. Pyxis – one data outlet.
  - e. Other medical or specific equipment – one data outlet.
  - f. Patient rooms – Provide a minimum of two (2) data outlets. Provide a minimum of one (1) telephone outlet.
  - g. Intensive Care Unit (ICU), Intensive Cardiac Care Unit (ICCU), Neonatal Intensive Care Unit (NICU) patient rooms – Provide a minimum of three (3) data outlets. Coordinate with University’s Representative for any additional requirements.
  - h. Operating rooms – Provide a minimum of one (1) data outlet per wall (four (4) minimum). Coordinate with University’s Representative for any additional requirements.
  - i. Coordinate with University’s Representative for telephone/data requirements for each space and provide accordingly.

P. Radiology Equipment:

1. Provide power quality metering per manufacturer requirements. Provide power conditioner as required and/or as required by equipment manufacturer.
2. Coordinate with equipment manufacturer to provide project specific modality drawings including existing conditions and specific project area restrictions.
3. Inform radiology equipment manufacturer representative if the electrical distribution equipment that serves the radiology equipment serves any other radiology equipment and/or other loads that may impact the operation of radiology equipment.

**26-5 SPECIFIC DESIGN GUIDELINES**

A. Medium Voltage Conductors (26 05 13):

1. This section refers to medium voltage conductors and cables, 15kV.



2. No aluminum wiring is allowed.
3. Direct burial of cables is not allowed.
4. Cable for 12 kV distribution shall be single conductor 15 kV Type with 133% insulation (220 mils min.) over Class B stranded copper conductor.
5. Splices and terminations for 12kV cable shall be made using compression connections. Long barrel terminals shall be used, and compression connectors shall have a minimum of three crimps. At splices three crimps are required on both sides of the joint. The crimps shall be applied by alternating each crimp 90° from the previous crimp. Splicer of 12 kV cables shall have a minimum of 15 years experience. Provide the University's representative with sample of the splicer work and documentation of experience.
6. Apparatus Connections: 200 amp load break - Used for connection of a feeder cable to a device. Consists of the following components:
  - a. Apparatus Bushing - Universal Bushing Well, with appropriate shank length.
  - b. Bushing Insert - 200A or 600A depending on circuit rating.
  - c. Elbow Connector – Load break Elbow, with grounding adapter and Bailing Assembly.
  - d. Apparatus Connections - 600 Amp. Used for connection of a feeder cable 250 kcmil and larger, to a device. Consists of apparatus connection with grounding adapter.
  - e. Junction Module – 600 Amp, four-way. Used for joining a combination of cables.
  - f. Provide parking stands for elbows and insulating caps for bushing well inserts where cable is not connected.
  - g. Terminations into existing oil-filled equipment where permitted in writing by the University shall use “stud” type terminators with compound-filled cable compartments covers. Terminators shall not require draining of oil or access into oil-filled reservoirs to terminate or remove primary conductors.
  - h. Indoor terminations shall be heat-shrink or cold-shrink kits suitable for indoor/outdoor use. Outdoor terminations shall have skirts to five additional separations. Kits shall be fully qualified to IEEE-48 requirements. Outdoor switchgear shall be treated as an outdoor installation.
7. Completed high voltage cable installations shall have fireproofing tape applied to exposed cable in vaults, manholes, and pull boxes.
8. Mechanical connectors (set screw, split-bolt, etc.) are not acceptable for medium voltage cable splicing and terminations, shield grounding, and bonding. Provide compression / crimp type connectors.

B. Low Voltage Conductors (26 05 19):

1. This section refers to low voltage conductors and cables, 600 volts or less.
2. No aluminum wiring is allowed.
3. Direct burial of power and signal cables is not allowed.
4. Conductors
  - a. Power circuits shall be 12 AWG minimum. Control circuits shall be 14 AWG minimum. The neutral conductor shall be the same size conductor as the phase conductors throughout the distribution system and rated at 100 percent within the distribution equipment, except where harmonic current levels require use of 200 percent neutral conductor ampacity.
  - b. Data lines for computer automatic building control system shall be multi-conductor, jacketed cable with four twisted pair, insulated 20 AWG, color-coded.
  - c. Coaxial cable for television systems shall be broad band shielded type, to allow the addition of future communication channels.
  - d. Sound, nurse call, intercom and public address system conductors shall be run in separate raceways from power. Low, medium and high level conductors shall be shielded and run separately to prevent cross talk and interference. Where practical, multi-conductor jacketed cable runs for large groups of conductors of the same signal systems are preferred over individual conductors.
5. Metal Clad Cable (Type MC): Light-Weight Steel with Copper conductors and insulated ground, hospital grade listed is allowed only on limited applications such as under-cabinet lighting in out-patient clinic. Coordinate with University's Representative if the installation of hospital grade Type MC, which may be allowed for other specific conditions in specific spaces, is acceptable.
6. Application
  - a. Conductors used for power and fire alarm shall be in conduit or approved raceway systems.

C. Conduit Hangers and Supports, Penetrations (26 05 29):

1. Provide complete as required for installation of Electrical work.
2. Equipment to be of metal only; no wood or combustible material will be permitted including supports for outlet boxes.
3. Hangers, anchors and supports for conduit runs: As shown and herein specified.

4. Anchors for floor and wall mounted equipment as shown.
  5. Supports for equipment as shown.
  6. Provide complete support system to comply with seismic requirements. The support system shall be reviewed by a structural engineer.
  7. Fire stop penetration must be provided at all rated walls and floors. The rating shall be matched with the wall and the floor fire rated hours. Provide “F” and “T” rating for all floor penetrations to meet requirements of the Agency Having Jurisdiction.
- D. Grounding and Bonding (26 05 26):
1. Grounding system requirements shall be defined by a diagram showing system ground method(s), earth connection methods (grounding electrodes), and bonding methods. The diagram shall include requirements for grounding electrodes, grounding electrode conductors, equipment-grounding conductors, and associated equipment and material connections. The grounding diagram shall specifically illustrate duct bank, manhole (or vault), power transformer, switchgear (or switchboard), distribution panels, unit transformers, ground bus connection requirements and bonding of non-current and current-carrying metal parts as well as specialized requirements for sensitive electronic equipment and loads.
  2. Electrical systems are to be solidly grounded unless specifically approved by the University. 12kV and 480V distribution systems shall include a counterpoise grounding electrode, as well as interconnecting ground conductors to tie all grounding systems together. Cable shields shall be utilized for grounding conductors. Ground systems shall be established at buildings with the interconnection of cold water metal pipe, building steel, Ufer, driven rods or plates, ground rings, and coils.
  3. In patient rooms, radiology procedure rooms, ICU, CCU, and operating rooms, outlets for medical equipment, computers, telecommunications and signaling systems, and other sensitive equipment shall have dedicated ground conductors installed from the source transformers to the load. Ground conductors shall be distinctly marked.
  4. Campus electrical distribution system grounding shall be in accordance with the requirements of IEEE Standards and Recommendations, Manufactures Requirements, NEC Article 250, and the requirements of this section. The measures taken shall ensure that a good connection to earth is established and extended to all electrical equipment and non-current carrying metal parts associated with the electrical equipment. Sectionalizing switchgear, transformers, vaults, manholes and duct banks shall have grounding systems that match their maximum rating and exceed the minimum requirements of the Code and manufactures recommendations.
  5. Specific design practices are described for each substation, sectionalizing switch, transformer, vault and manhole. The earth connection at each of those sites shall be interconnected with the duct bank system grounding conductors.

6. Coordinate grounding requirements for specific sensitive equipment, such as imaging equipment, data, networking, patient monitoring, and other related equipment, with equipment supplier and provide grounding accordingly to suit.
7. Grounding
  - a. Grounding ring conductors shall be #4/0 AWG copper and equipment connections shall be #2 AWG copper.
  - b. Grounding conductors shall be sized so that fault currents likely to be imposed on them will not damage them. Good grounding for the extensive distribution system requires that equipment and hardware are properly bonded and the paths of all circuits are accompanied by a low resistance ground path to ensure protective relaying and other devices function properly.
  - c. Regardless of the ohmic value of the electrode system, it shall include metal underground domestic water pipe (where regular access is available and a 25 length is in contact with earth), ground ring and made electrodes (ground rods.) High temperature and chilled water piping systems shall not be used as grounding electrodes. Provide upper grounding and bond grounding to building steel structure and foundation as required to suit.
  - d. Each duct bank run shall contain a bare copper grounding conductor cast in the concrete. The ground conductors shall be located in the top row of the duct bank. A minimum of 3-inch concrete cover shall be provided.
  - e. Provide a ground bus at each Service Distribution Panel for the joining of ground connections, and to provide an accessible grounding system test location. The following ground connections shall be required at each ground bus:
    - 1) Grounding electrode conductor.
    - 2) The metal enclosure of the associated Distribution Panel
    - 3) The metal tank of the associated Transformer.
    - 4) Other equipment ground conductor.
  - f. Feeder and branch circuits shall include a copper equipment grounding conductor run in the same raceway with the current carrying conductors. Metallic conduit and raceways shall not be used alone as an equipment grounding conductor.
  - g. The grounded neutral of each separately derived system shall be bonded to ground at the transformer only. Ground shall be established by connection to building system structural steel or other grounding electrode. Where service equipment is provided, the neutral may also be bonded to the grounding electrode conductor as permitted by the NEC.

- h. The main switchboard shall have a copper ground bus where grounding electrode conductors are connected. The ground bus shall also serve as connection point for equipment grounding conductors, one for each feeder or branch served by the switchboard.
- i. A 3' long x 4" wide x 1/4" thick copper ground bus shall be installed in electrical rooms. All equipment shall be bonded to the ground bus in addition to NEC required grounds.
- j. Electrical equipment enclosures shall be bonded to ground by mounting and bonding the enclosure to a grounded steel frame or by proper bonding of a grounding electrode conductor to the enclosure. Metallic piping systems in the building, except natural gas lines, shall be bonded to grounding system.
- k. Additional grounding measures shall be provided where specific systems require supplemental grounding to ensure performance.
- l. Provide bonding to ground for elevator jack plunger.

E. Raceway and Boxes (26 05 33):

1. Raceway systems shall be designed to properly deal with the constraints of the building environment including corrosion, exposure to physical damage, vibration, movement, temperature variation, moisture, electrical area classification and other conditions which may be unique to an application. Raceway systems shall be designed in accordance with the NEC, appropriate industry standards and recommendations of manufacturers. Where future access to a space will be limited or costly to rework, provide spare raceways to ensure main distribution routes contain the means to transport the ultimate design capacity of service switchboards or other significant equipment.
2. Materials Junction and Pull Boxes: Use outlet boxes with appropriate covers as junction boxes wherever possible. Semi-flush and surface mounted boxes shall not be specified in corridors and public access areas.
3. Outlet boxes: 4 inch square, minimum, for flush mounted devices and luminaires. Cast type with gasket covers for outdoor or wet locations. Provide NEMA 4X (stainless steel) for outdoor and wet locations.
4. Conductors shall be installed in raceways. 12kV distribution system conduits shall be 5-inch minimum. Manholes and pull boxes shall be traffic rated and oversized to accommodate installation of future equipment and spares. Spare conduits shall be provided when directed and where future access to add conduits is limited. Spares shall include pull ropes and be routed to an accessible location beyond hardscape and other interferences that would require expensive repairs or service interruptions.
5. Conduit Sizing and Arrangement
  - a. Raceways shall be sized in accordance with rules and guidelines identified in the NEC. Equipment grounding conductors are required to be run with the power

conductors in all types of raceway systems including both metallic and non metallic. Include the cross section of equipment grounding conductors in fill calculations for power distribution raceways. In addition, the inside conduit diameter shall be of an appropriate size to prevent cable jamming during installation.

- b. Size conduit per NEC for conductor type installed or for Type THWN/THHN and/or XHHW-2M conductors, whichever is larger; minimum size 3/4" conduit. Coordinate with University's Representative if 1/2" conduit is allowed for specific congested spaces.

6. Classified Hazardous Areas

- a. Areas that include flammable or explosive sources of vapor, liquids, dust or fibers require compliance with NEC Article 500. Specifically identify the sources and the extent of boundaries for the appropriate Class and Division of such substances encountered. Appropriate conduit seals, drains and other fittings shall be provided for conduit systems in such areas.

7. Raceways

- a. EMT shall not be used as a ground return path in lieu of a ground conductor.
- b. Metal Clad Cable may be used as specified in the campus master specification. Coordinate with University's Representative to confirm what is allowable for specific areas.
- c. Junction, Pull and Outlet Boxes.
- d. Minimum size for the electrical boxes shall be 4" x 4", and minimum size for signal system electrical boxes shall be 4-11/16" x 4-11/16".
- e. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- f. Use flush mounting outlet boxes in finished areas.

8. Cable tray or j-hooks may be used where permitted by NEC.

9. Code-gage steel wireways may be used for interconnection of multiple enclosure assemblies.

10. Laboratory multi-outlet assembly: The first outlet shall start 3" to 6" from the end of the Isoduct. Electrical outlets shall be 2'-0" on center. Each run of isoduct shall have two data outlets, one emergency power 120 volt outlet with red body and electrical outlets 2'-0" on center. Isoduct raceways over 10 feet shall have additional data outlet for every 4' added.

11. Installation

- a. Low voltage conduit bend radius shall be no less than 15 times the nominal trade diameter. Medium voltage conduit runs shall have a minimum horizontal bend radius of 20 feet using factory bends.
- b. Minimum Burial Depth: Underground 12kV power distribution duct banks shall have a minimum burial depth of 36 inches. Low voltage circuits require a minimum burial depth of 24 inches. Refer to NEC for minimum burial depth of raceway for other types and situations.
- c. Duct banks: Concrete-encased duct banks shall be provided for 12KV power distribution runs outside buildings between buildings, substations and control centers. Conduit shall be concrete-encased when routed through NEC Article 500 electrical classified areas. 600 volts and less conduit banks adjacent to buildings and under buildings do not require concrete encasement.
- d. Route conduit through roof using piping and ductwork openings where possible; otherwise, route through weatherproofed roof jack. Pitch pockets are not acceptable.
- e. Maximum Size Conduit in Slabs above Grade: As allowed by Structural Engineer of Record.

F. Underground Electrical Distribution (26 05 43):

1. Provide duct banks to interconnect 12 kV distribution equipment sites, manholes and vaults. Maximum spacing between essentially straight runs of conduit manholes, vaults or pull boxes shall be 400 feet. Reduce spacing by 50 feet for each 45-degree bend and 100 feet for each 90-degree bend. This shall not release the installer from producing the necessary cable-pulling calculations to make sure the maximum tension or sidewall pressures are not exceeded.
2. Manholes and vaults shall be precast reinforced concrete with traffic or parkway loading rating as appropriate. The size shall provide sufficient space for cable splice bending and training of the cables, but wall length shall not be less than 5'-0". Grade level removable opening shall be large enough to accommodate sectionalizing equipment installation and removal, pulling sheaves and associated hardware. Rectangular removable covers shall be provided with a 3'-0" circular manhole cover for normal access.
3. Electrical power ducts shall be 5-inch minimum.
4. Duct entrances into manholes shall be so located that sharp bends of cable at duct mouth will be unnecessary.
5. Concrete encased 12KV power duct bank shall be completely encased in a minimum of 3 inches of concrete or as required by structural engineer.
6. The 12KV power electrical system ground conductor shall be a minimum # 4/0 AWG bare stranded copper cast in duct bank 3 inches below top of concrete, entering each manhole, and bonded to ground to rod.

G. Identification (26 05 53):

1. Electrical distribution system equipment, conduit and wire shall have identification. Equipment number or plan identification shall be unique to the building; e.g., “LP-11” shall not be used in an addition if the building already has an “LP-11”. Labels shall be based on the University Electrical Equipment Numbering and Identification Scheme included in this Section.
2. Medium Voltage Identification

MARK OR TAG	DESCRIPTION	EXAMPLE
*	12kV Distribution Circuit	UC-1
FI	Fault Interrupter	FI-01
MH	Manhole	MH-102
OFC	Oil Filled Cutout	OFC-01
OS	Oil Switch	OS-01
PMH	Pad-Mounted Housing	PMH-01
PMS	Pad-Mounted Switch	PMS-02
SF6	Sulfur Hexafluoride Gas Switch	SF6-01
T	Transformer	T-001

- a. All new high voltage equipment, transformers, switches and vaults are to be assigned numbers. A proposed Hi-voltage connection drawing must be issued to the university electric shop for the numbers to be issued.
- b. The numbering scheme provided by the University accomplishes the following:
  - 1) Establishes a unique identifier for all system components and eliminates possible duplication.
  - 2) Identifies equipment by type as listed in the following table.
  - 3) Use the substation name abbreviation for 12kV circuit breaker identification such as UC, PCUP, MCUP for University Substation, Parnassus Central Plant, and the Mission Bay Central Plant.
  - 4) Allows for the addition of new devices by type in an ordered manner.
  - 5) Facilitates the creation of computer database to keep records on equipment.
  - 6) Reduces confusion when referring to a piece of equipment and enhance communication.
- c. The 12kV circuit breakers located at the substation and distribution substations will be unchanged. Existing device numbers shall be reused when replacing equipment.



Consult with the University on device number assignment before labeling equipment. The University is continually adding device numbers so tracking and controlled assignment is required.

- d. New and future equipment shall be assigned a number during the design phase of a project to minimize the need for new nameplates after construction.

3. Low Voltage Identification

- a. The following low voltage equipment numbering scheme shall be followed:

TYPE	DESCRIPTION
DP	208/120V Distribution Panelboard
LP	208/120V Panelboard - Receptacles & Lighting
HDP	480/277V Distribution Panelboard
HLP	480/277V Panelboard - Lighting
ATS	Automatic Transfer Switch
ATBS	Automatic Transfer By-Pass Switch
CB	Circuit Breaker
DS	Disconnect Switch
EDP	Emergency 208/120V Distribution Panelboard
ELP	Emergency 208/120V Panelboard
EHDP	Emergency 480/277V Distribution Panelboard
EMCC	Emergency Motor Control Center
MSB	Main Switchboard
MCC	Motor Control Center
T	Transformer
US	Unit Substation

- b. Utilize numbering convention as follows:

- 1) First letter or number = floor designation; B = basement, 1, 2, 3, etc. (B)
- 2) Subsequent lower case letter = panel number on each floor; a, b, c, etc. (Ba)
  - a) Example: Emergency 277/480V Distribution Panelboard installed in basement is “EHDP-B”.
  - b) Example: Emergency 120/208V Panelboard installed in basement is “ELP-B”.
  - c) Moffitt/Long, ACC, and Mt. Zion each have specific systems for electrical distribution system designation. Provide identification to suit the building standards. Coordinate with University’s Representative for identification designation.

H. Power Monitoring and Control (26 09 13):

1. The University requires each electrical service to have a power revenue meter. Record and automatically report kilowatt-hours and other electrical parameters to a central computer over the campus Facilities Management fiber optic network. Consult with the University's Representative to establish reporting requirements for the project, which include meter identification, building identification and network connection. The University's will be provided with all information they request in order to program the power meter.
  2. Metering required on all switchgears, switchboards, distribution panelboards, automatic transfer switches, and other electrical equipment as required by University's Facilities Management. Connect meters to power monitoring system. Provide required programming to suit.
  3. Options described in part number are as follows:
    - a. D=Meter with integrated display
    - b. C=Seabus/module/DNP
    - c. 1=Power supply 85/240V
    - d. 0=Input voltage 277V
    - e. 0=Frequency, 60 Hertz
    - f. 0=Network card
    - g. N=Network card
  4. The University's existing software shall be used and meter provided shall be compatible with that software. Provide programming, startup and testing of the meter at the building and at the Campus central metering computer. Request the University's Master Specification for specifying the electric meter with the required accessories.
  5. Provide 1" conduit only to meter location from power management system network.
- I. Lighting Controls (26 09 23,33,36):
1. Lighting control system shall be listed by the California Energy Commission at the time of installation. Should any device specified not be listed, Contractor shall notify the University in writing before such product is installed.
  2. Switching system provides on/off control of lighting fixture, individually or in a group, from switches, motion sensor, dimming switch, key switch, or time clocks. System programming is accomplished via automatic relay and time clock. The system is intended to satisfy Section 131(d). Automatic shut-off controls of the energy efficient standard for non-residential buildings, CCR, Title 24, Part 6.

3. Lighting control system must have multiple channel (minimum 8 channels) for control and each channel must have capability for multiple programming functions. System shall have the capability for 365 days programming independently.
  4. Each lighting control must have time clock with capability for multiple channel programming for 365 days. All modifications to programming shall be done at time clock at each lighting control panel.
  5. Lighting control panel shall support the blink warning function with LED indication for each relay.
  6. Each channel shall have an automatic blinking of lights before they are turned off to allow occupants the opportunity to enter an override.
  7. Each light switch, key switch, and dimming switch which controls lighting within the space shall have the capability to override the after hour lighting control system time clock for the designated spaces. Designated central override switch in each area is not acceptable, except as noted.
  8. Lighting control system shall have microprocessor based digital controller with "LCD" display for multiple channel programmable for each day of the week on separate schedule. For 365 days independently repeated day is not acceptable.
  9. System shall have network capability between each floor and allow programming control interface between each floor.
  10. System shall have the capability to interface with the occupancy sensor, multiple zone day light harvesting, dimming system, and other related lighting control devices.
  11. System shall have on-demand capability.
  12. Lighting control must comply with California Building Energy Efficiency Standards (Title 24).
  13. System shall have the capability to interface with BMS system.
  14. Provide commissioning for lighting systems for each project. All commissioning documents must be submitted for approval as required by Title 24 and University's Representative. At the completion of commissioning provide all documents and reports to the University's Representative.
- J. Unit Substations (26 11 16):
1. Primary transformation of medium voltage power shall consist of primary incoming line sections, transformer section, and secondary outgoing power section(s). Where space permits, unit substation construction shall be utilized for substations larger than 300kVA, 208/120 volts and larger than 500kVA, 480/277 volts. Indoor dry cast coil type; compact unit power center substation construction may only be used for smaller capacity loads when approved by the University's Representative.

2. Incoming line section shall consist of two primary load break gang operated heavy duty air switches, manual spring charged, 600 amp, 3 pole, with single set of current limiting load side fuses (one per phase). Switches shall be arranged for manual selection of one of two incoming radial primary feeders at a time with Kirk-key interlocks provided. Primary cable terminations shall be at the bottom rear of each switch compartment, with porcelain cable terminators and surge arrestors on each phase. One switch shall be fused to protect the transformer.
3. Medium power transformers shall be liquid-filled pad mount or unit substation style where installed outdoors or unit substation indoors. The transformers shall have a retention area for spill containment. This concrete curb system shall be capable of containing the total fluid capacity. The transformer pad shall be 2" above the maximum containment level. Provisions shall be made, if outside, for the release of rainwater.
4. Transformers shall have dual primary feed selector switches and primary fusing. A pad mount transformer shall incorporate two sets of bushings, an A-B-A&B-Off selector switch, and dry well bay-o-net fusing sized to protect the transformer. Pad mount transformers shall have 200A primary bushings for separable connectors.
5. Transformer and unit substation identification shall comply with the University's Numbering Scheme.
6. Transformer Section
  - a. Transformer operating life and efficiency decreases rapidly when transformer loading exceeds the manufacturer's optimum load range. The transformer shall be sized and loaded within the manufacturer's optimum load range in order to maximize efficiency. Select a transformer with loss ratios of 1:6 or lower to maximize the transformer's loading point efficiency range. As an option, determine the transformer's average loading and review the cost of utilizing an 80<sup>0</sup> C rise transformer with loss ratios of 1:2 compared to that of 150<sup>0</sup> C rise transformer with loss ratios of 1:6.
  - b. Unit substation transformers shall have provisions for forced air, fan cooling, to increase substation capacity. The secondary bussing and main circuit breaker shall have adequate capacity for the fan cool rating of the transformer. Fan cooling provisions shall include:
    - 1) Power source for the cooling fans.
    - 2) Mounting provisions for the fans.
    - 3) Temperature sensor with relay control contracts for control of fans.
    - 4) Adequate ventilation must be provided for transformer rooms. Transformer vaults shall be fire-rated.

- c. Transformer room details shall show plan location of equipment and elevations.
- d. Pressurized, gas-filled, medium voltage to low voltage dry-type transformers are not acceptable.
- e. Liquid-immersed, polychlorinated biphenyl (PCB) insulated transformers shall not be used under any condition.
- f. Liquid filled pad mounted transformers shall be manufactured and installed to meet the following minimum requirements.

- 1) Ratings: The required transformer KVA shall be one of the following KVA ratings:

75	500	2000
150	750	2500
225	1000	3750
300	1500	5000

- 2) Transformers shall be braced for seismic zone 4 and/or other seismic requirements as required by the Agency Having Jurisdiction.
- 3) All transformers shall have seismic certification as required by the agency having jurisdiction.
- 4) Cooling class: OA
- 5) Primary voltage: 12,000 volts.
- g. Basic impulse level (BIL):
  - 1) 95kV (12,000 volts primary delta windings).
  - 2) 60kV (4160 Y/2400 secondary windings).
  - 3) 30kV (480 Y/277, 480 delta volts and lower voltage secondary windings and solidly grounded).
- h. Taps for 150 – 3750 KVA transformers: Four 2½%, two above and two below nominal 12,000 voltage rating, 12,600 /12,300 /12,000 /11,700 /11,400 volts
- i. Windings: Primary winding connection shall be delta-connected and secondary shall be wye-connected. Primary and secondary winding shall be copper.
- j. Impedance:

KVA RATING	% IMPEDANCE
------------	-------------

750 – 1500	5.00 (minimum)	5.75 (nominal)
2000 – 3750	6.25 (minimum)	6.50 (nominal)

k. Transformer insulating fluid:

- 1) Liquid-filled transformers shall have Factory Mutual approved less flammable fluid with a fire point greater than 300 degree Celsius such as Enviro-Temp FR3.
  - 2) Transformers shall be factory-filled and shipped complete to job site.
- l. Liquid-filled transformers shall be 55° C rise air-cooled. A 65° C rise rating is also required in addition to the 55° C rating.
- m. Transformer shall be provided with a four-position, three phase, load break primary switch. The switch shall have positions A, B, A&B, and OFF. The switch shall be hotstick operable with permanently marked positions

K. Medium Voltage Switchgear (26 13 00):

1. Metal Clad Switchgear with Vacuum Circuit Breakers

a. Construction

- 1) The equipment shall be seismically qualified per the requirements of the California Building Code.
- 2) The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Two hinged rear doors, with 3-point latch and vault type handles, complete with provisions for padlocking, shall be provided for each vertical section.
- 3) The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device
- 4) The circuit breaker compartment shall be equipped to house the removable breaker element. The mechanisms for levering the breaker shall be cell mounted and include all of the necessary interlocks to render the breaker mechanism mechanically trip free during the levering procedure. A contact shall ground the breaker between and at the operating and test positions. Stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts

when the breaker is in the disconnected position or out of the cell. Provide rails to allow withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device.

b. Bus

- 1) The main bus shall be copper with fluidized bed epoxy flame-retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, glass polyester for 15-kV class. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. Main bus for 15 kV shall be rated 1200 amperes. Insulated copper main bus shall be provided and have provisions for future extension. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.
- 2) A 1/4" x 3" (minimum) copper ground bus shall extend the entire length of the switchgear.

c. Wiring/Terminations

- 1) The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminals shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.
- 2) Incoming line and feeder cable lugs of the type and size indicated elsewhere shall be furnished.

d. Circuit Breakers

- 1) The circuit breakers shall be horizontal drawout type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.
- 2) Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit, which can be removed easily. The vacuum interrupter pole unit shall be mounted on glass polyester supports for 15 kV class. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding

design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

- 3) The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.
- 4) Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.
- 5) The breakers shall be electrically operated by the following control voltages:
- 6) 125- volt DC close and 125 volt DC trip, 125 VDC spring charge.
- 7) Each breaker shall be complete with control switch and red (closed) and green (open) indicating lights to indicate breaker contact position. Provide with white indicating light to indicate spring charged. All indicating lights shall be long life LED type.
- 8) AC control voltage shall be derived from a control power transformer mounted in the switchgear.

e. Protective Relays

- 1) The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.
- 2) Microprocessor-Based Protective Relay
- 3) Coordinate with University's Representative. Provide all required protective relay required for each facility, and provide all protected relay to protect upstream and downstream devices.

f. Miscellaneous Devices

- 1) Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.
- 2) Electrical interlocks to prevent multiple breakers from being closed at the same time but with an electrical transfer control that permits no-break transferring of the load from one breaker to the other and then opens breaker.
- 3) Fused control power transformers shall be provided as indicated on the drawings or as required for proper operation of the equipment.



- 4) Device 25 synch-check relay wired to the line side of each main breaker to check for synchronism between the two sources serving the double feeder switchgear. Provide with auxiliary relay and permissive contacts wired to the close circuits of the breakers of one feeder source and other feeder source breaker to permit paralleling of the two sources only when the sources are synchronized.
- 5) Device 43M electrically operated lock-out/tag-out switch to select local or remote control. Provide with auxiliary relays and contacts wired to the trip and close circuits for local or remote operation as shown on drawings.
- 6) Device 43HT key operated trip pre-select switch for make-before-break from one source to another source. Switch shall allow selection of one source or second source for tripping after circuit breakers are closed simultaneously. Provide adjustable time delay for tripping selected breaker.

g. Auxiliary Devices

- 1) Ring type current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the 15 kV breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.
- 2) Voltage and control power transformers of the quantity and ratings indicated on the drawings shall be supplied. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Control power transformer, single-phase, with primary fuses and secondary main breaker shall be mounted in drawout drawers. Rails shall be provided as applicable for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.
- 3) A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn
- 4) Surge Arrestors.

h. Metering

- 1) Provide metering devices where shown on the drawings. Where indicated, provide a separate metering compartment with front hinged doors. Include associated instrument transformers.
- 2) Provide current transformers for metering as shown on the drawings. Current transformers shall be wired to shorting type terminal blocks.

- 3) Provide potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
  - 4) Provide metering test switch for current and voltage metering circuits, wired in metering circuits as shown on drawings.
  - 5) Provide Microprocessor-Based Metering System. Provide with communications interface module to permit communication with the existing Facility Central Control and Monitoring System (CCMS). The communications interface module shall be compatible with the existing system.
- i. Finish
- 1) The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts.
- j. Accessories
- 1) The switchgear manufacturer shall furnish accessories for test, inspection, maintenance and operation.
- k. D.C. Power Supply
- 1) Battery:
    - a) Nickel cadmium alkaline pocket plate medium discharge rate type with translucent polypropylene cell containers.
    - b) System nominally rated 125VDC.
    - c) Battery to consist of 94 cells rated 159A from fully charged to 1.05V/cell for one minute and 42.4A to 1.14 V/cell for one hour, with a float charge of 1.40 – 1.42 V per cell (131.6V – 133.5V) and a high rate charge of 1.55-1.65V per cell (145.7V-155.1V).
    - d) Provide cells with all intercell connectors, connector covers, and flame arresting flip top vents.
    - e) Packaged in a floor standing steel enclosure as shown. Enclosure and shelves with cells shall be seismically built to withstand the seismic forces of seismic Zone 4 per CCR, Title 24.
  - 2) Charger:
    - a) Fully automatic, solid state, constant voltage charger designed for use with nickel cadmium alkaline batteries and switchgear applications.
    - b) Rated 35A – 130VDC output and 208V-3phase, 60Hz input.

- c) Designed to carry continuous and intermittent loads to its maximum rated output.
  - d) D.C. output filtered to 30mV ripple and current limited at less than 140%.
  - e) Transistor controlled magnetic amplifier circuits with continuous taper charging. Output voltage regulation within +/- 10%.
  - f) With the following accessories:
    - 1. Separate potentiometers for float and equalize charge voltage adjustments of +/- 5% mounted on front panel.
    - 2. D.C. ammeter and voltmeter with 50 multivolt movement, 2% accuracy.
    - 3. Power failure relay with terminals for connections to a remote alarm system.
    - 4. Circuit breaker AC input and DC output for complete protection.
    - 5. Switch and 24 hour equalizing timer to transfer from float charge to high rate equalize charge.
    - 6. High/Low DC voltage alarm relay with light.
    - 7. Ground detection system with required voltmeter, relays, lights and switches.
    - 8. AC pilot light
    - 9. Automatic surge suppression.
    - 10. Common alarm relay for all alarm functions.
    - 11. Steel enclosure, pre-treated with zinc phosphate, gray primer and gray baked enamel finish.
2. Metal Enclosed Load Interrupter Switchgear
- a. Switchgear Equipment and Components
    - 1) Metal enclosed load interrupter switchgear can be used in limited applications. Coordinate with the University's Representative for approval.
    - 2) The switchgear shall be seismically qualified per the requirements of the California Building Code.
    - 3) Switchgear line-ups – Load Air Interrupter Switch and Fuse units: Provide factory-assembled, metal enclosed switchgear, of types, sizes and electrical ratings and characteristics indicated; consisting of stationary structures

containing load air interrupter switch and fuse units, of quantities, ratings and types indicated. Form section framework of steel, braced and welded into a rigid structure. Enclose frames on front, rear, bottom (except cable compartment), top and sides with sheet steel removable covers and hinged doors, with latches or locks, with doors accessible from front. Select units for incoming electrical service indicated; with main bussing and connections of copper flat bus bars, silver-surfaced and tightly bolted for maximum conductivity.

a) Construct for the following conditions:

1. Installation: Indoor, NEMA Type 2 with drip shield
2. Service Requirements: 12.47 kV AC, 3-phase, 3-wire
3. Momentary Short Circuit Rating: 40 kA
4. Front and rear accessible. Switchgear line-up shall have all terminations, fuses, operating handles, and all serviceable parts completely accessible from the front or rear.
5. Terminations into Switchgear line-up will be at top of structure.

b) Structure:

1. The assembly shall be a full height, metal-enclosed, free-standing, dead-front steel structure of dust-tight indoor construction. It shall contain a ground bus, interrupter switches, power fuses and necessary termination hardware.
2. The enclosure shall be rigidly constructed to allow mounting pad level variations of plus or minus 1/8 inch. Under these conditions, doors shall open and close smoothly and all mechanical interlocks shall function properly.
3. A ground bus shall be provided the entire length of the assembly and shall afford connections in each vertical section.
4. Suitable means of lifting shall be provided.

c) Equipment Enclosure:

1. Each assembly shall contain two compartments, each with a hinged door.
2. The top compartment shall contain the switch and the bottom compartment shall contain the fuses.
3. The doors shall be mechanically interlocked with the switch to prevent opening the doors with the switch closed or closing the switch with doors open.

4. The switch compartment door shall have a plexiglass or similar covered window adequate for viewing the position of all switch contacts.
  5. Surfaces shall be thoroughly cleaned, treated and finished with ANSI 61 light gray.
- d) Air Load Interrupter Switches:
1. Fused switch assembly shall consist of a load break switch and one fuse mounting base for three general purpose current limiting fuses. Each switch shall be mounted in a dedicated vertical section and shall be completely isolated from other switches in the switchgear line-up.
  2. The air interrupter switches shall be the “stored energy” type, using a direct acting spring charged mechanism for both the closing and opening strokes or an approved equivalent operating mechanism.
  3. Switches shall be 3-pole, load break type, 15kV voltage class and shall have 600A continuous, 600A load interrupting rating as indicated, momentary and fault close rating of 20,000 amps asymmetrical (minimum).
  4. Switch contacts shall be silver plated copper. Switches shall have main make and break contacts and separate arcing contacts.
  5. The switches shall have keyed interlocks between air interrupter switches and low voltage main breakers at remote switchgear to safeguard personnel and reduce switch contact maintenance. The switch shall be operable only if the substation secondary main circuit breaker is open.
- e) Fuses
1. One set of three fuses shall be mounted in separate compartment within switch unit. Fuses shall be accessible through a hinged door mechanically interlocked with interrupter switch such that entry may be accomplished by de-energizing the switch. Fuses shall have ampere rating as shown on drawings and suitable for use on circuit having short-circuit capacity of 180,000 KVA symmetrical at 15kV.
  2. Fuses shall be self-contained and provide fast, clean interrupting with minimum let-through current. Fuses shall not be of the expulsion type.
  3. Fuses shall be current limiting type.
  4. Fuses shall be easily removable for replacement and/or inspection.
  5. Each switch section shall include spare fuse storage capability.
- f) Cable Terminations

1. All interconnection conductors and their terminating hardware shall be provided.
2. Crimp type lug shall be provided for the termination of conductors. Lug shall be tin plated copper, long barrel, two-hole type, suitable for conductor size as shown on drawings.
  - g) A set of station class 15KV surge arrestors shall be mounted inside the incoming line terminal compartment.
- b. Finish
  - 1) Finish shall be ANSI 61 gray paint.
3. Medium Voltage Switch (SF6)
  - a. The SF6 gas-insulated, manually operated, load interrupting 600A SF6 puffer style switch shall be suitable for use on a 12,000-Volt, three-phase, three-wire, 60-Hertz system.
  - b. Medium voltage switch (SF6) can be used in limited applications. Coordinate with University's Representative for approval.
  - c. SF6 switch shall be located in the tunnel or above grade or inside a building. Below grade switches or switch in below grade vaults are not acceptable.
  - d. The switch shall have six (6) three phase entranceways and six switched ways unless otherwise approved by University's Representative.
- L. Low Voltage Transformers (26 22 00):
  1. General
    - a. Low-voltage dry-type distribution transformers shall be energy-saving type and selected with 115 degree C temperature rise above a 40 degree C maximum ambient under full load condition and 220 degree C insulation class.
    - b. Provide local transformation for equipment requiring other secondary voltages.
  2. Dry Type Two Winding Transformers
    - a. Dry Type Transformers: copper wound, factory-assembled, air cooled dry type transformers. K-4 Factor transformers are required for harmonics from non-linear loads.
    - b. Mounting: Transformers 25 KVA and less may be wall, floor, or trapeze mounted. Transformers larger than 25 KVA shall be floor mounted.

3. In research, laboratory, computer, office or electronic buildings, dry-type transformers shall be 480/208V/120V transformers, dry-type copper winding, 115 °C rise with double size neutral terminal and K-4 rating. The core and coil shall be mounted on rubber isolation pads if not installed on slab-on-grade and if any vibration or hum could affect occupied spaces.

M. Low Voltage Switchgear (26 23 00):

1. Ratings

- a. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service.
- b. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as shown on the drawings.
- c. The bus system shall have a minimum ANSI 4-cycle short-circuit withstand rating of 100,000 amperes symmetrical.
- d. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes at the rated operating voltage. To assure a fully selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings, regardless of whether equipped with instantaneous trip protection or not.
- e. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

2. Construction

- a. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. Hinged rear doors, complete with vault type handles and provisions for padlocking, shall be provided. The switchgear shall stack a maximum of four (4) individually mounted draw-out breaker per structure.
- b. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and welded to steel corner angles cast in to concrete pads.
- c. Each vertical steel unit, forming part of the switchgear line-up, shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment, and a rear cabling compartment. Each

individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections, including the bus compartment, by means of steel barriers. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells.

- d. The stationary part of the primary disconnecting devices for each power circuit breaker shall consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high-pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension buses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached.
- e. The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging flat contact segments at the rear of the compartment. The secondary disconnecting devices shall be silver-plated and sliding contact engagement shall be maintained in the CONNECTED and TEST positions.
- f. The removable power circuit breaker element shall be equipped with disconnecting contacts, wheels and interlocks for drawout application. It shall have four positions, CONNECTED, TEST, DISCONNECTED, and REMOVED, all of which permit closing the compartment door. The breaker drawout element shall contain a worm gear levering "in" and "out" mechanism with removable lever crank. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "in" or "out" of the cell. The breaker shall include a provision for padlocking open to prevent manual or electric closing. The padlocking shall also secure the breaker in the connected, test, or disconnected position by preventing levering.
- g. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.
- h. Provide a rear compartment steel barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.
- i. Provide in the cell, when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against accidental contact.
- j. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.
- k. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.



3. Bus

- a. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
  - 1) In addition to full UL air clearances, the bus phase shall be insulated with a minimum of 5 millimeter thickness of epoxy resin coating. Removable non-PVC boots shall be provided to give access to the cross bus joints for inspection and maintenance.
- b. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.
- c. A ¼" x 3" (minimum) copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.
- d. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers.

4. Wiring/Terminations

- a. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer's wiring diagrams.
- b. All control wire shall be type SIS.
- c. Mechanical cast bronze lugs shall be provided for all line and load cable terminations. Lugs shall be suitable for copper cable only, rated for 75 degrees C, and sized to match the conductor sizes indicated on the drawings.
- d. A termination system shall be provided such that no additional cable bracing, tying or lashing is required to maintain the short circuit withstand ratings of the assembly through 200 KA.
- e. Lugs shall be provided in the incoming line section for connection of the main grounding conductor.

5. Circuit Breakers

- a. All main, tie, and feeder protective devices shall be individually mounted, drawout low-voltage power circuit breakers with adjustable static trip devices. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

- b. Breakers shall be electrically operated (EO).
  - c. Electrically operated breakers shall be complete with 120VAC operators, OPEN/CLOSE control switch, plus red and green long life LED indicating lights to indicate breaker contact position. 120VAC control power shall be taken from control power transformers mounted in the switchgear assembly.
  - d. Provide auxiliary contacts on each breaker wired to an identified terminal strip, for breaker position (open/closed) (4a and 4b contacts, minimum).
  - e. Provide Under Voltage Release (UVR) device with adjustable time delay (0-6 seconds) on feeder circuit breakers where indicated on drawings.
  - f. Provide Overcurrent Trip Switch (OTS) on all Main, Tie, and Feeder circuit breakers.
  - g. Provide padlockable pushbutton covers on the Push-On buttons of the Main and Tie circuit breakers.
  - h. Provide separate, individually protected, trip and close circuits for each circuit breaker.
  - i. Provision for Future Breakers (PFB) shall be completely equipped and wired for installation of future circuit breaker. Provisions for future breakers shall have draw-out carriage, Open/Close breaker control switch, red and green long life LED indicating lights for breaker closed and open positions, and wiring to Central Control and Monitoring System (CCMS) for control and monitoring of the future circuit breaker. Trip and close circuits shall be wired to terminal blocks for connection to SCADA controls.
6. Trip Units
- a. Each drawout low-voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three (3) current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
  - b. Interchangeable rating plugs shall establish the maximum continuous trip ratings of each circuit breaker. Rating plugs shall be fixed type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
  - c. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:

- 1) All circuit breakers shall have adjustments for long delay pickup and time.
  - 2) All circuit breakers shall have individual adjustments for short delay pickup and time, and include selective flat or  $I_t$  curve shaping.
  - 3) All circuit breakers where indicated on the drawings shall have individually adjustable ground fault current pickup and time, and include selective flat or  $I_{2t}$  curve shaping.
- d. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
  - e. For trip units that do not have an instantaneous adjustment, a discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit.
  - f. Provide trip units with ground fault protection on breakers shown with ground fault protection on drawings. Internal ground fault protection pick-up settings shall not exceed 1200 amperes. Provide neutral ground fault sensor for all four-wire loads where four-wire loads are indicated on drawings.
  - g. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the LED indication after an automatic trip. A test push-button shall energize an LED to indicate battery status.
  - h. The trip unit shall be provided with a representation of the time-current curve on the trip unit that indicates the protection function settings. The unit shall be continuously self-checking and provide LED indication that the internal circuitry is being monitored and is fully operational.
  - i. The trip unit shall contain an integral test panel with a test selector switch and a test push-button. The test selector switch shall enable the user to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker shall be capable of being tested in either the TRIP or NO TRIP test mode. Provide a keyed receptacle for use with an optional auxiliary power module. The auxiliary power module shall allow the breaker trip unit to be tested with a 120-volt external power source.
  - j. A four-digit, 3/4-inch high, LED alphanumeric display shall be provided.
  - k. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, it shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. Internal relays shall provide contacts for remote indication of mode of trip and high load.

- l. A red LED shall be provided on the face of the trip unit pre-set to turn on when 85% of the trip setting is exceeded (a 40-second delay shall be provided to avoid nuisance alarms).
  - m. Metering display accuracy of the complete system including current sensors, auxiliary CTs, and the trip unit shall be +/- 2% of full scale for current values in the range of 5% - 100%.
  - n. The trip unit shall include a potential transformer module, suitable for operation up to 600V, 50/60 Hz.
  - o. The energy-monitoring parameter values (peak demand, present demand and energy consumption) shall be indicated in the trip unit alphanumeric display panel.
  - p. Metering accuracy of the complete system of full scale shall be +/- 4% for power values, +/- 5% of full scale for energy values.
  - q. The trip unit shall be equipped with an Arc-flash Reduction Maintenance mode that allows fast tripping of the breaker to reduce arc-flash hazard when maintenance is being performed on the breaker or switchgear assembly. The Arc-flash Reduction Maintenance mode shall be enabled from the front of the trip unit.
  - r. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control.
  - s. For enhanced system analysis additional parameter values shall be calculated and indicated in the trip unit alphanumeric display panel.
7. Miscellaneous Devices
- a. Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.
  - b. Electrical interlocks to prevent both main breakers and tie breaker from being closed at the same time but with and electrical transfer control that permits no-break transferring of the load from one main breaker to the other and then opens tie breaker after the mains are closed or opening of one or the other main breakers after the tie breaker is closed.
  - c. Fused control power transformers shall be provided as indicated on the drawings or as required for proper operation of the equipment. A manual disconnect shall be provided ahead of the primary fuses. Control power transformers shall have adequate capacity to supply power to the transformer cooling fans.
  - d. Device 25 synch-check relay wired to the line side of each main breaker to check for synchronism between the two sources serving the double-ended switchgear. Provide with auxiliary relay and permissive contacts wired to the close circuits of the main breakers and tie breaker to permit paralleling of the two sources only when the sources are synchronized.

- e. Device 43M electrically operated lock-out/tag-out switch to select local or remote control. Provide with auxiliary relays and contacts wired to the trip and close circuits for local or remote operation as shown on drawings.
  - f. Device 43HT key operated trip pre-select switch for make-before-break main-tie-main transfer. Switch shall allow selection of Main A, Tie, or Main B for tripping after all three circuit breakers are closed simultaneously. Provide adjustable time delay for tripping selected breaker.
8. Transition Section for Close Coupled Connection to Transformer
- a. Furnish with a transition section for close coupled connection to the substation transformer. Provide bussing with flexible copper braid connections from the switchgear sections to the connection point at the transformer. Provide instrument compartments with hinged doors at the front and rear of the transition section. The instrument compartments shall contain terminal blocks for all control interconnections to the transformer in addition to any other instruments or control devices shown or required. The bus compartment of the transition section shall be barriered from the front and rear instrument compartments. Barriers shall be removable to permit access to buss connections.
9. Metering
- a. Where indicated on the drawings, provide a separate metering compartment with front hinged door.
  - b. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal test blocks.
  - c. Provide potential transformers including primary and secondary fuses with test block disconnecting means fused potential taps as the potential source for metering as shown on the drawings.
  - d. Provide metering test switch for current and voltage metering circuits, wired in metering circuits as shown on drawings.
  - e. Provide Microprocessor-Based Metering System. Provide with communications interface module to permit communication.
  - f. Provide microprocessor-based local monitoring station to monitor metering and other data from the intelligent communicating trip units on each circuit breaker. The local monitoring station shall be factory wired to each trip unit for communication. Provide with communications interface module to permit communication.
10. Finish

- a. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized epoxy coating. The coating shall have corrosion resistance of 300 hours to 5% salt spray with minimum thickness of 3 mils. Color and finish of the switchgear shall be ANSI-61 Gray.

11. Accessories

- a. Provide a traveling-type circuit breaker lifter, rail-mounted on top of switchgear.
- b. Provide one complete spare set of all sizes of control fuses and one complete spare set of all sizes of metering fuses

N. Switchboards (26 24 13):

1. Main service switchboard shall be solid state trip insulated case type. Provide with electronic sensing, timing and tripping circuits for adjustable current settings, ground fault trip (for main and feeders), short-time trip (for main only), and instantaneous trip (for feeders only).
2. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials used.
3. Main Section Devices: Individually mounted and compartment drawout type. The main breaker shall be a power circuit breaker and shall have LSG trip functions.
4. Distribution Section Devices: Individually mounted and compartmented, fixed type.
5. Bus Material: Copper only.
6. Bus Connections: Bolted, accessible from front only for maintenance.
7. Enclosure shall align at front and rear.
8. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.
9. Provide 4-inch high concrete pad that is a minimum of 4 inches wider and longer than switchboard. Seismic restraint anchor bolts require 10 times the bolt diameter from the bolt to the edge of concrete.
10. Switchboard shall be seismic zone 4 and have seismic certification as required by the agency having jurisdiction.
11. The 480V switchboard shall include a bus connected drawout type Transient Voltage Surge Suppression Device (TVSS). It shall include an isolation disconnect. A bus connected TVSS device shall be provided for each separately derived 208/120V bus. It shall include an isolation disconnect.

12. The switchboard shall include a customer metering compartment with a front hinged door and the following.
  - a. Current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
  - b. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
  - c. At Parnassus Campus the digital meter shall communicate with the existing CCMS system.
  - d. At Mt. Zion provide with communication capacity to allow interface with future monitoring systems.
  - e. Multifunction Digital Metering Device: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
    - 1) Single microprocessor based unit capable of monitoring and displaying the functions listed below. The device shall provide the adjustable protection functions indicated and the capability to communicate data via network.
      - a) Digital Meter Menu Display (Accuracy): The meter shall have an accuracy of  $\pm 0.1\%$  or better for volts and amps, and  $0.2\%$  or better for power and energy functions.
        - i. AC Phase Amperes (0.1%) (Phases A, B, C, and average). Provide true RMS measurement per phase and neutral.
        - ii. AC Phase Voltage (0.1%) (Phases A-B, B-C, C-A, Average, A-N, B-N, C-N, Average). Provide true RMS measurement of phase to neutral and phase to phase.
        - iii. AC Phase Voltage (0.1%) (Phases A-B, B-C, C-A, Average, A-N, B-N, C-N, Average). Provide true RMS measurement of phase to neutral and phase to phase.
        - iv. Real Power - Watts (0.2%) (Phases A, B, C, and System)
        - v. Reactive Power - VAR (0.2%) (Phases A, B, C, and System)
        - vi. Apparent Power - VA (0.2%) (Phases A, B, C, and System)
        - vii. Energy Real KWH (0.2%) (Forward, Reverse, and Net)
        - viii. Energy Reactive - KVARh (0.4%) (No Reverse or Net)
        - ix. Energy Apparent (KVAh) (0.4%) (No Reverse or Net)

- x. Frequency (0.03%)
  - xi. Demand System Current, Real Power, Reactive Power and Apparent Power.
  - xii. Power Factor - (0.2%) (Phases A, B, C, System)
  - xiii. % THD Current - (Phases A, B, C, and N)
  - xiv. % THD Voltage - (Phases A-B, B-C, C-A, A-N, B-N, C-N) Factor
  - xv. Discrete Input and Output Status
  - xvi. Analog Input Reading
- 2) Meter surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41.
  - 3) The meter shall be user programmable for voltage range to any PT ratio.
  - 4) The meter shall accept a direct input voltage range up to 576 volts line to neutral and a range of up to 721 volts line to line.
  - 5) Meter shall be programmable for current to any CT ratio.
  - 6) The meter shall be capable of dual input method for current input.
  - 7) The meter shall include a three-line, bright red, LED display.
    - a) The meter shall fit in both DIN 92mm and ANSI C39.1 Round cut-outs.
    - b) The meter must display a % of FULL SCALE on the front panel to provide an analog feel. The % FULL SCALE shall have not less than 10 segments.
  - 8) The Transducer portion of the meter shall be capable of communications.
  - 9) Meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.
  - 10) The meter shall include independent communications port on the back, with advanced communication features.
    - a) The port shall provide RS485 communication speaking Modbus ASCII, Modbus RTU, or DNP 3.0 protocol through back plate.
  - 11) The meter shall provide user configured fixed window or sliding window demand. This shall allow the user to set up the particular utility demand profile.



- a) Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
  - b) All other parameters shall offer max and min capability over the user selectable averaging period.
  - c) Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
- 12) Meter shall be capable of operating on 90 to 265 VAC and 100 to 370 VDC. Provide with option to operate on a power supply from 18 to 60 VDC.
- 13) The meter shall provide Alarms and Control Capability as follows:
- a) Limit ranges can be set for any measured parameter.
  - b) Limit ranges shall be based on % of Full Scale settings.
  - c) Manual relay control shall be available through software
  - d) Relay set delays and reset delays shall be available
- 14) The meter shall have data-logging capability. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created.
- a) The meter shall have one historical log for trending profiles. The log shall be capable of being programmed. The user shall have the ability to adjust logging intervals between the total logged parameters in order to increase or decrease the time allotted to the log.
  - b) The meter shall have a log for System Events. The System Events log shall record the occurrences with a time-stamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes.
- 15) The meter shall have I/O expandability with card slots on the back.
- a) The cards shall be capable of being installed in the field, without removing the meter from installation.
  - b) The meter shall auto-detect the presence of any I/O cards.
  - c) The card slots shall accept I/O cards in all of the following formats: Four channel bi-directional 0-1mA Output Card; Four Channel 4-20mA Output Card; Two Relay Outputs/2 Status Inputs Card; Four KYZ Pulses/4 Status Inputs Card.
  - d) The meter shall be capable of accepting any combination of up to two cards.

- e) The 0-1mA Output Card shall provide the following features:
  - f) Bi-directional from 0-1mA Outputs.
  - g) Assignable to any measured parameter.
  - h) 0.1% of full scale.
- 16) The 4-20mA Output Card shall provide the following features:
  - a) Assignable to any measured parameter.
  - b) 0.1% of full scale.
- 17) The Two Relay Outputs/2 Status Inputs Card shall provide the following features:
  - a) Status Inputs – Wet/Dry Auto Detect up to 300 VDC
  - b) Trigger on User Set Limits/Alarms
- 18) The Four KYZ Pulses/4 Status Inputs Card shall provide the following features:
  - a) Programmable to any Energy parameter and pulse value
  - b) Programmable to End of Interval Pulse
- f. Input range of the device shall accommodate external current transformers with ranges from 5:5 through 10,000:5 Amperes. Synchronous pulse input shall be provided and when activated shall override the preset watt demand interval and let the utility control the demand window. Control powder shall be derived from the metered line. The meter shall have the capability to allow “CT” circuit to pass through meter.
- g. Outputs with separate Form C (NO/NC) trip and alarm contacts with ratings of 10 amperes at 115/240 volt AC or 30 volt DC resistive. In addition, provide a separate Form C (NO/NC) contact to provide a programmable kilowatt-hour pulse output.
- h. The display face - membrane type and rated suitable for NEMA 3R and NEMA 12 mounting. The device shall have a durable LED display screen. The display screen and LED’s shall indicate both cause of trip and alarm conditions.
- i. Provide communication card capable of transmitting all data, over a compatible network to the University’s Campus Monitoring System.
- j. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door. Integral part of main switchboard.

13. Secondary switchboards shall be of the dead front, metal enclosed type with circuit breakers of a type and interrupting capacity suitable for the particular installation. Space shall be provided for metering equipment where required.
  14. Secondary outgoing power section shall consist of one or more bussed sections, with the following equipment:
    - a. Main secondary circuit breaker and attached or remote feeder protective devices.
    - b. Provide circuit breakers with the following requirements:
      - 1) Main and feeder breakers shall be solid state trip insulated case or molded case circuit breakers to achieve satisfactory coordination. If thermal-magnetic is used, oversize breaker and bus to utilize 100% of transformer rating.
      - 2) Minimum symmetrical interrupting current rating shall exceed calculated fault current at the device location by a minimum of 10% of worst case calculated.
    - c. Branch circuits that justify individual measurement of amps and volts, such as a motor over 50 HP shall utilize the solid state multi-function meter.
    - d. Current transformers (C.T. - one per phase) 5 amp secondary, primary rating to match bus rating. Relaying circuits may utilize relay accuracy class CT's.
    - e. Control power transformer with protective fuses.
    - f. Ground fault protection on main circuit breaker where required by Code. When ground fault is provided on the main circuit breaker, each feeder device shall be equipped with ground fault protection. Ground fault systems shall operate at 120 volts AC. Provide secondary control power transformer for ground fault control power.
- O. Distribution Panels (26 24 16A):
1. Conform to NEMA PB-2.
  2. Enclosure: Code-gauge sheet steel cabinets, front accessible. Door of code gauge hot rolled steel with flush type combination latch and lock, all keyed. Panel enclosures to be of door-in-door construction for full access to cable terminations and circuit breakers. Fully hinged and latch front cover.
  3. Bus: Silver plated copper, sized in accordance with industry standards and with maximum current density of 1250A per sq. in. Bus braced for 200KAIC. Provide with full rated copper neutral and copper ground bus. Provide with dead front. Provide 200 percent rated neutral bus where indicated on the drawing.
  4. Circuit breakers: Molded case type, thermal magnetic or solid state trip devices, bolted to bus; rating and arrangement as shown. All products of the same manufacturer.

Minimum fully rated short circuit interrupting rating 200KA at 240 volts for 120/208V panels and 100KA at 480 volts for 277/480V panels.

5. Distribution panelboard interior shall be designed and assembled such that circuit protective devices shall be solidly connected to the distribution panel vertical bus. The bus bars shall be attached to the feeder device by bolts and to the vertical bus by bolts and anti-turn methods.
  6. Circuit breaker connectors shall be designed so that circuit breakers may be removed without disturbing adjacent devices.
  7. Provide each breaker with handle padlocking device, and provide each breaker rated over 150A with an extended operating handle.
  8. Provide with copper ground bus ¼" x 2" running entire length of the distribution panel. Provide cast copper/bronze lug to suit ground conductors' requirements.
  9. Provide cast bronze lugs to suit conductors' requirements.
  10. Finish: One (1) coat electrostatically applied rust-resisting epoxy primer and two (2) coats gray epoxy enamel inside and out.
  11. Provisions for future breakers – Provide all mounting hardware, bus straps, filler panels and required accessories including load terminals.
  12. Provide customer metering as integral part of distribution panel.
- P. Branch Circuit Panelboards (26 24 16B):
1. Panelboards shall be of standard manufacture, bussed for 3-Phase, 4-Wire, containing either 1, 2, or 3-poles, bolted to bus connection, and branch circuit breakers. The neutral bus shall be isolated from ground.
  2. Every panelboard shall have a dedicated feeder from the main distribution board. Indicate upstream distribution panel on nameplate on front of panelboard.
  3. Separate panelboards shall be provided for building emergency power circuits. These panelboards shall be connected to the emergency generator if this source is required by the building occupancy.
  4. Loads on panels shall be balanced as accurately as possible between phases.
  5. Provide flush cabinet front with concealed trim clamps, concealed hinge and flush lock all keyed alike. Surface mounting is acceptable when located in electrical room or other non-public areas. Provide with door-in-door construction with hinged dead front. Provide NEMA 1 enclosure for indoor, and provide NEMA 4X for exterior installation.

6. In science, computer, research and laboratory buildings, receptacle and end user equipment panel boards shall be 120/208V with 200% rated neutrals and ground bus insulator kit with 42-circuit minimum, 3-phase, 4-wire.
7. Leave spare breakers off and directory shall list “spare” for those breakers. Provide a minimum of 20% spare breakers.
8. Load centers may only be used for residential single family dwelling and apartment units. It is not acceptable in commercial buildings.
9. Lighting and Appliance Branch Circuit Panelboards: circuit breaker type. Enclosure: Cabinet Size: 6 inches deep; 20 inches wide minimum.
10. Provide panelboards with copper bus. Provide copper ground bus in all panelboards. Provide with copper lugs for main lug only panelboard.
11. Minimum Integrated Short Circuit Rating: 22,000 amperes RMS symmetrical for 208 volt panelboards; 14,000 amperes RMS symmetrical for 480 volt panelboards or as required by Short Circuit Study.
12. Molded Case Circuit Breakers: bolt-on type thermal magnetic trip circuit breakers, with common trip handle for multi-poled breakers. Provide circuit breakers UL listed as Type SWD for lighting circuits. Do not use ground fault interrupter circuit breakers.
13. Provide a minimum of four ¾” conduits from the panelboard stubbed above the ceiling for future.

Q. Motor Control Centers (26 24 19):

1. Three-phase induction motors are generally started with across-the-line starters. However, certain requirements including transformer capacity, main breaker size and voltage drop or flicker may limit the size of motor using this type of starting equipment.
2. When reduced voltage starting is required, the specific equipment and application shall determine the best-suited method. Reduced voltage autotransformer, or solid state soft start method for large motor starting, is the preferred reduced voltage starting methods. Closed circuit transition shall be incorporated in the autotransformer style starter.
3. Centralized motor control centers shall be used whenever possible. The minimum motor starter size shall be NEMA 1. Starters shall have Hand-Off-Automatic (HOA) switch, green running pilot light with push-to-test, single phasing protection for motors over 1 HP, manual reset thermal overload protection, motor overcurrent and short circuit protection, elapsed and running time meter (larger than 5 HP), and one set of auxiliary SPDT relay contacts. Minimum starter size shall be NEMA size 1. Provide solid state overload to suit motor full load amps.
4. Where power factor is less than 90%, correction is necessary. Provide power factor correction capacitors at induction motors or motor starters as identified in the power factor correction study. Solid state automatic power factor regulation may be considered.

5. The University requires premium efficiency motors for almost any application. Variable speed drives or multiple speed motors shall be considered for fan and pump loads. The motor short-circuit protective device type and rating shall be selected to allow trip-free motor starting under normal conditions.
  6. Electric motor specification is generally not under the control of the electrical engineer. Coordinate installation requirements, including environmental, with mechanical engineer to insure compliance with the project requirements.
  7. Control Transformer: Provide control transformer in motor control center to provide 120-volt control source for all motor starters in control center.
  8. Provide with relay for auxiliary contact.
  9. Provide pilot indicator light, color as selected by University's Representative.
  10. Provide with solid state overload.
  11. Provide 4-inch-high concrete pad and a minimum of 4 inches wider and longer than each Motor Control Center. Seismic anchor bolts require 10 times the bolt diameter from the bolt to the edge of the concrete pad.
  12. Motor Control Centers: NEMA ICS 2; Class I, Type B.
  13. Horizontal Bussing: Copper, with a continuous current rating of 600 amperes minimum. Include copper ground bus entire length of control center.
  14. Vertical Bussing: NEMA ICS 2, copper with a continuous current rating of 300 amperes minimum.
  15. Integrated equipment short circuit rating adequate for duty available at line terminals plus motor contribution.
  16. All motor control centers shall have solid state metering, with molded case switch, shorting block and terminal block. The meter shall have communication capability to interface with Campus Monitoring System. Communication shall be compatible with Facility Monitoring System. Coordinate with the University's Representative.
  17. Configuration: front mounting only, accessible from the front only.
  18. Enclosure: ANSI/NEMA ICS 6, Type I indoors and Type 4X outdoors.
- R. Enclosed Bus Assemblies (26 25 00):
1. Indoor Plug-In Busway: NEMA BU 1; 4-wire, low impedance plug-in busway rated 120/208 or 277/480 volts, 60 Hz. Provide non-ventilated housing with plug-in openings on 24-inch centers each side, with hinged doors to protect opening where plug-in unit is not installed.

2. Conductors: Copper bars, fully insulated, except at joints. Provide full neutral. Provide 50% internal ground bus of same material as phase conductors.
  3. Joints: Provide single bolt type, with silver-plated contact surface for bus and splice plate.
  4. Plug-in busway circuit breaker must be compatible with busway.
- S. Wiring Devices (26 27 26):
1. A criterion for locating and sizing receptacles and switching is included in Part 1.1, "Campus Electrical Overview."
  2. Receptacles
    - a. Receptacles shall be installed in electrical equipment rooms, mechanical equipment rooms, offices, conference rooms, cafeterias, kitchens, dining rooms, patient areas, support areas, etc.
    - b. Receptacle mounting heights and locations shall be such that they do not interfere with the equipment they serve. Mechanical drawings and furniture layouts shall be checked carefully to prevent receptacles from being isolated behind cabinets, etc.
    - c. Receptacle capacities or rating shall be adequate to carry the particular loads involved.
    - d. Provide hospital grade receptacles for all I occupancy. Provide hospital grade with illuminated face for all patient care areas.
    - e. Provide receptacles with control designation for all spaces as required to meet California Building Energy Efficiency Standard (Title 24)
    - f. Receptacles or other outlets in partitions subject to change or relocation should be branched from receptacle or other outlets in permanent walls. Do not use movable partition outlets for wiring necessary to maintain the continuity of a circuit. Drywall partitions not penetrating the finished ceiling shall be considered movable.
    - g. Receptacles installed outdoors, within 6 feet of sinks or in other wet or damp areas including toilets, showers, mop sinks, and restrooms, shall have automatic 5mA, individual ground fault (GFI) protection. Self-contained GFI protected devices are preferred over GFI circuit breakers located in remote panelboards.
    - h. Receptacles shall be hospital grade, NEMA 5-20R.

- i. Surface mounted multi-outlet raceways: The minimum surface raceway size should be 1-3/4 inch D x 5-1/4 inch H with divider and separate covers, equivalent to Wiremold AL 4320, for multiple voltages or signal systems. Surface raceways shall generally be used for the following conditions:
    - 1) Workshop benches.
    - 2) Verify exact program requirements for additional area
  - j. Hazardous Areas: Wiring devices in hazardous areas shall be rated for the type of hazard per the electrical codes. The classification of hazard shall be clearly indicated on the applicable drawings.
  - k. Symbols: Drawings shall symbolize each wiring device location and associated branch circuit conduit and wire. Wiring devices shall be identified on the electrical symbol list as to type, mounting height and mounting method (i.e., ceiling, wall, floor, concealed, flush or surface, etc.).
  - l. Voltage drop shall be calculated for every receptacle, and shall not exceed 3% total at the connection point of the load. Steps shall be taken to maintain voltage drop to 3% or less for all normal and emergency system loads.
3. Switches
- a. Switches shall be 20A, 120V or 277V, 60Hz, for control of lighting circuits. Switches shall be Industrial/Institutional grade.
  - b. Provide red jewel pilot (ON) light for switches controlling equipment not visible from switch location.
  - c. Switches controlling lighting system or equipment which should not be accessible by the general public, and shall be located in space accessible to authorized personnel.
  - d. Switches shall be mounted on the striker plate side of doors.
  - e. Wall and/or ceiling mounted occupancy sensor with integral switch.
- T. Fuses (26 28 13):
1. Fuses: Dual element, current limiting, time delay, one-time fuse, 600 volt, Class RK1.
  2. Interrupting Rating: 200,000 RMS amperes.
- U. Enclosed Switches and Circuit Breakers (26 28 16):
1. Provide lockable safety disconnect switch within 10 feet and in sight of any motor over ½ horsepower. This is in addition to Code required disconnects.



2. Provide molded case circuit breaker with magnetic trip and/or molded case circuit breaker with solid state trip.
3. Provide flush enclosure with other required options as required to suit project requirements.
4. Provide ground and neutral bus bar in enclosed circuit breaker.

V. Enclosed Controllers (26 29 13):

1. Manual motor starters
  - a. Fractional Horsepower Manual Starter: general-purpose Class A manually operated, single pole, full voltage controller for fractional horsepower induction motors, with thermal overload unit and green pilot light, normally open auxiliary contact and toggle operator.
  - b. Motor Starting Switch: general-purpose Class A manually operated, single pole, full voltage controller for fractional horsepower induction motors, with auxiliary contact, and toggle operator.
  - c. Enclosure: Type 1 indoors and Type 4X outdoors.
2. Magnetic motor starters
  - a. Enclosure: NEMA ICS 6 Type 1 indoors and Type 4X outdoors.
  - b. Combination Motor Starters: Combine motor short circuit protector, overload and disconnect in common enclosure. Provide control transformer, pilot light, auto hand-off, selector switch, and auxiliary contact.
  - c. Enclosed starter only acceptable in limited locations if it is approved by University's Representative
3. Types of starters shall be selected as follows:

Motor H.P.	Voltage	Type Starter
Up to 7 ½	208	Across line magnetic
7 ½ to 15	208 and/or 460	Across line magnetic, part wind or wye delta
15 to 30	460	Across line magnetic part wind or wye delta
Above 15	208 and/or 460	Part wind or wye delta
Above 30	460	Part wind or wye delta

	Sizing	Spares	Spacing	Notes
Lighting	Demand load	None except if	Min. 3	1 per floor w/

panelboard	plus spares Min. 100 amps	surge shell space provide spare(s)		horizontal wiring
Lab Power Panelboards	Min. 150 amp panel with 42 poles	Min. 6 - 20 amp CBs	2 - 30 amp spaces	w/ horizontal wiring Conduit sized for 225 amps
Office Power Panelboards	Demand load plus spares	Min. 3 – 20 amp CBs	Min. 3	w/ horizontal wiring.
Switchboards	Demand load	None	*	*W/provision for future expansion
Distribution boards	Demand load plus space	None	20-30% additional	
Motor Control Center	Demand load		*	*W/ provision for future expansion
Unit Substation	Demand Load	None		W/ provision for future expansion
EP lighting panelboard	Demand load plus spaces	None	Min. 3	1 per floor
EP Power panelboard	150 amp with 42 poles	Min. 3 – 20 amp CBs	Min. 3	1 per floor
Generator	100% load	Per University direction		
Transformers	Demand load			Interior only
Exterior 12 kV Trans- formers	Per University direction	.		Size will be 60% of total demand load or smaller
Main electrical room			20-30% wall space for future	
SF6 switches	Per University direction			Project specific

Note: Demand load shall be in accordance with the California Electric Code.

W. Engine Generator Assemblies (26 32 13):

1. Science, Engineering, Computer, Medical and Research Buildings shall include an emergency generator sized for 100% of the calculated emergency load. Generator shall be an outdoor unit and/or indoor unit; diesel fueled, and has a main breaker. Emergency systems shall be isolated from normal source systems via automatic transfer switches. Emergency distribution systems wiring shall be segregated and include separate wiring, transformers, distribution, and panel boards. Emergency systems shall be connected to building ground system.
2. Emergency power sources shall have spare capacity when directed by the University for electrical loads requiring standby power sources. Planned emergency power measures shall be thoroughly discussed with the University and diagrammed for approval.

3. Health care facilities shall have emergency loads grounded and connected to Life Safety Branch, Critical Branch or Equipment Systems Branches as defined by NFPA.
4. Emergency power source shall be diesel engine driven generator.
5. At least one elevator in a building shall be on emergency power when building has a backup power generator system.
6. Engine-driven generators shall include the following features:
  - a. Provide manual bypass switch in Health Care, Research and other areas on a case-by-case basis, with automatic engine generator no-load exerciser and time delay shutdown.
  - b. Generators 250kW and larger shall be provided with a load bank of 50% capacity, to extend life of generator by testing under load. Load banks shall be mounted on the radiator exterior. The load bank shall be wired through a shunt-trip circuit breaker. The load-dump control circuit in the load bank shall be wired to the transfer switch(es).
7. Engine generators shall be located at grade elevation in a separate dedicated room when indoors, and in a fenced or walled enclosure when outdoors. Outdoor units shall be enclosed in a weatherproof enclosure with lockable doors.
8. The sound for indoor and outdoor generators must comply with University sound level requirements and Local Agency. Use the most stringent requirements.
9. In research, science and laboratory buildings, and outpatient clinic the emergency generator shall be installed to provide emergency power for egress lighting and exit signs, fire alarm, telecommunication, security, fume hood exhaust fans, supply air fans for laboratory, atrium exhaust, fire pump, elevators to sequence the return of a pre-determined level (one elevator at a time), and emergency outlets in the laboratories, electrical and mechanical rooms, warm and cold rooms. Emergency loads shall include University-furnished refrigerators, 208V outlets in equipment hallways or support spaces.
10. The generator shall be located within 100 feet of the main service switchgear and/or switchboard and supply an automatic Transfer Switch (ATS). The Automatic Transfer Switch shall be a four-pole unit with a switched neutral, close transition with isolation by-pass. Emergency system and normal system grounding shall be bonded. The ATS shall be capable of transfer to normal power without interruption of load. If the distance between the generator and main switchgear and/or switchboard cannot be met, review and coordinate with the University's Representative.
11. Emergency systems wiring shall be separated from normal systems in every aspect except for ground. Emergency equipment shall be plainly marked to distinguish it from normal source equipment. Emergency outlets shall be red in color.

12. Emergency generator shall have accessories such as super critical exhaust silencer, battery, battery charger, radiator on unit and/or remote radiator, jacket water heater, space heater for outdoor unit, double wall fuel tank, outdoor weather proof sound attenuated housing, diesel particulate filter with active filter, structural base, and spring vibration isolator/seismic snubbers.
13. Provide annunciator on the generator unit and remote annunciator as required by Agency Having Jurisdiction at Parnassus Campus. Interface all required alarms to campus SCADA and CCMS system. Provide all components as required to interface with the existing system. Coordinate with the University's Representative.
14. The location and direction of the engine exhaust shall not adversely affect the air intake for the building. The preferred direction of the exhaust is up, from a sound rating standpoint. A hinged rain cap shall be provided on vertical discharge exhaust pipes.
15. Provide a separate fuel tank when capacity of base-mounted tank raises engine off ground and would require ladder for access to controls, etc. for maintenance, or as an option, provide 3'-0" wide fixed service platform with railings around generator. Review control access with the University's Representative.
16. If generator is indoors, provide room sound attenuation and design for air intake must include combustion air and cooling air. Add additional 10% to this air volume. Provide means to remove indoor generator should it need replacement.
17. Testing:
  - a. Factory testing of engine-generator set. Provide complete factory standard test at factory and submit certification. Testing shall include calibration, temperature, frequency, current voltage, meters, circuit breakers, fuel system, emission control, and other related items.
  - b. Provide field test. Each unit must be tested with load bank at job site, and confirm all calibrations, pressure, temperature, current, voltage, meters, generator breaker fuel system, emission control, all alarms, and annunciator panels.
  - c. Provide non-stop load banks for each unit minimum as follows:
    - 1) 1 hour at 50% of kW rating at 0.8 P.F.
    - 2) 2 hours at 75% of kW rating at 0.8 P.F.
    - 3) 3.5 hours at 100% of kW rating at 0.8 P.F.
    - 4) 1 hour operation with cold start and hot start at varying loads. Utilize building load and/or load bank.
    - 5) Step load – one step of full load of generator rating.

- 6) Step load – step one at 50% of rating and second step at 100% of generator rating.
  - 7) Step load – step one at 75% of rating and second step at 100% of generator rating.
  - 8) Step load – step one at 25% of rating, second step at 50%, third step at 75%, and fourth step at 100% of generator rating.
  - 9) Other load steps as required by University’s Representative.
- d. Prior to start up and before final acceptance, include testing of generator at 115% of capacity for a minimum of 30 minutes.
  - e. Test all annunciator panels, alarms, other remote station interfaces, sound attenuated performance testing, and other related items.

#### X. EMERGENCY GENERATOR PARALLELING SWITCHGEAR (EGPS)

1. The emergency generator paralleling switchgear shall be dead type with front and rear access, low-voltage metal enclosed switchgear with electrically operated draw out circuit breakers. Generator control section for each generator, master control paralleling section must be fully integrated and assembled.
2. GENERAL: The Emergency Generator Paralleling Switchgear (EGPS) shall consist of generator control panel, one per generator, a master control/paralleling panel, and with close-coupled connection to Emergency Distribution Switchgears sections. Each panel and distribution section shall be located in a free-standing switchboard conforming to ANSI/IEEE and C37.21, and UL 1558.
  - a. Built in accordance with NEMA SG3 and SG5 and U.L. Standard 1558, ANSI/IEEE C37.21, C37.13, C37.16 and C37.17. Front and rear accessible, draw-out construction
  - b. Generator and distribution feeder devices, individually mounted, electrically operated, draw-out circuit breakers with adjustable electronic trip devices.
  - c. With silver plated copper bus, 3 phase, 4 wire with ground bus. All bus shall be silver-plated. All lugs: cast bronze / copper alloy for copper cable with set screw and saddle, T&B “Loctite” or equal. All bus and joints to be fully insulated. Removable boots shall have maximum current density of 1,250A per sq.in. Provide lower current density where required by industry standards temperature rise criteria of 65°C over a 40°C ambient.
  - d. Provide with 1/4 inch x 2 inch copper ground bus running the entire length of switchboard. Provide cast bronze lugs to accept ground conductors.

- e. With code gauge (12 ga. min.) formed steel construction with formed hinged doors both front and rear as shown on drawings. with all metal surfaces steam-cleaned, phosphate coated and finished with gray epoxy enamel on outside and white enamel on inside. Access to all components through hinged front and access to line and load connections through hinged back door. Provide rear doors with 3 point latch and padlockable vault type stainless steel handles. All external hardware shall be corrosion resistant.
- f. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, centralized bus and rear cabling or bus connections. Equip with draw-out rails and primary and secondary disconnecting contacts. Locate current transformers for feeder instrumentation within the appropriate breaker cells.
- g. The stationary part of the primary disconnecting devices for each power circuit breaker to consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts suitably spaced shall be furnished on the power circuit breaker studs which engage in only the connected position. Include the necessary three phase bus contained by springs. Each circuit, including provisions for future breakers, shall include the necessary three phase bus connections between the section bus and the breaker line side studs. Equip load studs with insulated copper load extension busses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be silver-plated.
- h. Provide secondary disconnecting devices consisting of contacts mounted on the removable unit and engaging fixed contact segments at the compartment. The secondary disconnecting devices shall be silver-plated and sliding contact engagement shall be maintained in the "connected" and "test" positions.
- i. Equip the removable power circuit breaker elements with disconnecting contacts, wheels and interlocks for drawout application. Units to have four positions, "connected", "test", "disconnected" and "removed". Provide mechanical interlocking so that the breaker is in the tripped position before levering "in" or "out" of the cell. Provide for padlocking each breaker open to prevent manual or electric closing. Provide safety shutters behind each circuit breaker.
- j. Control wire shall be copper (#16 AWG minimum) type SIS Class K stranded switchboard wire, bundled and secured with nylon ties. Provide insulated locking flanged fork terminals for all control connections, except where saddle type terminals are provided integral to a device. Connect current transformer secondary leads to an accessible short circuit terminal block before connecting to any other device. Provide all groups of control wires leaving the EGPS with terminal blocks with suitable numbering strips. Tag all wires at each connection point with slip-on tube type markers. Provide wire markers at each end of all control wiring. All groups of control wire leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provision for larger conductor termination as required.

- k. Control power shall be VAC and VDC derived from external generator starting battery source, 24VDC from an external source for circuit breaker control power and connection to monitoring station components, and control power transformers. Provide best battery selector power supply with control power input from three VDC sources. Provide terminal blocks at each generator control section for internal connection of VDC and VAC control power sources. Provide terminal blocks at EGPS Master section for single point connection of external control power sources. Breaker charging and closing power to match with facility requirements. Breaker tripping power to match existing. Control power transformers shall be connected to line side of generator breakers. Provide electrical and mechanical interlocks to prevent control power transformer primary from being energized simultaneously from two different generators.
- l. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.
- m. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.
- n. Provide a metal barrier full height and depth between adjacent vertical structures in the cable compartment.
- o. Provide a glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for main bus.
- p. Provide mimic bus diagram and master nameplate in front of each section identifying each section, with nameplate arrangement as shown on drawings. Provide individual plastic laminate nameplate for each control/protective device, relay, etc., within or mounted on the EGPS. Nameplates as shown on Drawings.
- q. Provide a single line diagram, ink on mylar, of generator control sections and close-coupled EGPS switchboards, framed and covered with 1" thick plexiglass cover. Mount on outside of EGPS enclosure.
- r. Provide one complete spare set of each size of metering fuses and control fuses.
- s. Provide a traveling type circuit breaker lifter, rail-mounted on top of switchgear complete with breaker lifting attachments and seismic position locking device.
- t. The EGPS shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete generator control sections will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute between live parts and ground.
- u. Shipping splits: Fabricate and ship the generator control sections to jobsite in shipping splits as required.

- v. With accessories and devices shown or required for proper operation, arranged generally as shown.
  - w. Circuit Breakers:
    - 1) Drawout power circuit breakers electronically operated to match existing and/or as required by facility. All breakers U.L. listed for application in their intended enclosures for 100% of their continuous ampere rating.
    - 2) Electrically operated. Charge, close, and trip from control power source and shunt trips. Provide separately fused trip and close circuits for each circuit breaker. The charging time of motor shall not exceed 6 seconds.
    - 3) With open/close circuit breaker push buttons, and control switch, plus main contact status indicator to indicate breaker contact position, and spring status indicator to indicate spring charged or discharged. Provide cover over manual push buttons to prevent inadvertent operation.
    - 4) With breaker position indicator to indicate when the breaker is in the connected, test, and disconnected position. The levering door shall be interlocked so that when the breaker is in the close position, the breaker levering in door shall not open.
    - 5) Each power circuit breaker shall include, but not be limited to the following:
      - a) One (1) Drawout power circuit breaker electronically operated rated as shown
      - b) Three (3) phase current sensors and neutral sensor where shown
      - c) One (1) Microprocessor based 3 phase RMS Trip Unit
    - 6) With auxiliary contacts on each breaker wired to an identified terminal strip, for breaker position (open/closed) (4a and 4b contacts); one overload trip contact to be normally open and closed on trip. These auxiliary contacts are in addition to those required for normal system functions.
    - 7) Temporary/Load bank circuit breaker shall be provided with removal 3 position selector key switch with interface to generator circuit breakers to allow this circuit breaker(s) to be used for connection to load bank or to use for temporary generator connections in case the generators requires maintenance and temporary generator is needed.
  - x. Digital Metering Module to show load for each generator and combined load. Digital meter shall have capability to communicate with monitoring system.
3. The automation and control system shall facilitate overall emergency generator operation including automatic standby operation, monitoring and control of the generator sets



including start/stop, alarm/fault monitoring, synchronizing, generator kW load sharing, generator kVAR load sharing, generator loading/unloading, load shed/add, and protective relaying.

4. The generator control panel automation and controls shall utilize true redundant, distributed processing technology to maximize system reliability and fault tolerance. The distributed processing system shall include a separate automation processor for each power source, and a separate processor dedicated to each touchscreen Human/Machine Interface (HMI) operation.
5. The generator control panel automation and controls shall be with the generator sets as a total coordinated and integrated system.
6. Generator Control Panel Sections: Engine generator controls for each unit shall consist of a generator control section with electrically operated drawout air power circuit breaker for the generator, engine controls, alarm and metering. Voltage adjusting and speed sensing wires to be shielded. Provide laminated plastic nameplates for all devices, including relays, etc., with black letters engraved in white background. Generator connections with load connections bussed to switchboard main bus with provisions for bussed connections to EGPS. Circuit breaker control voltage to suit. Provide individual nameplate for each device/component on the front and within the control panel. Include the following components:
  - a. HMI – Human/Machine Interface:
    - 1) Generator control panel automation interface shall be via a touchscreen with the following characteristics:
      - a) Color, 19” diagonal TFT LCD display capable of displaying both text and graphics.
      - b) HMI screen lighting to suit facility requirements.
      - c) Annunciator screen to show alarms and report menu screen.
      - d) Annunciator to show alarm and monitoring for all components such as engine, fuel, battery, battery charger, water, oil, and other components to meet NFPA compliance and JACHO requirements.
      - e) Coordinate with the University’s Representative for requirements of analog meters for each generator and combined unit.
    - 2) All units will start upon sensing a power failure. The first unit to reach rated voltage and frequency shall be placed on the load bus by automatically closing its circuit breaker (dead bus relay). The other unit’s circuit breaker shall be prevented from closing until it has been synchronized with the load bus and shall close automatically upon such synchronization. Synchronizing shall be done by electrically forcing the second unit to match the frequency of the bus.
    - 3) Engine emergency shutdown system shall open generator circuit breaker.

- 4) Engine cranking system shall crank the unit continuously for an adjustable cranking time. A cranking limiter shall discontinue cranking if the engine fails to start in 30 seconds of cranking. The “overcrank” light and alarm is activated at this time.
- b. Time delay relay to prevent momentary opening of generator breaker upon momentary loss of engine start signal from automatic transfer switch(es). Adjustable from 0.15 to 15 seconds, set at 5 seconds.
- c. Generator Control Panel:
  - 1) The generator control automation and controls shall consist of the hardware and software required for the control of the engine-generator plant and associated distribution feeder circuit breakers. The system shall include all automation controllers, HMI (Human / Machine Interface) touchscreens, automation controller, supervisory networks and all ancillary control equipment necessary to automatically execute the specified functional sequence of operations.
  - 2) The EPS automation and controls shall be provided with an HMI consisting of a touchscreen display.
    - a) The HMI shall provide all metering, status, monitoring, and control information to the operator.
    - b) The HMI shall serve only as an operator interface. The generator control must continue to function normally with a complete HMI failure.
    - c) The HMI to be provided with a removable enable / disable key switch.
  - 3) The EPS automation and controls shall be designed to eliminate single points of failure.
    - a) For redundancy, multiple automation controllers shall be utilized.
    - b) At a minimum, the generator control shall utilize a separate controller for each power source.
    - c) Control systems utilizing a single automation controller are not acceptable.
  - 4) The generator control automation and controls shall be capable of surviving a fault of one or more of its automation controllers. The failure of any generator controller shall only cause loss of automatic operation of a single generator. The failure of any single master controller shall in no way hinder the full automatic operation of the entire generator control automation and control system.
  - 5) Operator/System Safety Provisions

- a) Circuit Breaker Control Switch (CBCS) - A separate circuit breaker control switch (CBCS) shall be provided for each generator source circuit breaker controlled by generator panel automation. CBCS functionality shall be manual and separate from generator automation. Each CBCS will include a "Pull to Lock" function in the trip position. A CBCS locked in the trip position shall override all EPS automation functionality.
- b) A separate industrial grade synchronization check relay (ANSI Device 25) shall be furnished in addition to the sync check functions provided by the EPS system for each paralleling circuit breaker.
- c) Reverse Power Monitors
  - 1. Self-contained, single phase, solid state type reverse power monitors, one for each generator, shall be furnished to detect excessive reverse power flow, caused by the motorizing of a failing generator plant. Upon detection of a true reverse power flow, the monitor shall signal the alarm circuits to immediately disconnect the generator. The reverse power monitor shall automatically reset upon generator power disconnect.
- d. Provide a Programmable Logic Controller (PLC) for all engine and alarm functions. System shall be capable of maintaining 24VDC output with input of +20% to -75% of nominal 24VDC. Provide all required I.O. modules, CPU, terminals and required accessories. Provide programming to Schneider Modicon Momentum, Allen Bradley, or equal. Contractor shall ensure that the Emergency Generator Paralleling Switchgear (EGPS) manufacturer provides PLC programming for system operation.
  - 1) The system will be controlled by a programmable controller. In the event that the controller system fails, the operation will be backed up by relay logic, to allow all units to start and parallel to the main switchgear bus.
  - 2) Provide complete logic, input/output, and wiring for alarm, shutdown, and indicator lights / annunciation functions as herein specified. In addition, provide logic, input/output, and wiring for all related components.
- 7. Master Control / Paralleling Panel: The master control / paralleling panel shall include the following components:
  - a. Master control functions shall be fully redundant. Provide redundancy for PLCs and automation control network.
  - b. Any required transfer of master control functions shall be transparent and bumpless.
  - c. Master control functions: Automatic start of the generator, first-up, dead-bus function, and automatic generator demand priority.
    - 1) Automatic Load Shed / Add

- a) The load shed control shall have one essential load shed priority level for each generator in the system plus one non-essential load shed priority level (which is always shed in the emergency mode of operation).
  - b) The load shed control shall control each of the distribution circuit breakers as shown on the drawings. Distribution circuit breakers to be controlled shall be electrically operated. Each electrically operated distribution circuit breaker shall be field selectable to be assigned to any of the available load shed priority levels.
- d. Synchronization equipment for manual paralleling operation:
- 1) Synchroscope for frequency comparison between three generators and the bus, with 360 degree scale, calibrated for “SLOW-FAST”, 4 ½ inch dial, 1% accuracy. A selector switch shall be arranged to compare one unit with bus and to disconnect the synchroscope from the circuit during normal automatic operation.
  - 2) Two synchronizing lamps for paralleling lights. Medium base sockets with light blue 10 watt lamps.
  - 3) Manual Synchronizing Selector Switch to compare each unit with the load bus and to disconnect the synchroscope from the circuit during normal automatic operation.
  - 4) Safety check synchronizing relay. Interface with safety check synchronizer relay and generator breaker control systems.
- e. The generator automation shall support the following sub-modes: Load Shed/Load Add, and Generator Demand Priority.
- 1) Generator Demand Priority Control
    - a) Upon entrance into emergency or load management modes, all generator sets shall be started and paralleled to the bus. After a load stabilization delay, generator sets are automatically added to or removed from the bus according to system load demand.
- f. Indicating Lights: Provided as an integral part of the paralleling switchgear HMI touch screen display as shown on drawings. Provide common lamp test switch for all indicating lights. Provide indicating lights for fuel system, alarms, controls, PLC, automatic transfer by-pass switches, and other related items.
- g. Alarm horn to sound pulsing signal upon preliminary alarm and to sound continuously upon shutdown alarm. Provide alarm with silencing feature with pilot that remains lit until system is restored. Upon system restoration, alarm shall be automatically reset. Alarm horn sound level: 95 dB at ten feet.
- h. Multi-function solid state digital metering module (MM1) with communication capability.

- i. Provide signal for remote annunciations that indicates system is on-line and carrying load.
  - j. Automatic DC Control Voltage Sensor System:
    - 1) An automatic DC control sensor system shall be provided in the master control section to provide DC control voltage. DC control power shall be obtained from any one of the engine starting batteries or the station battery supplied with the new switchgear. The sensor shall automatically select the best control voltage from the available batteries. The DC control voltage sensor shall insure a stable system control voltage, as long as any one of the battery sources are available.
    - 2) In each generator control cubicle a DC overvoltage protection circuit and power supply shall be provided to protect the system from excessive overvoltage and undervoltage conditions, particularly during engine cranking. The protection shall extend to all circuits connected to the best battery selector.
    - 3) Generator automation control power system shall be protected against single point of failure by the utilization of a 24VDC, best source DC system strategy.
8. Load Shed / Load Add Distribution Circuit Breaker I/O:
- a. Load shed / load add I/O shall be monitored and controlled via the supervisory network.
  - b. Load shed / load add distribution circuit breaker I/O shall include:
    - 1) Circuit breaker auxiliary contact monitoring
    - 2) Circuit breaker bell alarm contact monitoring
    - 3) Close circuit breaker output
    - 4) Open circuit breaker output
  - c. Load shed / load add distribution circuit breaker I/O redundancy
    - 1) Load shed / load add I/O shall be fully redundant.
    - 2) Transfers from primary to back-up load shed / load add I/O shall be transparent and bumpless.

Y. Generator Automation & Controls:

- 1. The automation and control system shall facilitate overall generator operation including automatic standby operation, monitoring and control of the generator sets including start/stop, alarm/fault monitoring, synchronizing, generator kW load sharing, generator kVAR load sharing, generator loading/unloading, load shed/add, and protective relaying.

2. The generator automation and controls shall utilize true redundant, distributed processing technology to maximize system reliability and fault tolerance. The distributed processing system shall include a separate automation processor for each power source, and a separate processor dedicated to each touchscreen Human/Machine Interface (HMI) operation.
  3. The generator automation and controls shall be by the same manufacturer as the switchgear and generator sets. It shall be furnished with the generator sets as a total coordinated and integrated system.
  4. Charger:
    - a. Fully automatic, solid state, constant voltage charger designed for use with valve-regulated lead-calcium batteries and switchgear applications.
    - b. Designed to carry continuous and intermittent loads to its maximum rated output.
    - c. D.C. output filtered to 30mV ripple and current limited at less than 140%.
    - d. Transistor controlled magnetic amplifier circuits with continuous taper charging. Output voltage regulation within +/- 10%.
    - e. Provide with accessories for alarm and other components.
- Z. Generator Annunciation System:
1. The generator shall be provided with local annunciation to monitor and display critical generator set, utility, and system status, fault, and shutdown information as displayed on the HMI touchscreen.
  2. Annunciation shall comply with NFPA 110 requirements.
  3. The annunciation system shall be equipped with a fast pulse horn (rated 95 dbA), a horn silence push-button, and an acknowledge push-button. Any generator pre-alarm, generator shutdown alarm, or generator alarm shall cause the alarm horn to sound until the horn silence button is depressed. Any subsequent alarms shall re-sound the horn. The display shall operate such that any alarm point shall “flash” until acknowledged.
  4. The annunciation system shall be provided with the following types of annunciation points:
    - a. Status Points – These annunciation points shall show the status of critical system or generator set components. Status annunciation points shall not sound the annunciation system horn. They shall not require acknowledgement.
    - b. Generator Set Pre-Alarm Points – These annunciation points shall show fault conditions that could jeopardize the ability of the generator to function properly without immediate attention. Generator set pre-alarm annunciation points shall

sound the annunciation system horn. They shall require acknowledgement. Generator set pre-alarm annunciation points shall reset automatically as the alarm condition is cleared.

- c. Generator Set Shutdown Alarm Points - These annunciation points shall show fault conditions that have caused the shutdown of one (1) or more generator sets. Generator set shutdown annunciation points shall sound the annunciation system horn. They shall require acknowledgement. Generator set shutdown annunciation points shall cause the generator set to shutdown and the generator main to trip open. The generator main is then locked out until the cause of the shutdown is corrected, the engine control switch is placed in Off/Reset, and then placed back in Auto or Manual position.
  - d. Generator Alarm Points – These annunciation points will indicate system wide fault conditions. Generator annunciation points shall sound the annunciation system horn. They shall require acknowledgement.
5. Provide remote annunciation panel at the following locations:
- a. Provide local control and annunciation panel on each generator unit as required by agency having jurisdiction.
  - b. Provide remote alarm annunciators: conforming to NFPA 99, NFPA 110, and NEC 700-7, with additional annunciation points such as main fuel oil tank status, fuel oil pump status, fuel oil monitoring panel group alarm, and automatic transfer switch position.

AA. Installation:

1. It is intended that the Emergency Power Unit (EPU) be furnished as a complete and compatible assembly with the Emergency Power Unit/system including but not limited to the Engine, Generator, Voltage regulator, starting equipment, radiator, silencer, control panels, fuel oil system, and all accessory equipment herein specified.
2. Contractor responsible for ensuring the proper operation of the complete system upon delivery.

BB. Start-Up and Instructions:

1. Provide factory-authorized representative to verify correct connection of all external electrical connections to the generator, and to start-up and test all mechanical components, instrumentation, and wiring integral to the generator set package.
2. Provide factory-authorized representative to fully instruct the University in the operation and maintenance of the equipment. Instruction to consist of five 6-hour periods at the jobsite. Three instruction periods shall be during start-up and field-testing and with load banks available for demonstration of system operation. Two instruction periods shall be within guarantee period at time designated by the University.

3. Factory-authorized representative shall review system trouble shooting with University's Representative and train facility engineers for repairing the system and trouble shooting.

CC. Maintenance Manuals and Guarantees:

1. Provide four (4) copies and one electronic copy of manuals covering operation, parts and service and as-built details and drawings.
2. Provide four (4) copies and one electronic copy of a comprehensive parts listing.
3. Provide guarantee of complete system for one year, including 24-hour emergency service for EPU.
4. Provide spare parts for EPU and emergency system to allow system to operate properly. Coordinate with University's Representative to identify all required spare parts.
5. Provide cost proposal for an extended five year / 1,500 hour limited warranty in accordance with Manufacturer's standard optional agreement.
6. Provide 2-year full replacement guarantee for battery and 5-year pro-rata replacement warranty.

DD. BAAQMD Permits

1. Provide assistance to the University in obtaining the Bay Area Air Quality Management District (BAAQMD) permits.
  - a. Provide EPA/CARB certification for the engine.
  - b. Provide complete technical data regarding engine emissions.
  - c. Prepare the permit application forms and all supporting documents for the Authority to Construct and Authority to Operate.
  - d. The permit application forms shall be submitted to the University and the University shall submit the permit applications to BAAQMD.
2. University Responsibilities
  - a. The University will provide site plan or map of Emergency Power Unit location and adjacent properties within 1000 feet of the generator.
  - b. The University will maintain all logs regarding the operation of the Emergency Power Unit and will operate the Emergency Power Unit within the parameters specified in the BAAQMD operating permit.
  - c. The University will submit the permit application forms to BAAQMD

EE. Automatic Transfer Switches (26 36 00):



1. Provide two sets of single pole, double throw contacts that operate 3 seconds before transfer in either direction and reset 3 seconds after transfer. Rated 10 amps, 480 volts, 60 Hz AC. Provide and install three # 12 conductors in ¾-inch conduit from each set of contacts to the building management system to disconnect motor loads before transfer and reconnect them after transfer in either direction.
2. Automatic Sequence of Operation: Close transition switches shall be rated less than 100 milli-seconds.
3. Automatic Transfer with Bypass/Isolation Switch (Closed Transition) (ATBS):
  - a. Closed Transition type complete with accessories specified herein and as shown in Contract Documents.
  - b. Bypass/isolation, closed transition, 4 poles, built in accordance with NEMA standards PB-2 and U.L. 1008; front accessible.
  - c. Ratings: As shown on the drawings and/or as required for Emergency System (ATBS), 277/480V - 3 phase-4 pole-4 wire with a ground landing pad and/or 120/208V-3 phase-4 pole-4 wire. Maximum 1200 amp switches shall have withstand and close-on rating of 65kA minimum.
  - d. With “3-Phase Power Available” (extended life) lights on both normal and emergency sources. Lamps shall be Light Emitting Diode (LED) type. Provide one (1) lamp for each phase on each source.
  - e. NEMA Class 1 indoor construction - code gauge (13 ga. min.) Formed steel with formed, hinged doors for indoor, and NEMA 4X (stainless steel) for exterior installation. Finished inside and out with two coats of epoxy paint, manufacturers’ standard color. Provide doors with closed cell neoprene gaskets. With the following features:
    - 1) With cable feed and cable load connections.
    - 2) Four pole double throw switch without an intentional off position.
    - 3) With Current Coil type magnetic blow-out or de-ion arc quenchers on each pole.
    - 4) Three phase microprocessor-based control panel, with special features and accessories as specified herein.
    - 5) The controller LCD display shall include a system status screen. The controller shall contain a self diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to controller which may be preventing load transfer commands from being completed. The controller shall have capability for communication interface through serial communications module.

- 6) Close differential, three phase solid state field adjustable voltage sensing relays, factory-set to drop out at 85 percent rated voltage for normal and 75% for emergency, and pick-up at 90% rated voltage for both normal and emergency positions.
- 7) Time delay emergency to normal, adjustable 2-30 minutes and with time delay defeat switch. Time delay set at five minutes. Provide with a momentary contact switch, mounted on the door, to override the time delay.
- 8) Time delay from normal to emergency adjustable 0 to 300 seconds; set at 0 seconds.
- 9) Unloaded running time delay (cool down) adjustable 0 to 60 minutes, set at 5 minutes.
- 10) A time delay activated output signal shall also be provided to drive external relay(s) for selective load disconnect control. The controller shown shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
  - a) Prior to transfer only.
  - b) Prior to and after transfer.
  - c) Normal to emergency only.
  - d) Emergency to normal only.
  - e) Normal to emergency and emergency to normal.
  - f) All transfer conditions or only when both sources are available.
- 11) Time delay on emergency power system starting, adjustable 0 to 6 seconds, set at 0 seconds.
- 12) Engine start relay with one (1) contact that closes to signal engine to start.
- 13) Frequency relay to prevent transfer to emergency until generator is within 90 to 100 percent of rated frequency set at 95%, with fixed differential of approximately 12% below pick-up.
- 14) Two position maintained selector switch - "TEST" "AUTO". The "TEST" position simulates power failure, engine starts if not running, and complete transfer is made. The "AUTO" position returns the transfer switch to normal operation. Upon power failure, with the emergency source available, the switch will transfer to the emergency source. Failure of emergency source with normal source available shall transfer the system immediately to the normal source. The engine start contact shall be maintained while moving the selector switch from "TEST" to "AUTO" position.

- 15) Auxiliary contacts: Direct-connected type to provide four contacts for both normal and emergency function. Provide one (1) set of gold flashed contacts for each position. These contacts are in addition to any contacts required for switch functions. Wired out to terminal blocks.
- 16) Mount all controls and pilot lights on transfer switch access door. Pilot lights to be extended life LED type.
- 17) Provide lighted indicators for transfer switch position “NORMAL”, “EMERGENCY”.
- 18) Relay and control system to be solid state. Any special function relays are to be enclosed. Provide tight fitting gasketed door over control section.
- 19) With normal source voltage sensing and control power taken from the line side of the transfer switch.
- 20) In-phase monitor to compare the phase relationship and the frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency difference. In-phase transfer shall be accomplished if both sources are within 2 Hz of nominal frequency and 70% or more of nominal voltage.
- 21) Closed transition type with bypass/isolation capability that allows momentary paralleling of the normal and emergency sources and allows transfer switch to be bypassed and isolated for servicing. Paralleling time shall not exceed 100 milliseconds. Provide synch-check device with adjustable voltage and phase angle windows to ensure normal and emergency sources are synchronized when closed transition occurs. Provide with bypass switch and isolating mechanism for transfer switch.
- 22) With synch-check device to compare the phase relationship, voltage difference and the frequency difference between the normal and emergency sources and permit momentary paralleling of the normal and emergency sourced during a transfer operation (closed transition transfer). The allowable phase angle window shall be adjustable between 0 and 30 degrees, factory set at 5 degrees. The allowable voltage window shall be adjustable +/- 10%, factory set at 5%.
- 23) Provide safety interlock feature, wired to terminal blocks for field wiring connection, to trip normal source or emergency source circuit breakers in the event of transfer switch malfunction that results in maintained parallel between the normal and emergency sources.
- 24) The automatic bypass closed transition switch shall include the following options:
  - a) Load shedding with interface with existing load control system.

- b) Indicator light for voltage availability on each phase for normal and emergency source. Provide separate LED light for each phase for normal and emergency source.
  - c) OSHPD seismic certification with pre-approval (OSP).
  - d) Remote test operation capability via University monitoring system. Provide all required hardware and wiring interconnections.
  - e) Inhibit transfer to normal (return to normal lock-out - RNL). Upon power failure during activation of "RNL" transfer switch must automatically transfer to available source. Coordinate with University's Representative.
  - f) Remote annunciator to Moffitt/Long emergency load control system. Provide all required hardware and wiring interconnections. Coordinate with the University's Representative for requirements for each site.
- 25) With a bypass switch to bypass the load to either normal and emergency source and isolation switch to isolate the transfer switch from the system and as follows:
- a) Arrange the two operating handles, one to bypass the load and the other to isolate the transfer switch.
  - b) Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs which disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
  - c) Isolation switch with three positions: "CLOSED", "TEST" and "OPEN/DISCONNECTED". The "TEST" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "OPEN" mode shall completely isolate the automatic transfer switch from all source and load power conductors.
  - d) With the same electrical ratings as the transfer switch.
  - e) Arranged with positive mechanical interlock to prevent simultaneous connection of the two power sources.
- 26) Provide Normal, Emergency, Preferred, Alternate, and Load feeders as shown on drawings. For automatic transfer bypass switches provide control wiring and connections to generator paralleling for switchboard for engine start, spare wires for future use, and any other functions shown on drawings. For automatic transfer bypass switches provide control wiring and connections to Parnassus Campus

SCADA system Remote I/O cabinet for ATBS position indication, remote test, inhibit transfer to normal (Return to Normal Lockout – RNL), spare wires for future use, provide control wiring and connections to campus monitoring system for ATBS position indicators, provide control wiring and connection to Moffitt/Long emergency load control system for ATBS position indicator, and any other functions.

- 27) With draw-out construction so that the transfer switch can be withdrawn, when by-passed, and isolated for testing and service.
- 28) With solid state digital metering module, interface with monitoring system to match existing. Provide with communication mod bus TCP, PG, output relay, analog output, and discrete input module for interface to campus Central Control and Monitoring System. Digital meter shall be compatible with Campus Central Control and Monitoring System.

FF. Testing Requirements:

1. Documents shall require specific testing of electrical equipment and material. Refer to Division 1 for additional commissioning test specification standard references. Testing shall be required before and after power is energized to assure proper operation.
2. Acceptance testing shall be performed in accordance with NETA Acceptance Test Specification (ATS), latest revision, and will include applicable sections for electrical equipment installed. Tests are required to be performed by an approved third-party testing laboratory or shall be made by a lab acceptable to the University. NETA membership or American Association for Laboratory Accreditation (A2LA) accreditation is minimum selection criteria for laboratory competency.
3. Provide documents for field testing to the University's Representative.
4. System shall be field tested per manufacturer's requirements.
5. Systems testing requirements shall be included in the project scope of work. The work shall proceed under the direction of the University's Design Team and require prior notification and witness by the University's Inspector of Record and documented in a final report.

GG. Interior Lighting (26 51 00):

1. The aesthetics and type of luminaires shall be compatible with the task and area in which it is located. Placement, candlepower, distribution and luminance ratios shall be chosen to reduce veiling reflections and promote visual performance.
2. Lamp diffusers shall be hinged so as not to require removal of diffuser or louver for changing lamps, and allow removal for cleaning or replacement of diffuser or louver. The

bottom of luminaires shall be at least 7 feet above finish floor; 8 feet minimum is preferred.

3. Custom manufactured luminaires shall not be used unless approved or requested by the University.
4. Ceilings heights less than 8 feet 6 inches high shall employ recessed luminaires except as approved or directed by the University.
5. Ballasts shall be removable through luminaire opening in non-accessible ceilings.
6. Lamps
  - a. Incandescent lamps, including low voltage incandescent, shall not be used except as approved or directed by the University.
  - b. In general, use LED lights for different applications such as linear 4 feet and/or 3 feet. Provide 2' x 4' with LED lamp 2' x 2' direct/indirect LED lamp. Provide dimming ballast for all LED light fixtures.
  - c. Linear fluorescent lamps shall be 4 feet nominal, 32 watt, 30,000 hour extended life at 3 hours per start, "super" T8 type. Where required for completing coves, 3 foot matching lamps shall be provided. 2 foot lamps shall be provided for nominal 2 x 2 luminaires. Use fluorescent lamp if LED is not available for light fixture and/or is acceptable to University's Representative.
  - d. Reduced wattage "energy saving" lamps shall not be provided.
  - e. T5 lamps shall only be provided for luminaires and installations that prohibit the direct view of lamp, including cove applications.
  - f. T5HO lamps shall not be used.
  - g. Linear fluorescent lamps shall have a minimum Color Rendering Index (CRI) of 84, color temperature of 3500 degree Kelvin.
  - h. Compact fluorescent lamps shall be 4100 K color temperature with a CRI of 82 and rated average life of 16,000 hours. The wattage shall vary according to the application.
  - i. Compact fluorescent lamps shall be 4-pin type. 2-pin type and self ballasted screw in type shall not be provided.
  - j. Fluorescent lamps shall pass the EPA TCLP test for low mercury content.
  - k. H.I.D. lamps, including high pressure sodium and metal halide, shall have a ceramic arc tube. Probe start lamps shall not be provided.
  - l. Eight-foot long, "U" shaped or circular shaped fluorescent lamps shall not be used.

7. LED fixtures shall include the following:
  - a. Comply with IES LM-79 and LM-80 requirements.
  - b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in Lighting Fixture Schedule.
  - c. Minimum rated life: 50,000 hours per IES L70.
  - d. Light output lumens as indicated in the Lighting Fixture Schedule.
8. Luminaires
  - a. All luminaires shall be fully enclosed for infection control.
  - b. The most common luminaire on campus will be a 2' x 4' or 1' x 4' recessed fluorescent luminaire. Luminaire shall meet the following criteria:
    - 1) Coefficient of Utilization (CU): 0.89 minimum for 2' x 4' luminaire and 0.79 minimum for 1' x 4' luminaire at room cavity ratio of 1.0 and ceiling/wall/floor reflectance of 80%/50%/20%.
    - 2) Parabolic-type reflector luminaires shall not be used in public spaces except for large open areas with computer screens to provide less reflective glare.
    - 3) Lensed luminaires shall be provided in service areas. Lenses shall be virgin acrylic, polycarbonate or Lexan.
    - 4) Provide special light fixtures fully gasketed and fully enclosed for special areas such as operating rooms, ICU, CCU, cath lab, neuro-angio lab, CT scan, patient rooms, and other related areas.
  - c. Under counter task luminaires shall be stainless steel housing 1" height, one-piece co-extruded clear DR acrylic prismatic bottom lens with opaque front, electronic ballast. Fluorescent lamps shall be T8. Luminaire length shall coordinate with casework for full coverage. Provide with integral On/Off rocker switch. Provide hardwire concealed connection.
9. Ballasts:
  - a. Fluorescent ballasts shall be high frequency, high power factor electronic and reduced harmonic type.
    - 1) For linear lamps, ballasts shall be program rapid start, series wired, maximum 2-lamps per ballast. Ballast factor can be selected to suit design conditions.
    - 2) For compact fluorescent lamps, ballasts shall be rapid start, series wired, maximum 1-lamp per ballast. Ballast factor shall be 1.0.

- 3) Use LED lighting fixtures to meet energy saving requirements per University of California requirements.
- b. Dimming fluorescent ballasts:
- 1) Fluorescent electronic dimming ballasts shall be utilized in patient rooms, radiology rooms, X-Ray viewing areas, exam and testing rooms, and rooms with projection equipment and similar areas as identified in the project program.
  - 2) The ballasts shall provide a flicker-free dimming range from 100 percent down to 1 percent. Control protocol shall be 0-10V type.
  - 3) In areas where projection equipment is utilized, the dimming range shall be from 100 percent down to 1 percent. Control protocol shall be 3-wire type.
- c. H.I.D ballasts shall be integral to the luminaire and specifically designed for the lamp controlled.
- 1) For high pressure sodium lamps, ballast shall be high reactance autotransformer (HX-HPF) type. In noise-sensitive areas, ballast shall be fully encapsulated or remote mounted in an adjacent area where noise will not be objectionable.
  - 2) For metal halide lamps, ballast shall be high power factor electronic type, pulse start.
- d. LED driver:
- 1) Driver must be compatible with LED.
  - 2) Allow dimming without flicker.
  - 3) High power factor.
  - 4) Total harmonic distortion less than 20%.
  - 5) Non volatile memory restores all driver settings after power failure.
  - 6) Lamp end-of-life detection and shutdown circuit.
  - 7) Capability of 0-10V dimming system.
  - 8) Dimming switches for controlling light fixtures must be compatible with driver.
10. Electronic Suppression
- a. Provide proper protection for radiated and line transmitted electromagnetic noise to prevent magnetic and radio frequency interference. Suppression techniques shall be included in areas sensitive to electromagnetic interference including the following:



- 1) X-ray facilities.
- 2) Other areas designated by the University.

#### 11. Special Luminaires

- a. Certain task areas will require highly specialized luminaires. The special requirements shall be individually reviewed with the University's representative or were identified in the detail project program. These areas are as follows:
  - 1) Surgeries
  - 2) Medical treatment rooms
  - 3) Medical exam room
  - 4) ICU, CCU, cath lab
  - 5) Autopsy room
  - 6) X-ray rooms and other imaging rooms
  - 7) MRI
  - 8) Laboratory
  - 9) Pharmacy
  - 10) Other areas designated by the University

#### 12. HID Interior Lighting

- a. High Intensity Discharge (HID) lamps may be used in large indoor areas where frequent switching is not required.
- b. HID lamp ballasts shall provide maximum lamp output energy efficient designed for specific lamp
- c. Utilize Pulse Start lamps and Ballast for all Metal halide applications.

#### 13. Interior Illumination Levels

- a. Design to the recommended illumination levels for the type of areas indicated. Illumination levels are not necessarily average levels over an entire space. Task oriented lighting is encouraged where its use will not adversely affect general appearance of space. For areas not listed, refer to the most current issue of the IESNA Lighting Handbook for illumination levels. Levels indicated are maintained illumination levels unless otherwise noted. This table shall be used by the Designer in

developing a lighting system for the project based on current IES recommended practices, code, life safety and good engineering practices. Daylighting contribution can be considered in calculation of illuminance. Footcandle levels do not include task lighting contribution to the room.

- b. Maintained lighting levels shall, at a minimum, include the following Light Loss Factors (LLF):
  - 1) Lamp Lumen Depreciation (LLD): Selected values shall be from manufacturer's data, at 70% of rated life.
  - 2) Luminaire Dirt Depreciation (LDD)
  - 3) Ambient Temperature Factor (ATF): for T5 lamps.

<b>MAINTAINED FOOTCANDLE REQUIREMENTS</b>	
<b>TYPE OF OCCUPANCY</b>	<b>ILLUMINATION LEVEL**</b>
<b>Ambulatory Care</b>	
Examination - General	50
Exmination – Bed/Table	100
Observation - General	10
Observation – Bed/Table	50
Colloquia and team rooms	40-50
<b>Corridors</b>	
Nursing	10
Intensive Care	10
Surgery	10
Emergency lighting	1 minimum, 3 average, 10 maximum*
<b>Diagnostic Procedures</b>	
Endoscopy - General	50
Electrocardiography (ECG)	15-30
Electroencephalography (EEG)	15-50
Dialysis	10-100
Electron Microscope	30-200
<b>Laboratories</b>	
General	30
Benches	100
<b>Nurses' Station</b>	
General	10-50
Intensive Care	30-50
Surgery	50
<b>Patient Rooms</b>	
General/Reading	5-20
Exam	50
Night Observation	3
<b>Pharmacy</b>	
General	50-100
<b>Radiology</b>	
Diagnostic	50
Therapy	50
<b>Sterile Processing and Distribution</b>	
Clean side	30
Preparation, Assembly, and Sterilization	30
<b>Surgical Suites</b>	
Clean and Sterile Supplies	30
Clean Core Support Area	50
Operating Rooms	100-200
Table	300

Patient Holding Area	50
Recovery	10-100
Miscellaneous	
Restrooms	10-15
Service areas (mechanical, electrical rooms)	10-20
Elevator equipment rooms	Comply with Elevator Code
Storage rooms	10-15
Main telecom equipment room	50
Stairwells (interior)	10-15
Stairwells (exterior)	3-5
Stairwells emergency lighting	1 minimum, 3 average, 10 maximum

HH. Exterior Lighting (26 56 00):

1. The University has many fixtures that are high-pressure sodium (HPS) as the energy efficient light source for exterior lighting. Exterior lighting shall be 480 volts and for the security of students shall remain on all night. See Section 31, "Site Work" for additional Plaza and site lighting information.
2. Installations shall comply with Illuminating Engineering Society of North America (IESNA) lighting handbook standards.
3. Calculations:
  - a. A computer point-by-point printout of exterior and parking structure lighting shall be submitted for approval. The printout shall depict location of luminaires at their respective mounting height, to verify horizontal illumination requirements on grade. Maximum 5 foot on spacing for calculation points.
  - b. Include any existing campus luminaires in the computer analysis that may exist around the perimeter of the new site lighting. Do not include city street lighting in calculation.
  - c. A sample luminaire cut sheet(s) with candlepower curves and isolux charts shall be submitted.
4. Exterior lighting circuits shall be multi-staggered circuits to minimize a total outage.
5. Lighting Contactor Control circuits shall be a separate dedicated circuit from lighting branch circuits to minimize disruption.
6. Lighting circuits shall be activated and deactivated by a single photocell or astronomical timeclock per building or parking lot. Do not use luminaires with individual photocells.
7. Plaza luminaires shall be pole mounted type luminaires to match existing.
8. Luminaires set into building exteriors or retaining walls shall be avoided due to difficulty in re-lamping or replacing, and rusting of the luminaire housing.

9. Light bollards shall be not be used if possible; if used they shall be located in planting areas where exposure to pedestrian and bicycle traffic is minimal.
10. Outdoor signage shall be placed near luminaires to improve visibility at night.
11. Pedestrian walkway luminaires layout shall be designed to prevent bright spots or heavily shadowed areas coordinate with landscape and growth of bushes and tress.
12. The University shall approve the use of Handrail lighting.
13. To minimize stocking numerous lamp sizes the University has standardized on 100, 150 and 250-watt high-pressure sodium lamps. Other wattage shall not be used.
14. Design lighting standards and base anchor for 100-mph wind.
15. Luminaires that are difficult to change lamps are unacceptable to the University.
16. Comply with the USGBC LEED credit SS 8 for light pollution reduction. Only light areas as required for safety and comfort. Do not exceed 80% of the lighting power densities for exterior areas and 50% for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1, latest edition, Exterior Lighting Section, without amendments. Design exterior lighting so that all site and building mounted luminaires produce a maximum initial illumination value no greater than 0.20 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site boundary. Uplights at trees and buildings shall not be provided.
17. Pole Height
  - a. General Pole Height by Area should be as follows. These heights must be reviewed and approved by University's Representative, agency having jurisdiction (AHJ), city, and/or county that may have jurisdiction for outdoor pole lights.

AREA	POLE HEIGHT
Mall (theme light)	10 ft.
Pedestrian Paths	12 ft.
Pedestrian Paths / Fire lane	18 ft.
Fire Lane	18 ft.
Bike Paths	18 ft.
Main Campus	18 ft.
Open Areas	24 ft.
Parking Lots	28 ft.
Street Lighting	30 ft.

- 1) Note 1: Where cars can contact pole light, provide a 3 foot-4 inch high concrete base. Adjust pole height to provide luminaire head at height above grade as listed above.
- 2) Note 2: Variation in height due to landscape and trees should be considered and variations indicated to the University.
- 3) Note 3: All pole lights must be supported properly for wind load.

#### 18. Street Lighting

- a. High-pressure sodium 250-watt luminaires with self-contained 480-volt ballast shall be utilized along streets, roadways and pedestrian crossings, and/or LED luminaires to suit.
- b. Street lighting shall be concrete standards with eight-foot aluminum davit arm. Ameron Contemporary Series, 1C1 octagonal pole anchor base with anti-graffiti sealer.
- c. Minimum set back is 30 inches back from face of curb.
- d. Check with the University when adding luminaires of this type to the campus existing power circuits.
- e. Each luminaire shall be fused with time delay fuse in a weatherproof holder in the luminaire head.

#### 19. Parking Structure Lighting

- a. Provide ultra-long life luminaires (minimum 50,000 hours to L70).
- b. Provide luminaires with integral occupancy sensors, to reduce light output to 20% or less when area is not occupied for more than 10 minutes.
- c. Provide LED luminaire parking lights with antiglare lens, integral driver, and integral occupancy sensor with dimming capability for each luminaire.
- d. Luminaires shall be specifically designed for use in parking structures. Luminaires on the top level shall be pole mounted campus standard parking lot luminaires but not HPS lamps.
- e. Luminaires on the perimeter of above grade open parking structure shall be photocell controlled. Provide a minimum of two photocells to zone by exposure.

#### 20. Parking Area Lighting

- a. Provide LED luminaire fully gasketed, antiglare lens, integral driver, and integral occupancy sensor with dimming capability for each parking lot pole to suit each site.

- b. Luminaires shall be 250 watt, 480 volt self contained, high pressure sodium, 22 inch, bronze anodized finish.
- c. Poles shall be 5-inch diameter, straight round aluminum, with dark bronze anodized finish.
- d. All pole must be painted for anti-corrosion. Coordinate with University's Representative for corrosion requirements for each site.

#### 21. Grounds Lighting

- a. Landscape lighting of trees and plants shall be limited. Ground lighting must account for the very corrosive nature of the University's soil. Do not recess metal luminaire housings in the soil. Provide a concrete pedestal or non-metallic materials.

#### 22. Pathway Lighting

- a. Pathway luminaires shall be cylindrical cutoff luminaires, aluminum housing, Type III distribution, single mount. LEDs with integral driver.
- b. Lighting standards shall be 12' high, one way, bronze anodized finish, 4-inch diameter, aluminum bronze anodized, straight round pole with a round pole base cover.
- c. Pathway lighting with bollards should be minimized. If bollards are used locate in planting areas where exposure to pedestrian and bicycle traffic is minimal. Bollard shall be LED type with louver, 480V, concrete aggregate type.
- d. Pathway lighting for major spokes from the ring mall shall use the campus theme luminaire. The University shall determine when a pathway is a major spoke.

#### 23. Exterior Building Lighting

- a. Exterior surface building mounted lighting in public areas that has been used on campus is a round 10-1/2" diameter nominal, 8-5/8" deep maximum lensed fixture with die-cast low copper aluminum alloy with vertical and horizontal double ribs. LED with integral driver.
- b. Service area luminaires shall be LED Wallpack type fixtures.

#### 24. Footcandle Levels: The following maintained levels shall be provided:

TYPE OF OCCUPANCY	FOOTCANDLE ILLUMINATION LEVEL	UNIFORMITY RATIO (AVERAGE: MINIMUM)
<b>EXTERIOR LIGHTING</b>		
BIKEWAYS	0.5*	5:1
PARKING LOTS	1.0***	4:1
PATHWAY**	1.0*	4:1
PLAZA	1.0*	5:1
RING MALL LIGHTING	2.2#	5:1
SERVICE YARD (SECURITY)	0.2*	Na
WELL LIT PATHWAY	2.2#	5:1
<b>ROADWAYS (AVERAGE)</b>		
PRIMARY AND SECONDARY	0.9	4:1
RESIDENTIAL	0.6	4:1
SERVICE ROADS AND ALLEYS	0.4	4:1
<b>PARKING STRUCTURES</b>		
PARKING & PEDESTRIAN AREAS	5.0 & 5.0##	4:1
RAMPS AND CORNERS	10.0 & 5.0##	4:1
ENTRANCE AREA	50.0 & 5.0##	4:1

\* Average maintained horizontal level on grade or pavement.

\*\* Crosswalks traversing roadways in the middle of long blocks and at street intersections shall be provided with additional illumination.

\*\*\* Minimum maintained on the parking lot surface.

# Average maintained vertical level at six feet above walkway.

## Day and night footcandles. Day footcandle level is sum of electric lighting and daylight.

## II. EMERGENCY LIGHTING (26 52 00):

### 1. General

- a. Multiple corridor lights on each floor level shall be serviced from the Life Safety Branch panelboard for egress.
- b. Egress stairwell lights shall be served from the Life Safety Branch Panelboard.
- c. Home runs for both normal and emergency power shall be in separate conduits.
- d. At least one luminaire in a public toilet shall be an emergency luminaire. Rooms over 30 feet deep from exit door shall have two emergency luminaires.
- e. Life Safety Branch lighting may also serve as night lighting.
- f. Exit signs shall be served from the Life Safety Branch.
- g. Provide switched emergency lighting in mechanical and electrical rooms.





- b. In operating rooms, ICU, CCU, and cath lab provide integral self testing, and batteries for light fixtures which are served from life safety branch. Coordinate with the University's Representative for additional requirements for above listed spaces by each facility.

JJ. UPS and Batteries

1. General: Provide Un-interruptible Power Supply (UPS) equipment to render a complete and operational un-interruptible power supply (UPS) system. The system shall consist of a rectifier, system batteries, solid-state inverter, automatic static bypass transfer circuit, maintenance by-pass isolation transformer, and power distribution and circuit breakers.
2. The UPS shall be seismically qualified per the requirements of the California Building Code.
3. The UPS shall be medical grade.
4. Work included in this section:
  - a. Un-interruptible Power Supply Control Arrangement, three phase continuous duty, on-line, solid state un-interruptible power supply (UPS) Multi-Module System (MMS). It shall operate in conjunction with the existing building electrical system to provide back-up and distribution for critical electrical loads as shown. Unit shall be capable of supporting and/or be supported by at least, but not limited to distribution panelboard, DC battery bank, integral maintenance by-pass arrangement, output isolation transformer with power distribution system, and other related features as described, as shown and/or as required.
  - b. Un-interruptible Power Supply Direct Current (DC) Battery Arrangement, valve regulated, high rate discharge, lead-acid batteries which provide energy to support the critical load during a momentary loss of utility power to the UPS control arrangement. The battery cabinet will be installed remotely from UPS maintenance by-pass. See drawings for additional requirements.
  - c. Un-interruptible Power Supply Maintenance By-Pass Arrangement, to provide electrical power to the critical load from the UPS control arrangement under normal operating conditions or utility source so that UPS control arrangement can be serviced.
  - d. Un-interruptible Power Supply Output Transformer and power distribution system shall be installed in same enclosure as maintenance by-pass enclosure if required due to space limitations.
5. The UPS system shall consist of the following major equipment and can be divided into two sections and shall be comprised of the following:
  - a. Converter Section
  - b. DC Input and associated Battery System (Including battery disconnect circuit breaker)

- c. Inverter Section
  - d. Bypass Static Switch Circuit (sized to provide fault clearing)
  - e. UPS MMS Control
  - f. Interface terminal for connecting control cables between each individual UPS Module (for UPS MMS Control)
  - g. Operation/Display panel
6. The parallel cabinet shall consist of the following:
- a. UPS Module output circuit breakers
  - b. Parallel bus power circuit
  - c. Load bank test circuit
  - d. System Maintenance Bypass circuit breaker (SMB) and power circuit
  - e. System Output circuit breaker
  - f. System output power circuit and terminals
  - g. Interlock System
  - h. System Emergency Power off (System EPO) push button that will shutdown all system UPS Modules.
7. The UPS shall be designed to operate continuously at rated capacity as an on-line, automatic reverse transfer system in the following modes:
- a. Normal - The inverter continuously supplies AC power to the critical load.
  - b. Emergency - In the event of a utility AC power failure, the inverter shall derive its input from the system battery, therefore providing uninterrupted power to the critical load.
  - c. Recharge - Subsequent to restoration of utility AC power, the converter shall automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery.
  - d. Normal, Emergency and Recovery Charge Parallel Operation - Each UPS Module utilizes cross current control signals between the UPS Modules to calculate and perform fast simultaneous inverter reference voltage and phase waveform control.
  - e. Bypass Operation - Each UPS Module contains an independent automatic bypass static switch circuit and associated control circuitry.

- f. System Maintenance Bypass/ Operation – System Maintenance Bypass Operation shall allow total system repair and testing for parallel operation as well as individual UPS Module repair and testing without affecting load operation.
- g. Inverter and Bypass Operation Inhibit -The UPS Bypass Operation Control contained in each independent UPS Module ensures that UPS Inverter and UPS Bypass Operation will never occur simultaneously.
- h. Module Maintenance Operation - It is possible for individual UPS Modules to be removed from the system for maintenance purposes while the remaining UPS Modules sustain on-line power to the load from inverter supply.
- i. Individual UPS Module Emergency Power Off (EPO) - When the UPS Module Emergency Power Off (EPO) button is activated, the EPO function shuts down the UPS module.

#### KK. Surge Protection

##### 1. Transient Voltage Suppression Devices At Main Switchboard

- a. Provide Transient Voltage Surge Suppression (TVSS) equipment having the electrical characteristics, and ratings. To maximize performance and reliability, the ac surge protection shall be integrated into electrical distribution.
- b. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.
- c. Unit Operating Voltage – Refer to drawings for operating voltage.
- d. Maximum Continuous Operating Voltage (MCOV).
- e. The suppression system shall incorporate a hybrid designed Metal-Oxide Varistors (MOV) surge suppressor for the service entrance distribution switchgear.
- f. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.
- g. Minimum single-impulse current rating shall be as follows:
  - 1) Line to Neutral: 100,000 A.
  - 2) Line to Ground: 100,000 A.
  - 3) Neutral to Ground: 50,000 A.
- h. Protection modes shall be as follows:
  - 1) Line to neutral.

- 2) Line to ground.
- 3) Neutral to ground.
- i. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the insertion loss test method.
- j. Extended Range Filter – The Surge Protective Device shall have a High Frequency Extended Range Tracking filter in each Line to Neutral mode with compliance to UL and NEMA.
- k. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 277/480 V systems.
- l. Overcurrent Protection Fusing: In order to isolate the TVSS under any fault condition, provide:
  - 1) Individual Fusing: MOVs shall be individually fused.
  - 2) Thermal Protection: MOVs shall be equipped with Thermal Fuse Spring (TFS).
  - 3) All protection components shall be tested in compliance with UL 1449-Limited Current Test and AIC rating test.
- m. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the California Building Cod (CBC) through zone 4 application.
- n. Accessories:
  - 1) Each unit shall provide a green / red solid-state indicator light provided on each phase. The red light shall indicate which phase(s) have been damaged.
  - 2) Remote Status Monitor – The TVSS device must include Form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state if any of the three phases detect a fault condition.
  - 3) Audible alarm activated on failure of any surge diversion module.
  - 4) Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.
  - 5) Push to Test – The TVSS shall be equipped with push-to-test feature. A test button shall be provided to initiate a self test procedure. If the system is fully operational, the self test will activate all indicator lights.
  - 6) The TVSS shall be equipped with a display system designed to indicate to the user how many surges, sags, swells and outages have occurred at the location. Provide with a reset pushbutton allowing all counters to be zeroed.

- 7) Voltage Monitoring – The TVSS shall display true root mean square (rms) voltage line-to-line.
- 8) Network Communication – The TVSS shall have the ability to communicate to a network Ethernet.
- 9) Total Harmonic Distortion (%THD) – The TVSS shall display Total Harmonic Distortion.

LL. Power Filter/Conditioner

1. Conditioned Power System

- a. Input Main Circuit Breaker: The Medical Grade Power Conditioner shall be equipped with an input main circuit breaker with shunt-trip. The Input Main Circuit Breaker shall be rated for 125% of the full load amps and be of thermal magnetic molded case construction. The Input Main Circuit Breaker shall have a minimum of 25,000 AIC rating. Provisions for higher interrupting capacity shall be incorporated into the design to accommodate this rating breaker, if required. The Input Main Circuit Breaker shall be UL listed.
- b. The power conditioner shall be seismically qualified per the requirements of the California Building Code.
- c. The power conditioner shall be medical grade.
- d. Cabinet
  - 1) Frame: The Frame shall be of tubular construction of heavy gage metal and welded for maximum strength. Each frame shall be treated before paint is applied and be of textured baked enamel. The base shall be supported by movable casters.
  - 2) Internal Sheet Metal: All internal sheet metal, attached to the base shall be plated with Gold Zinc Wash to ensure RFI, EMI susceptibility is reduced to the absolute minimum.
  - 3) Removable Access Panels: Removable front and rear panels shall be provided. Access to the Input Main Circuit Breaker shall be through a heavy metal door attached with a continuous hinge and held shut with a magnetic strip which shall be attached to the door with screws and nuts.
  - 4) Cover: The top cover shall not contain any openings into the interior of the Medical Grade Power Conditioner.
  - 5) Conduit entry: Input and output conduit entry shall be provided to suit mounting arrangement in field.
- e. Isolation Transformer: A multi-shield, copper wound, convection cooled, 3 phase, isolation transformer shall be provided. Construction of the transformer should

separate the Primary connections and the Secondary connections by placing them on opposite sides of the core. In addition, the output terminals of the secondary shall be at opposite ends of the coil for the input terminals of the primary to minimize the possibility of transverse node injection. A copper foil shield shall be provided to allow a large surface area for shunting RFI signals of the core to ground. The isolation transformer shall be mounted on rubber isolation pads. The transformer core clamp shall be grounded to the frame through a 1" copper strap. The Transformer insulation system shall be 220 degrees C. The transformer temperature rise shall be 150 degrees C. Full load taps shall be provided (2) FCAN and (4) FCBN for connection to the tap switching regulator module. Two (2) temperature monitors shall be provided: 140 degrees C (alarm) and 160 degrees C (shut-down).

- f. Regulation Electronics: A solid state, electronic, zero current crossing tap switching regulation system shall be provided. This technology shall use SCR's (Silicon Control Rectifier) technology in its construction and shall be rated at 100% above worst case current ratings (10% below nominal) without any adverse effects. The regulation system shall respond to a change in the input voltage within a minimum of 1 cycle. The electronics shall be separated from the transformer area by a heat shield of sheet metal. This barrier shall be zinc plated for maximum conductivity.
- g. Phase Imbalance: The maximum phase imbalance shall be 2%. The electronics and the transformer characteristics shall be of such construction that will provide for the 2% regulation band under all load and line conditions.
- h. Neutral to Ground Potential: The Maximum resistance of the neutral and ground connections shall be less than 0.5 volts maximum potential.
- i. Bypass Switch: A manually operated bypass switch shall be provided, in the event that the regulation circuit malfunctions, it shall select the 100% tap of the isolation transformer and provide unregulated nominal power to the output circuit. Access to the bypass switch shall not require removal of any panels.
- j. Internal Wiring: All internal wiring shall be UL Listed appliance wire or Power wiring of multi stranded construction. Secondary and Primary Power wiring from the transformer shall not be in close proximity of each other.
- k. Indicators: The following indicators shall be provided:
  - 1) Power On: There shall be one indicator for each phase which has primary power being supplied to it.
  - 2) Service Required: Indicators shall be provided to indicate the status of the Secondary Surge Suppression Network fuses. The indicator shall be illuminated any time any of these fuses are open.
- l. Single Point Ground (SPG): A single point ground bus shall be provided and shall be of copper construction. Minimum thickness shall be 1/4" X 1/4" and be silver plated to provide connection of the lowest possible resistance to all ground wires secured to the SPG.

- m. Input/Output Transient Noise Filter: The input transient noise filter consists of a resistor/capacitor network which acts as a large snubber circuit to eliminate high frequency impulses from entering the power conditioner. The output transient noise filter consists of a capacitor network installed on the secondary. This capacitor network, when coupled with the primary filter, virtually eliminates most electronic noise from reaching the applied load or being fed back to the unit from noise generation loads.
- n. Secondary Surge Suppression Network (SSSN): A transient suppression network shall be located on the secondary side of the isolation transformer. The SSSN shall suppress load induced noise to reduce the sensitivity of one load from another load.
- o. Electrical Characteristics
  - 1) Transformer
    - a) Type: Dry, multi-shield
    - b) Impedance: Less than 3%
    - c) Efficiency: > 96% @ 80% load
    - d) Load Power Factor: Unity to 0.3 lead or lagging
    - e) Harmonic Distortion: < 1% maximum added
    - f) Waveform Distortion at Tap Switching: <1% added
    - g) Noise rejection (typical): Normal Mode -60 dB/decade
  - 2) Audible Noise: Meets or exceeds NEMA standards
  - 3) Input Voltage Regulation: + 8% to -10% of nominal
  - 4) Input Voltage Surges: 20% Maximum above nominal line voltage, 50 Ms. maximum duration
  - 5) Input Voltage Sags: 30% Maximum below nominal line voltage, 20 Ms. Maximum duration
  - 6) Line Transients: 20% above nominal voltage for 1/hr max.
  - 7) Output Voltage Regulation:  $\pm 1.5\%$  Typical,  $\pm 2\%$  maximum for all load / line conditions.
  - 8) Correction Times: 1 cycle typical
  - 9) Load Rating: Continuous regardless of line / load conditions.



- 10) Overload Inrush Rating: 200% of full load for 10 seconds. 1000% of full load for 1 cycle.

## **26-6 LOW VOLTAGE SYSTEMS**

### **A. Communication (27 00 00)**

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
2. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
3. Coordinate with the University's Representative.

### **B. Communication Horizontal Cabling (27 15 00)**

1. Provide cable management system consisting of j-hooks. All j-hooks should be readily accessible and not blocked by mechanical duct work, piping, structural supports, conduit, etc.
2. Provide EZ-Path, or equal fire penetration where required.
3. Coordinate with the University's Representative.
4. Coordinate with the University's Information Technology Services group for requirements of cabling for devices and system backbone cabling requirements for each site and provide accordingly.

### **C. Patient Monitoring and Telemetry Communication (27 15 01)**

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
2. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
3. Coordinate with the University's Representative.
4. Coordinate with equipment supplier for cabling and device coordination and provide accordingly

### **D. Paging Communication System (27 15 02)**

1. Provide additions and modifications to existing hospital sound system as required to allow for operational of new devices as shown on drawings, existing system 70-volt system and/or 25-volt system.
2. Provide speaker/transformer/baffle/back box to suit each facility's requirements.

3. Volume Control: Provide volume control with priority relay located per facility requirements. Coordinate with the University's Representative.
4. Provide all additions and modifications to the existing sound system equipment to suit each facility.
5. If existing system cannot be extended, provide new system with all required interface. Coordinate with the University's Representative.
6. Mixer Power Amplifiers:
  - a. Mixer Power Amplifiers control and mix up to six independent input signals with expanding kit to allow for two inputs for total of eight inputs.
  - b. Provide with 120 watts amplifier.
  - c. Provide with optional modules for microphone input modules, auxiliary preamplifiers, line input models, line matching transformers and signal generator modules.
  - d. Mixer Power Amplifier shall have:
    - 1) Eight channel mixer power amplifier.
    - 2) 120 watt amplifier.
    - 3) Wide frequency response.
    - 4) Low distortion and noise.
    - 5) Output regulation.
    - 6) One-octave graphic equalizer with nine bands to tailor sound system frequency response to room acoustics, reducing feedback tendencies.
    - 7) Compressor circuit to protect output from distortion.
    - 8) Self-protection circuitry.
    - 9) Separate output terminals to match 4- or 8-ohms speaker or connect to the 25- or 70-volt terminals.
    - 10) Space to allow custom optional module installation.
    - 11) LED pilot light.
    - 12) LED peak indicator.
    - 13) Full range of plug-in modules.

- 14) Wall-mounted enclosure surface or flush as shown on the drawing.
  - 15) Key locked door.
  - e. Mixer Power Amplifier to interface with hospital paging system, local paging system, hospital telephone system and intercom system.
7. Coordinate with the University's Representative.
- E. Interior Communication (27 15 43)
1. Provide Hand Free Microprocessor-Controlled "Duplex" communication System. The System shall include a digital central exchange and all necessary boards, power supplies, paging adapters, Master Control stations, substations, receptacles, special mounting boxes, loudspeakers, terminal boards, cable connectors and accessories for a complete operational communications system.
  2. System Capacity: To suit project needs plus additional capacity for future expansion.
  3. Speech Paths: Expandable to 6 speech channels.
  4. Master Station:
    - a. Capable of selectively calling any station with 1, 2, or 3 digit dialing.
    - b. Microprocessor-Controlled with internal circuitry to incorporate all internal switching, encoding and decoding facilities, and all internal receiving and transmitting transducers.
  5. Controller Features:
    - a. Group Call Feature: Any Master Station to have the capability of making an announcement to pre-determined group of stations.
    - b. All Call Feature: Any Master Station to have the capability of making All Call
    - c. Over Head Paging: Any Master Station to have capability of dial or direct dial access into one or more voice paging System(s).
    - d. Reply Feature: A page or group call shall be able to begin an immediate hands free conversation from any Master Station by dialing two digits. System shall allow multiple page/reply functions simultaneously.
    - e. Volume Controls: The volume of each station shall be adjustable by programming the subscriber board in the exchange, either from Station or a remote Master Station. In addition, each Master shall have an adjustable volume control.

- f. Fault/Alarm Logging: System shall provide data output to allow print-out of fault conditions within the system.
  - g. Power line for supplying master stations.
  - h. Data line communications between Master Station and System Microprocessor.
6. Central Exchange:
- a. The central exchange shall provide all control, logic, signaling, “duplex” switching amplification, power and all operating features. All circuitry and components shall be arranged on slide-in printed circuit boards that are 100 percent solid-state.
  - b. Expansion to ultimate cabinet capacity shall require only addition of “Hot Plug in/out” type subscriber boards. Station capacity of the exchange shall be increased by (6) and speech paths by (1), each time a single subscriber board is inserted. All subscriber boards shall be identical and interchangeable. Malfunction of one subscriber board shall not affect more than six stations. Malfunction of one wire to a subscriber board shall not affect more than one station.
  - c. Exchange shall provide (6) Remote Control Outputs RCO’s per subscriber board.
  - d. Exchange shall have capacity for simultaneous conversations equal to the number of speech channels installed. There shall be (1) speech channel for every (6) subscribers. System shall assign speech channels in absolute rotation, and all stations shall have access to all speech channels. Malfunction of one speech channel shall not affect operation of the system. Every speech channel shall include “compression” circuits to automatically control and limit sound volume during conversation.
  - e. All size exchanges shall include audio program channels, in addition to speech channels. These shall be available to all stations in the system through programming. Exchange shall also include technical alarm inputs that allow external contacts to send text messages and alarms to selected stations.
  - f. The intercom exchange shall include a software program, specifically designed for the system. Software shall operate on a PC with Windows, and include a menu for standard features and directory numbers, which may be entered by one operation. Software shall provide unlimited flexible numbering and programmable features. Microprocessor shall include (8) serial output data ports to allow direct transfer of call processing information, to and from other microprocessor controlled equipment.
  - g. All programmable information shall be protected against power failure and reset, and maintained by “battery back-up”. It shall be possible to easily connect a PC computer and/or printer to view or print-out the intercom directory and programming.
  - h. Exchange shall be powered by regulated power supplies. System shall easily have redundancy power supply to the exchange.

- i. Exchange shall provide self-diagnostic circuitry and alarms for electronic supervision of boards and wiring.
        - j. Audio power output to each station shall be adjustable.
        - k. Central exchange shall include all necessary boards, hardware, software, and accessories to support features and functions described herein, with adequate space for future expansion
  7. Each university facility may have different systems. Coordinate with the University and provide accordingly to suit the University's needs.
  8. Coordinate with the University's Representative.
  9. The above system descriptions are based on systems available in current market. Due to changes in technology, provide the most updated system available in market. Coordinate with the University's Representative and submit for review and approval by the University's Staff.
- F. Data and Voice Communication (27 20 00)
1. Provide rough-in (backboxes, conduit, cable management system, etc.).
  2. Show pathway of cable installation.
  3. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
  4. Coordinate with the University's Information Technology Services Group (ITSG) for any upgrade requirements to system network infrastructure components, and for cabling, devices, testing, and other requirements per IT standard requirements for each site. Each site scope of data/voice may be different. Provide all required items as directed by the University for each site to suit.
  5. Coordinate with the University's Representative.
- G. Audio-Video Communication (27 40 00)
1. Provide rough-in (backboxes, conduit, cable management system, etc.).
  2. Show pathway of cable installation.
  3. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
  4. Coordinate with the University's ITSG for any upgrade requirements to system network infrastructure components and provide accordingly per IT standard requirements.
  5. Coordinate with the University's Representative.

H. Health Care Communication and Monitoring System (27 52 00)

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
2. Coordinate with equipment supplier for all rough-in requirements.
3. Coordinate with hospital information technology representative for head end equipment locations and provide all required power and signal devices.
4. Show cable pathway to allow cable installation.
5. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
6. Coordinate with University's Information Technology Representative for any upgrade requirements to system network. Backbone cabling and equipment to suit new project requirements.
7. Coordinate with health care communication and monitoring system equipment representative and provide all required items accordingly for each site.
8. Coordinate with the University's Representative.

I. Telemedicine System (27 52 16)

1. Several facilities at the University have telemedicine system capability.
2. Coordinate with University's Representative for cabling and device requirements and other related components.
3. Provide rough-in (backboxes, conduit, cable management system, etc.).
4. Show cable pathway to allow cable installation.
5. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
6. Coordinate with the University's the University's ITSG and Telemedicine Representative for any system upgrade requirements, all devices, wiring and equipment upgrades to suit project requirements.
7. Coordinate with telemedicine system equipment supplier and provide all required items accordingly for each site.
8. Coordinate with the University's Representative.

J. Healthcare Imaging System (27 52 19)

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
  2. Coordinate with equipment supplier for all rough-in requirements.
  3. Coordinate with the University's ITSG for head end equipment locations and provide all required power and signal devices.
  4. Show cable pathway to allow cable installation.
  5. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
  6. Coordinate with the University's ITSG and each site imaging information technology representative for any upgrade requirements to system network. Backbone cabling and equipment to suit new project requirements.
  7. Coordinate with health care imaging system equipment supplier and provide all required items accordingly for each site.
  8. Coordinate with the University's Representative.
- K. Nurse Call / Code Blue System (27 52 23)
1. The system shall be a single, networked system, with on network consoles throughout the building, control stations and sub-stations. Nurse call systems that utilize discrete area control units are not acceptable.
  2. System integrations are established for ADTHL7, wireless phones, and pocket pager. Infrared locator system for personnel and equipment with hospital wide mapping integration. The University's hospital wide nurse call system is Rauland-Borg system, the Rauland-Borg Locator system, and the Versus Information system as a design basis for the fully integrated nurse/patient communication network.
  3. System hardware shall consist of a nurse/patient communications network comprised of nurse consoles, control stations, dome lights, entertainment cords, call cords, pull cord stations, emergency push button stations, wiring and other options such as bed side-rail interfaces, pocket page interfaces, computer interfaces, printer interfaces, wireless/telephone network interfaces, and infrared locating system interface. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating nurse/patient communications network.
  4. Systems firmware shall be the product of a reputable firmware manufacturer with product reliability and sole control over all source code. Provide, free of charge, product firmware/software upgrades for a period of two years from date of acceptance for any product feature enhancements. In addition, the equipment (parts) warranty for all core system components including control/switching equipment and power supplies shall extend to a total of at least five (5) years. Warranty for ancillary devices shall extend to a

total of at least two (2) years. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the warranty period of any product feature enhancements. System configuration programming changes shall not require any exchange of parts and shall be capable of being executed remotely via a modem connection. Equipment shall have capability for remote system configuration programming via modem.

5. All specified equipment shall be manufactured using surface mount technology (SMT) and manufacturing testing shall utilize Hewlett Packard ATE (Automated Test Equipment) to assure the highest quality production. Specifying authority may request test procedures and/or results of tests on specific equipment being supplied.
6. All work must be performed by authorized manufacturer's representative utilizing certified technicians.
7. The System Supplier shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of two years from the date of acceptance. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years. Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the warranty period for any product feature enhancements.
8. Nurse call system shall consist of:
  - a. Floor plan showing all device arrangements with complete wiring diagram between devices, sequence of operation, cable schedule, and programming.
  - b. Network wiring, hub controller, information network, call display, patient whiteboard, staff directory, staff scheduler, nurse consoles, locate in nurse station or monitoring station, bedside control station, universal interface module, staff control station, duty control station, substation, pull cord toilet station, code blue, shower station, etc.
  - c. Misc. Components: Fire auxiliary module, control station, J-bus, J-drop, control station, non-audio universal interface module, single/dual bed digital TV, isolation module, patient entertainment, speaker/call cord, auxiliary power jack outlet, corridor dome lighting (multi-color LED), zone light, telephone line interface, data interface, terminal cabinet, power supply amplifier, all required software, and any other related components.
9. Nurse Call System in Different Facilities:
  - a. Coordinate with the University's Representative to confirm each facility's existing nurse call system and provide accordingly.



- b. Each facility may have multiple manufacturers' nurse call systems. Coordinate with the University and provide accordingly.
- c. Moffitt/Long: Nurse call system and code blue is Rauland-Borg. Coordinate with manufacturer's representative and the University's Representative for nurse call requirements. Nurse call system must be compatible with new nurse call systems.
- d. ACC Building: Nurse call system is limited and several nurse call systems with products of multiple manufacturers are currently in ACC. Coordinate with the University's Representative and provide accordingly to suit project requirements and compatibility with existing nurse call systems.
- e. Mt. Zion Hospital: Provide nurse call system and code blue as required to suit project requirements. Currently there are several manufacturers' products installed in Mt. Zion. Coordinate with University's Representative and provide accordingly to suit project needs and compatibility with existing system.

10. All items must be coordinated with University's Representative.

L. Clock System (27 53 13)

1. Provide additions to existing clock signal generator/electronic master clock control system.
2. Provide clock to match with facility clock system. The new clock must be compatible with existing system.
3. Coordinate with the University's Representative.
4. Each facility may have multiple manufacturers. Coordinate with the University's Representative and provide accordingly.

M. MATV System (27 52 )

1. Coordinate with the University's Representative for television requirements.
2. Provide rough-in (back boxes, conduit, cable management system, etc.).
3. Provide coaxial cable from television location to head end location. Coordinate requirements with television equipment representative.
4. Provide insert, splitter, and other related components.
5. Where additions to existing systems are indicated, provide new equipment to match and be compatible with existing.
6. Coordinate with the University's Representative.

7. Each facility may have different TV systems. Coordinate with the University's Representative and provide accordingly.

N. Electronic Safety and Security System (28 00 00)

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
2. Provide all required power for power supplies and other equipment.
3. Coordinate all device locations, hardware, and other components to suit project requirements.
4. Provide floor plan showing all devices and wiring interconnections between devices.
5. Coordinate security device arrangement and requirements with University's security system representative to suit project requirements.
6. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing. Each university facility may have different electronic safety and security system manufacturers. Coordinate and provide accordingly.
7. Coordinate with the University's Representative.

O. Electronic Access Control and Intrusion Detection (28 10 00)

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
2. Provide power for all access control and intrusion detection equipment.
3. Provide floor plan showing all devices and wiring interconnections between devices.
4. Coordinate security device arrangement and requirements with the University's security system representative to suit project requirements.
5. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
6. Coordinate with the University's Representative.

P. Electronic Surveillance (28 20 00)

1. Provide rough-in (backboxes, conduit, cable management system, etc.).
2. Provide all required power for all equipment that requires power connection.
3. Coordinate all devices, locations, and all components.
4. Provide cabling and device connections per equipment supplier and manufacturer requirements.

5. Provide floor plan showing all devices, wiring arrangements, and interconnections between devices.
6. Coordinate security device arrangements and requirements with University's security system representative to suit project requirements.
7. Where additions to existing systems are indicated, provide new equipment to match and to be compatible with the existing.
8. Coordinate with the University's Representative.

Q. Fire Detection and Alarm (28 31 00)

1. Moffitt/Long Hospital Fire Alarm System:

a. Description of Fire Alarm System.

- 1) The Medical Center Main Fire Alarm System is an Edwards System Technology (EST) FCC microprocessor based Fire Alarm System with EST-3 Signature Series devices. All work and equipment provided in this project must be compatible with the new system.
- 2) Operation of any alarm initiating device will:
  - a) Sound speakers.
  - b) Flash warning lights.
  - c) Interrupt power to door holders in Moffitt/Long Hospital and close all doors with door holders.
  - d) Annunciate new zones at Building Fire Alarm Control Systems (BFCS's), Building Annunciator Panels, and Campus Central Supervisory Systems.
  - e) Shutdown fans and fire/smoke dampers. Coordinate work with work specified in Division 23.
  - f) Additional functions as noted on drawings.

b. Additions and Modifications to Existing Fire Alarm System as Follows:

- 1) Provide new equipment as manufactured by Edwards System Technology (EST), to match existing, compatible with existing system configuration.
- 2) Provide all terminations and wiring.
- 3) Provide all Fire Alarm devices. (Manual pull, speaker, strobe, control module, monitor module, smoke sensor, duct smoke sensor, etc.)

- 4) Provide modifications, programming, testing, and certification of the Moffitt/Long Building Fire Alarm Control Systems (BFCS), and Central Supervisory Systems.
- 5) Provide Fire Alarm Submittals to the University's Representative and OSHPD Fire Marshall for review and approval.
- 6) Provide Fire Alarm "As Built" drawings stamped and signed by Fire Alarm Contractor.
- 7) Strobe circuit shall be synchronized. Provide all additions and modifications as required to suit.
- 8) Individually addressed smoke detectors, manual pull stations, and control modules.
- 9) Provide all additions and modifications to existing Building Fire Alarm Control System (BFCS) and Building Annunciator Panels for annunciation of the new Fire Alarm devices.
- 10) Provide all software interface programs and additional hardware as required for a complete and operable system.
- 11) Provide complete fire alarm design including floor plans showing all fire alarm devices, wiring arrangements, all fire alarm interface, fan fire shutdown, fire/smoke damper control, fire alarm zone arrangements, zone schedules, sequence of operation, device arrangements, flashing candela for visual devices, and other related items as required by the University's Fire and Life Safety System.
- 12) The fire alarm design documents shall be forwarded to the University's Fire and Life Safety System utility division to prepare submittal. Review fire alarm submittals prepared by the University and include fire alarm submittal in design documents for submission to OSHPD for review and approval. Fire alarm submittals shall be stamped by Engineer of Record.
- 13) All fire alarm devices in Moffitt/Long Hospital shall be annunciated at Moffitt and Long Hospital Building Fire Alarm Control System (BFCS), Central Supervisory Systems at Central Utility Plant (CUP), and the University's Fire and Life Safety System offices. Coordinate other requirements with the University's Representative.
- 14) Coordinate with the University's Fire and Life Safety Systems Utilities Division and the University's Representative for proper timing of submittals, installations, programming, testing, and certification of the Fire Alarm System.
- 15) Coordinate all related fire alarm work with the University's Representative.

- 16) All the above equipment, submittals, terminations, programming, testing, certification and “As Built” drawings are provided by the University.
2. ACC Fire Alarm System:
    - a. Description of Fire Alarm System.
      - 1) The ACC Main Fire Alarm System is an Edwards System Technology (EST) FCC microprocessor based Fire Alarm System with EST-3 Signature Series devices. All work and equipment provided in this project must be compatible with the new system.
      - 2) Operation of any alarm initiating device will:
        - a) Sound speakers.
        - b) Flash warning lights.
        - c) Interrupt power to door holders in Moffitt/Long Hospital and close all doors with door holders.
        - d) Annunciate new zones at Building Fire Alarm Control Systems (BFCS’s), Building Annunciator Panels, and Campus Central Supervisory Systems.
        - e) Shutdown fans and fire/smoke dampers. Coordinate work with work specified in Division 23.
        - f) Additional functions as noted on drawings.
    - b. Additions and Modifications to Existing Fire Alarm System as Follows:
      - 1) Provide new equipment as manufactured by Edwards System Technology (EST), to match existing, compatible with existing system configuration.
      - 2) Provide all terminations and wiring.
      - 3) Provide all Fire Alarm devices. (Manual pull, speaker, strobe, control module, monitor module, smoke sensor, duct smoke sensor, etc.)
      - 4) Provide modifications, programming, testing, and certification of the ACC Building Fire Alarm Control Systems (BFCS), and Central Supervisory Systems.
      - 5) Provide Fire Alarm Submittals to the University’s Representative and OSHPD Fire Marshall for review and approval.
      - 6) Provide Fire Alarm “As Built” drawings stamped and signed by Fire Alarm Contractor.

- 7) Strobe circuit shall be synchronized. Provide all additions and modifications as required to suit.
  - 8) Individually addressed smoke detectors, manual pull stations, and control modules.
  - 9) Provide all additions and modifications to existing Building Fire Alarm Control System (BFCS) and Building Annunciator Panels for annunciation of the new Fire Alarm devices.
  - 10) Provide all software interface programs and additional hardware as required for a complete and operable system.
  - 11) Provide complete fire alarm design including floor plans showing all fire alarm devices, wiring arrangements, all fire alarm interface, fan fire shutdown, fire/smoke damper control, fire alarm zone arrangements, zone schedules, sequence of operation, device arrangements, flashing candela for visual devices, and other related items as required by the University's Fire and Life Safety System.
  - 12) The fire alarm design documents shall be forwarded to the University's Fire and Life Safety System utility division to prepare submittal. Review fire alarm submittals prepared by the University and include fire alarm submittal in design documents for submission to OSHPD for review and approval. Fire alarm submittals shall be stamped by Engineer of Record.
  - 13) All fire alarm devices in ACC shall be annunciated at the ACC Building Fire Alarm Control System (BFCS), Central Supervisory Systems at Central Utility Plant (CUP), and the University's Fire and Life Safety System offices. Coordinate other requirements with University's Representative.
  - 14) Coordinate with the University's Fire and Life Safety Systems Utilities Division and the University's Representative for proper timing of submittals, installations, programming, testing, and certification of the Fire Alarm System.
  - 15) Coordinate all related fire alarm work with University's Representative.
  - 16) All the above equipment, submittals, terminations, programming, testing, certification and "As Built" drawings are provided by the University.
3. Mt. Zion Hospital Fire Alarm System:
- a. Description of Fire Alarm System.
    - 1) The Mt. Zion Hospital Fire Alarm System is a Notifier AM2020 Intelligent Fire Detection Alarm System with interconnection to the existing Autocall Fire Alarm Control. All work and equipment provided in this project must be compatible with the new system.

- 2) Operation of any alarm initiating device will:
  - a) Sound audible (chimes) devices.
  - b) Flash visual (strobe) devices.
  - c) Interrupt power to door holders.
  - d) Annunciate new zones at Fire Alarm Control Panel (FACP).
  - e) Shutdown fans and fire/smoke dampers. Coordinate with Division 23.
  - f) Additional functions as noted on drawings.
- b. Additions and Modifications to Existing Fire Alarm System as Follows:
  - 1) Provide new equipment as manufactured by Notifier, to match existing, compatible with existing system configuration.
  - 2) Provide all terminations and wiring.
  - 3) Provide all Fire Alarm devices. (Manual pull, speaker, strobe, control module, monitor module, smoke sensor, duct smoke sensor, etc.)
  - 4) Provide modifications, programming, testing, and certification of the Fire Alarm Control Panel.
  - 5) Provide Fire Alarm Submittals to the University's Representative and OSHPD Fire Marshall for review and approval.
  - 6) Provide Fire Alarm "As Built" drawings stamped and signed by Fire Alarm Contractor.
  - 7) Strobe circuit shall be synchronized. Provide all additions and modifications as required to suit.
  - 8) Individually addressed smoke detectors, manual pull stations, and control modules.
  - 9) Provide all additions and modifications to existing Fire Alarm Control Panel for annunciation of the new Fire Alarm devices.
  - 10) Provide all software interface programs and additional hardware as required for a complete and operable system.
  - 11) Provide complete fire alarm design including floor plans showing all fire alarm devices, wiring arrangements, all fire alarm interface, fan fire shutdown, fire/smoke damper control, fire alarm zone arrangements, zone schedules, sequence of operation, device arrangements, flashing candela for visual devices,

and other related items as required by the University's Fire and Life Safety System.

- 12) The fire alarm design documents shall be forwarded to Notifier equipment representative to prepare submittal. Review fire alarm submittals prepared by equipment representative and include fire alarm submittal in design documents for submission to OSHPD for review and approval. Fire alarm submittals shall be stamped by Engineer of Record.
- 13) Coordinate with the University's Representative, and the equipment supplier's representative, for proper timing of submittals, installations, programming, testing, and certification of the Fire Alarm System.
- 14) Coordinate all related fire alarm work with University's Representative.
- 15) All the above equipment, submittals, terminations, programming, testing, certification and "As Built" drawings are provided by the University.