Distribution Automation System Provides Reliable Power to University of California, Santa Barbara

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CAMPUS ELECTRICAL SYSTEM

The campus electrical distribution system is comprised of two high voltage systems:

1. 16kV System - SCE Owned
2. 4kV System - UCSB Owned
Three main areas were evaluated:

- Age and condition of existing equipment
- System capacity
- Reliability/Efficiency/Serviceability
DISTRIBUTION SYSTEM
FINDINGS
AGE AND CONDITION

16 kV & 4kV Systems

– Over 90% of system is greater than 30 years (industry average life-span is 30-40 years)
– 1-2 outages annually (8 hrs restoration time)
– Equipment in vaults showing signs of erosion and in some cases complete failure
– Lead cable
– No documented maintenance records
SCE/UCSB Substation:

- Capacity limitation is 22MVA
- Campus peak load is 15MVA
- Projected additional load over the next 4-5 years is 9MVA
- Estimated campus peak load 24MVA (2008)
- The substation will be overloaded
16kV System (SCE Owned):
- “A” feeder is loaded at 95% of its rating
- “A” feeder serves the 4kV system as well as the east campus
- Only 2 circuits serve the campus (“A & “B”) - if one feeder fails it cannot be backed up by the other
16kV System (SCE Owned):

- Only 2 distribution circuits serve the campus
- Distribution feeders reliability is suspect
- Limited switching configurations
- No automated switching (smart switches)
- 16kV not an industry standard voltage
4kV System (UCSB Owned):

- Although 2 circuits are run to each building, the reliability of this system is limited to SCE’s “A” feeder.
- More electrical losses ($$) due to extra transformation (16kV - 4kV)
- Many duplicate facilities and overlapping service area with the 16kV system.
What Does It All Mean?

Immediate concerns:

• The campus distribution system is rapidly approaching the end of its anticipated life.
• Limited investment/maintenance has been made in the system over the last 30 years.
• SCE’s “A” feeder is at its capacity limit.
• The substation exit is reaching its capacity limit.
What Does It All Mean?

Immediate concerns:

• If a fault on SCE’s “A” feeder occurred, the campus 4kV system along with the East Campus will be out of power until the fault is cleared

• Reliability of SCE’s distribution feeders are suspect due to their age and lack of routine maintenance
What Do We Need To Do?

- Reliance on existing system is increasingly evident
- The need for a reliable, robust electrical system that meets the needs of its end users is paramount
- The new system must be designed to provide flexibility, reliability and have enough capacity for future growth
What Do We Need To Do?

• Install 4 distribution circuits to serve the campus electrical load
• Replace aging facilities
• Investigate/evaluate installing distribution automation
DA Technology Strategy

- Two Feeder Closed Loop Network.
- High-Speed Fault Interrupting Switchgear (S&C Vista® UnderCover™ Style)
- Multifunction Directional Overcurrent Relays on Source Ways (Schweitzer SEL-351)
  - High Speed Tripping, Coordinated Response, SCADA Functions
- SEL 351 relays communicate via H&L 570 Fiber Optic Infrastructure.
- Automated Fault Clearing before Station Breaker operation.
- No Service Interruption (voltage sag for few cycles)
Performance Specifications

- Dependable – Operate Correctly Every Time
- Secure – Never Operate Incorrectly
- Selective – Isolate the Smallest Cable Segment
- Sensitive – Protect for all Types of Faults
- Clear All Faults in Less Than 6 cycles (0.1 sec)
- Initiate Tripping in 3 cycles (0.050 sec) or less
- Recognize Fault in ½ cycle (0.008 sec) typ.
- Continuous System Monitoring and Control
  - Status, Alarms, and Analogs (V, I, P, Q)
System Design

- Duct & Manhole System - Equipment in Vaults
- S&C Vista® SF6 Gas Insulated Switchgear.
- Upstream and Downstream Protective Relays.
- Vacuum Fault Interrupters on Protected Ways.
- Permissive Over-reaching Transfer Trip (POTT).
- Directional Comparison Blocking (DCB).
- Duct & Manhole Electric System and Communications Network.
Protective Relay Schemes

- “Transmission Line” Relay Schemes applied to the Distribution System
- Secure, Reliable, High-Speed Tripping
- Communication-dependent tripping provides high-speed coordinated response not attainable using only time-overcurrent coordination.
- Backup Schemes – overreach intervening switchgear.
- Final backup – non-communication time-overcurrent tripping at the substation feeders.
Permissive Over-reaching Transfer Trip (POTT)

Reverse Direction for currents INTO the Protected Zone
“Instantaneous” tripping for In-Zone fault.
Restrain for Out-of-Zone fault
Directional Comparison Blocking (DCB)

Protected Zone

Reverse Direction for current INTO the Protected Zone
Forward Direction for current OUT of the Protected Zone
TDPU = Time Delayed Pick Up (to allow communication)
Typical Switchgear

- Two “Source Ways” with Multifunction Relays
  - Motor operators for remote control and automatic closing.
- One to Four “Load Ways” with Vista Overcurrent Controls

-Vacuum Fault Interrupters
- Integral 3-position Visible Disconnect / Ground Switch
Typical Switchgear
S&C Vista
UG Primary Network Normal Condition

- Number of switchgear per loop limited only by system capacity.
  - Communications allows zone-selective response without “stacking” time-overcurrent curves
UG Primary Network
Fault Condition

Current from Both Sources.
Relays “see” Forward Current or Reverse as indicated

BOTH see Reverse and trip.
UG Primary Network
Fault Cleared

Fault total clearing time less than 6 cycles (0.100 seconds) on primary schemes (POTT or DCB)
Other Relay Functions

- Back-up Over-reaching POTT and DCB
- Bus Fault Clearing
- Breaker Failure Scheme
- SCADA monitoring and control functions
Factory Testing and Field Startup
Testing Assure Design Performance
UCSB – Substation Equipment

HMI One-Line

Alarm Display
Contact Information

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