Cornell University
AgriTech Campus in Geneva, NY

Electrical Master Planning, Substation, Distribution and Building Service Entrance Upgrades

Presented by:
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Electrical Project Engineer – High Voltage Electrical Group
Agenda

- Campus Electrical Master Planning Process
- Cornell University AgriTech Case Study
- Substation Upgrades
- Distribution System Upgrades
- Building Service Entrance Upgrades
Campus Electrical Master Planning Process

Site Survey and Investigation

• Inspection of:
  • Main substation
  • Medium voltage distribution system
  • Building service entrances.

• Visual Inspection:
  • Equipment nameplate data age, condition
  • E-Room safety and code compliance.

• Equipment settings.
• Electrician experience and institutional system knowledge.
Campus Electrical Master Planning Process

Site Survey and Investigation

• Site Utility Survey
• Manhole Investigation:
  • Butterfly Diagrams
• Infrared Survey
• Hazardous Material Survey:
  • Asbestos, etc.
• Document Review:
  • Previous studies/engineering drawings.
  • Equipment drawings/manuals.
  • Maintenance records.
  • Historical metering data – load, PF, Harmonics.
Campus Electrical Master Planning Process

Site Survey and Investigation
Campus Electrical Master Planning Process
Analysis and Evaluation

• Power System Study:
  • Arc Flash.
  • Protection Coordination.
  • Short Circuit.
• System Condition Matrix:
  • Age, condition, system study.
• System Configuration Analysis:
  • Substation/Distribution loops, building Dual Feeds / Bus Tie’s.

• Electrical Room Conditions:
  • Code Compliance:
    • Working Clearance, Egress.
  • Grounding.
  • Mechanical Ventilation.
  • Fire Detection.
• Power Analysis:
  • Loading Analysis.
  • Power Factor Analysis.
  • Harmonics Analysis (if data available).
Campus Electrical Master Planning Process
Master Plan Report

- Power System Study.
- Arc Flash Stickers.
- Equipment Condition Matrices.
- Prioritized Improvement List:
  - Substation, Distribution, Buildings.
  - Equipment upgrades.
  - System re-configurations.
  - AF, coordination improvements.
- ROM Costs for improvements.
- High level schedule, based on resources.

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<th>Primary Fuse Switch Age/Condition</th>
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Table X4 - Building Electrical Service Entrance System Condition Rating

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Cornell University – AgriTech Campus

Campus Summary

- 8 nearby research farms, totaling 850 acres.
- 65,000 square feet of greenhouse space.
- Fruit and vegetable processing facilities
- Refrigerated and controlled atmosphere storage.
- 3MW Electrical Substation.
- 14 Buildings:
  - Research facilities, laboratory buildings and office space.
Cornell University – AgriTech Campus
Electrical System Summary

- **34.5kV Substation:**
  - 34.5kV overhead line switch
  - 34.5kV-4.8kV, 3MVA Transformer.
  - 4.8kV switchgear with 2 loop feeders.
  - Peak load of 1.5MVA.

- **4.8kV Distribution:**
  - Underground distribution loop of 500kcmil in concrete ductbanks.
  - Manhole 3-way junctions and splices to buildings.

- **14 MV building service entrances:**
  - Switches, transformers, LV (208 or 480V) gear.
Main Substation Assessment

- Equipment age of ~50 years, past expected life.
- 34.5kV switch marked ‘Do Not Operate’, manufacturer instruction.
- Transformer:
  - On-load tap changer (OLTC):
    - Monitored change counter.
  - Infrared identified some radiator blockages.
  - ~40% peak loaded.
- 4.8kV switchgear:
  - Old electro-mechanical relays – lack of coordination.
  - One breaker unable to electrically switch.
Main Substation
Recommendations

- Replace all major equipment and cable.
- Slightly Downsized Transformer.
- Maintain OLTC.
- Replace 4.8kV switchgear with SF6 relay-managed pad-mount switch.
- Install in empty substation space, to minimize construction outage.
Medium Voltage Distribution
Assessment

- Manhole and Conduit evaluation:
  - ~40% of ductbank was found to be compromised (not useable).
  - One manhole found to be structurally concerning (old, brick).

- 4.8kV System Considerations:
  - Capacity vs. Cable Size vs. Conduit fill.
  - Vs. 4.16kV system – high TX replacement costs.

- Cable/Switch evaluation:
  - Majority of cable is ~50 years old, past its expected life: Experienced failures 2011.
  - Manhole junction configuration and one mid-way loop switch:
    - Lack of selective switching and increased outage impact.
    - Poor access, operability of manhole junctions.
    - Unsafe mid-point switch
Medium Voltage Distribution

Recommendations

• Replace all old cable (50 years old).
• Install new ductbank, as needed, to abandoned compromised ductbank sections.
• Install strategically placed pad-mounted loop switches to allow for more selective switching and reduce the impact of outages.
• Install pad-mounted junction boxes to provide easier access to remove building junctions during switching.
• Construction phasing switching orders:
  – Configured to replace all cable with five ~4h building outages.
Medium Voltage Distribution

Recommendations
Building Service Entrance Upgrades

Assessment

- 85% of building entrances ~50 years old, past design life.
- 30% of buildings had ‘extreme danger’ arc flash conditions.
- Areas of unsafe equipment or conditions:
  - Manufacturer ‘Do Not Operate’ direction.
  - Exposed fuse cutouts in E-Room.
Building Service Entrance Upgrades

Recommendations

- All services past their design life should be upgraded.
- Priority list of building upgrades produced.
- Top 5 priority buildings included arc flash safety hazards or unsafe equipment conditions.
- Recommended to perform 5 top priority upgrades in one construction package:
  - New MV switch, MV transformer and LV switchgear.
- Construction phasing plans (staged demo/install) produced to install in parallel and use temporary generators to keep all outages to >8h.
Building Service Entrance Upgrades

Recommendations
Completed Upgrades

Main Substation
• All equipment and cabling replaced, per recommendations.
• All old equipment removed.

Distribution
• New ductbank installed and all old cable replaced.
• New pad-mounted switches and junction boxes installed, per recommendations.
• All old cable removed.

Building Service Entrances
• Upgrades to be completed in 2020 for 5 highest priority buildings.
Completed Upgrades
Cornell University
AgriTech Campus in Geneva, NY

Electrical Master Planning, Substation, Distribution and Building Service Entrance Upgrades

Thank you