System Analysis for Construction
Work Plan

Justin Chase
Engineering Supervisor
Great Lakes Energy
Great Lakes Energy (GLE)

- 26 counties in the lower peninsula of Michigan
- 125,000 meters
- 14,000 miles of line
- 82 substations
- 300 MW peak
Agenda

- Rural Utility Service (RUS) Construction Work Plan (CWP) Guidelines
- Utility Design Standards
- Load Balance
- Voltage Analysis
- Overloaded Devices
- Seasonal Load Swings
RUS CWP Guidelines

• Bulletin 172D-101B Construction Work Plan Guide
  – Use of CWP
  – Preparation
  – Determining Construction Requirements
  – The CWP Report
Use of CWP

• Prepared every 2-4 years
  – GLE uses a 3 year CWP
  – Takes about a year to complete

• Include projects regardless of financing source

• Reference for annual construction budgets

• Used as engineering support for RUS loan application
Preparation

• Review data
  – System and substation peaks
    • Adjust for any load transfers
  – Design standards
  – Long Range Plan (LRP) typically 20 year
    • Refresh after 10 years
  – Operations and Maintenance (O&M) Report
  – Engineering model
Determining Construction Requirements

- New consumers and anticipated loads
- Substation peak projected loads
- Load allocation and model analysis
  - Create base load first and verify before projecting
- Project recommendations
  - Alternative solutions
The CWP Report

- Documentation of the CWP study
- Executive summary
- Historical and projected data
- Project lists and costs
- Maps
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Utility Design Standards

• RUS has recommendations but each utility should develop their own unique standards
  – Number of voltage regulation after substation
    • Max of 2
  – When to use regulators vs upgrade line
    • GLE has an aging system so line rebuilds are used when copper weld wire is upline of voltage violation
Utility Design Standards (cont.)

– Max load on single phase line
  • GLE upgrades line to three phase after 40 amps is projected. Helps with load balancing and sectionalizing

– Device loading
  • 100% for regulators
  • 70% for reclosers

– Voltage requirements
  • ANSI C84.1-2016
  • Primary voltage between 126 - 118
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Load Balance

• Should be the first part of the system analysis
• Large imbalances affect losses and voltage levels
• Feeder voltage issues can be fixed just by balancing load
• Can be challenging on residential feeders
Load Balance (cont.)

• GLE will balance substations based on peak loading
  – Can cause substations to be unbalance due to seasonal load swings

• GLE standards
  – 10% on substations
  – 15% on feeders
Single Phase Loading

- GLE typically tries to keep single phase loading down to 40 amps.
- Custom Query built to find single phase devices with over 40 amps
Single Phase Loading (cont.)
Load Balance Analysis

• Great tool for easily balancing load on feeder

• Requires engineering and field review
  – Not ideal to jumper across pole

• Analysis Manager can be used to setup preference
Load Balance Analysis (cont.)

A to C

C to B

Analysis Manager

Load Balance Colors

File

Analysis Manager

Load Balance Colors

File

Analysis Manager

Load Balance Colors

File

Analysis Manager

Load Balance Colors

File

Analysis Manager

Load Balance Colors

File

Analysis Manager

Load Balance Colors

File
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Voltage Analysis

• After the system is balanced, the next step is to look for voltage violations
• This can be done using the Voltage Drop analysis
• Analysis Manager can be used to setup preference
Voltage Analysis (cont.)

Voltage Drop Settings
- Voltage Drop Solution:
  - Balanced
  - Unbalanced

Settings:
- Maximum Number of Iterations: 20
- Voltage Drop Tolerance: 0.01 0000%
- Base Output Voltage: 120.0V
- Clamp Constant kVA Load Voltage: 0.790 PU
- Initiate Voltages At: Last Case

Voltage Drop Colors
- Voltage Problems:
  - No Problems
  - Generators outside of kvar limits
  - Voltage UNDER 118 Volts
  - Voltage ExCEEDS 128 Volts
  - Use gradient for other voltages
  - Power Factor UNDER 80 %
- When coloring give priority to:

Selected Elements:
- Screen Background

Refresh Colors
Run
Run & Close
Close
• In this example there is a radial tap that has low voltage
• The main line is 336 ACSR and the tap is 1/0 ACSR
Voltage Analysis (cont.)

- Since the wire size and age is adequate, a voltage regulator will be installed.
- GLE would typically install it around the 119V range.
  - Allows for future load growth.
Voltage Analysis (cont.)

• In this example there is a feeder with low voltage at the end
• The main line is 4/0 ACSR and the tap is 8A CWC
Voltage Analysis (cont.)

- Since the conductor is old cooper weld, the line would be upgraded to fix the low voltage.
- 2 miles of line needs to be rebuild to fix the voltage but since this feeder ties to another, the full 4 miles will be rebuild for backfeeding capacity.
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Overloaded Devices

• Good time to review with projected loading
• Recloser and switchgear upgrades become projects
• Fuses are technically not part of the CWP
• Couple different ways to identify
  – Visual
  – Tabular
Overloaded Devices - Visual

- Voltage Drop Analysis Manager - Capacity Problems
  - Choose capacity and color
- Display Options - Circuit Element Symbols
  - Make devices larger
Overloaded Devices - Tabular

• Create query
  – Include devices
  – Capacity % >100
• Verify Current Rating is setup properly
Current Rating

- Defined in EQDB
- Can be setup to use Light Table
- Based on TCC but can be changed
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Seasonal Load Swings

• If only the substation peak is used, seasonal load swings can be overlooked
• GLE analyzes system for summer and winter peaks regardless of substation peak season
• Prime examples are substations that peak in the winter but have seasonal vacation homes or campgrounds that have no winter load
Questions?

Justin Chase
Engineering Supervisor
Great Lakes Energy
jchase@glenergy.com