Lake Mina Substation
Current System
As of October 2014

Primary Conductor:
- UG Primary, A-Phase
- UG Primary, B-Phase
- UG Primary, C-Phase
- UG Primary, V-Phase
- OH Primary, A-Phase
- OH Primary, B-Phase
- OH Primary, C-Phase
- OH Primary, V-Phase
- OH Primary, ABC-Phase

Legend:
- UG: Underground
- OH: Overhead
- A, B, C: Phases
PLANNING CRITERIA

- Voltage
- Conductor Loading Limits
- Service Reliability
- Age of Plant
PLANNING CRITERIA CONTINUED*

- Minimum voltage on the distribution system is not to exceed 118V on a 120V base under normal peak load conditions, assuming a starting voltage at the substation of 126 volts

PLANNING CRITERIA CONTINUED*

- Upgrade device (or further analyze) if loading level exceeds:
  - Voltage Regulators 75%
  - Line Fuses 75%
  - Reclosers 75%
  - Sectionalizers 75%
  - Substation Transformers 100%

- Sectionalizing equipment when fault currents exceed 100% of rating

- Loading on any primary conductor is not to exceed 50% of its emergency thermal loading limit

PLANNING CRITERIA CONTINUED*

- Loading on single-phase lines greater than 50 amps will be considered for upgrading
- Pole/equipment/conductor replacement will be considered on overhead line that is greater than 50 years old
- Underground line that is greater than 35 years old
- System improvements will be considered in areas where excessive member outages or blinks are occurring

PLANNING CRITERIA CONTINUED*

<table>
<thead>
<tr>
<th></th>
<th>Maximum</th>
<th>Minimum</th>
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<tbody>
<tr>
<td>Substation regulated voltage bus</td>
<td>126</td>
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<tr>
<td>Primary terminals of distribution transformer</td>
<td>126</td>
<td>118</td>
</tr>
<tr>
<td>Meter or service entrance switch</td>
<td>126</td>
<td>114</td>
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<tr>
<td>Point of utilization</td>
<td>126</td>
<td>110</td>
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BASE LOADING IN THE MODEL

- Monthly kWh Consumption Used for Allocation
- Substation Load Data from SCADA
  - Each Circuit and Phase Load Is Available
- Simulation Is Validated as Much as Possible with Actual Voltage Readings
PROJECTED GROWTH

- Examine U.S. Census Statistics
- Look at Historical Trends
- Interview Local Utility Employees
- Apply Practical Experience
POSSIBLE SOLUTIONS

- Voltage Regulators and Capacitor Banks
- Feeder Re-Conductoring
- New Substation
VOLTAGE REGULATORS

- Work Well for Taps
- Do Not Work Well During Emergency Operation of the System (Backfeeds)
- Try to Avoid Voltage Regulation in the Main Three-Phase System
- Not a Good Solution for This Situation
FEEDER RE-CONDUCTORING

- Many Miles of Overhead Line in This Area
- Aged Poles, Inadequate Length and Class
- Largest Standard Conductor for This Utility is 4/0 ACSR or 4/0 Cable
- Cost Per Mile to Rebuild Lines Is $80,000 to $100,000
- Upgrades Necessary: 20 Miles or $1.6m
- Still Issues During Emergency System Operation
- Power Reliability Is Not Improved Because Line Length Is Not Shortened
SUBSTATION CONSTRUCTION

- Is Transmission Nearby?
  - In This Case, Within ¼ Mile
- What Will Feeder and Integration Improvements Cost?
  - In This Case, Less Than Three Miles of Line
- Is Sufficient Land Available and Can It Be Developed?
  - Yes, and It’s Affordable
- Feeders Are Shortened, Improving Reliability and Emergency Operation
- Substation Cost Is $1.1m Plus Integration
- Best Overall Option
Circuit Diagram I
Existing System
Projected Summer Load
Construction Work Plan 2008 - 2010

Voltage Levels

- Red: 117.9 or Less
- Yellow: 118.0 - 120.0
- Cyan: 120.1 - 122.0
- Blue: 122.1 - 126.0

This map has been produced for Traverse Electric Rural Electric Cooperative by STARC Energy Services LLC, Alexandria, MN. This map is not the final design. Final designs will be updated as the installation is completed. Updated October 28, 2014.
LAKE MINA SUBSTATION
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DISCUSSION & QUESTIONS

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