The Impact of Ice

Nebraska Public Power District

2006-2007
Christmas Storm Outcome

• 10 transmission lines out – made temporary repairs to 8 – 2 remained out of service

• 4 telecommunications fibers inoperable – no telecommunications west of Holdrege

• 2,500 retail customers impacted

• 21 NPPD technicians assist Dawson PPD

• $1.0 Million in damages (approximate)
New Year’s Storm Timeline

Friday – December 29
• Rain, freezing rain, icing, wind

Saturday – December 30
• Severe icing conditions and wind
• Widespread, extensive damage
• Crews respond to numerous outages

Sunday – December 31
• Major effort to assess damage and restore power
Back-to-Back Storms

Christmas Storm: circle

New Year’s Storm: circle
Normal NPPD Transmission System
System Condition January 1
System Condition January 4
Kearney Area Damage Assessment

- Wood Structures
- Steel Towers
- Shield Wire Miles
Early Priorities

• Kearney
  – Lost 4 of 5 transmission feeds
  – Priority restoration of second feed
  – Rolling blackouts during initial restoration

• Holdrege
  – Lost all 3 transmission feeds
  – Mobile generation located within the community

• Key Messages
  – Energy conservation
  – Fragile system
  – Safety
# System Status – March 2, 2007

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Current</th>
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<tbody>
<tr>
<td><strong>Miles assessed</strong></td>
<td>2,650</td>
<td></td>
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<tr>
<td><strong>Customers without power</strong></td>
<td></td>
<td></td>
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<tr>
<td>– NPPD Retail (service restored: 1/6/07)</td>
<td>11,612</td>
<td>0</td>
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<tr>
<td>– Wholesale customers</td>
<td>31,000</td>
<td>0</td>
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<tr>
<td><strong>Transmission System (approx, 71% repaired)</strong></td>
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<td></td>
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<tr>
<td>– Number of line segments out</td>
<td>37</td>
<td>7</td>
</tr>
<tr>
<td>– Transmission miles out-of-service</td>
<td>1,053</td>
<td>184</td>
</tr>
<tr>
<td>– Number of substations out</td>
<td>18</td>
<td>0</td>
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<tr>
<td>– Miles of conductor down</td>
<td>301</td>
<td>86</td>
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<tr>
<td>– Number of structures damaged</td>
<td>1,136</td>
<td>473</td>
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<td></td>
<td>Up to</td>
<td>Up to</td>
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<td><strong>GGS east flow limitation</strong></td>
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<td>224 MW</td>
<td>990 MW</td>
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*These MW will depend on transmission system status, loading conditions and regional transmission system conditions.*

- Communities on Mobile Generators: 14, 0
- More than a dozen public power utilities impacted by storm
- Contractors on site throughout reconstruction: 260 - 320
Ice on a guy wire
Engineering Design Criteria

• National Electrical Safety Code 1997
  – Heavy combined ice and wind loading, \( \frac{1}{2} \) inch radial ice, 40 mph wind, 0°F

• National Electrical Safety Code 2007
  – Heavy combined ice and wind loading, \( \frac{1}{2} \) inch radial ice, 60 mph wind, 15°F

• New Year’s storm
  – 2 inch radial ice, winds averaging 21 mph, gusts up to 40 mph, temperatures hovering around freezing
Effect of Ice on Power Lines

• Typical weight of conductors without ice – $\frac{1}{2}$ to 1 pound per foot

• Weight of lines with ice can increase by 4 - 8 pounds per foot

• Weight on structures increased up to 8 - 10 times after ice storm
  – Example: 115kV structure load went from 3,000 pounds to 26,000 pounds (2-inch radial ice)
Size of ice one week after storm
The ice mangled 345-kilovolt structures like twist-ties
More than 40, 345-kilovolt structures were destroyed
The storm snapped H-frame structures like twigs
More than 300 miles of line and 1,137 structures were damaged
Ice on Substation near Holdrege, Neb.
Emergency Restoration
Emergency mobile generation was brought in for 14 communities
Mutual aid near Elgin, Neb.
Day-after-day diligence for more than 30 days. The last community on emergency generation was restored line service on Jan. 29, 2007.
Reconstruction
Restore Transmission System

- Material procurement and delivery
- Focus on primary reconstruction efforts
- Hire and assign contractors
- Parallel efforts (Customer Service Priorities)
- System Network Priorities
- Watch the weather
- Ensure equipment functions
More than 3,000 wood poles ordered.
Unloading conductor at NPPD’s York Operations Center for 400 + miles of line
Contractors Reconstructing South of Holdrege, Neb.
Restoration efforts near Prosser, Neb.
Questions?