History and Use of Long Line HEC Methods at WAPA

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Transmission Asset Maintenance Manager
Western Area Power Administration
History and use of Helicopter Long-Line Maintenance Human External Cargo (HEC)

At Western Area Power Administration
Who/What is Western
Western by the Numbers:

- 15 States
- Top 10 largest transmission providers in the U.S.
- 17,200 circuit-miles of transmission lines (96% at 100-kV and above)
- 177,000+ structures
- 320 substations
- 475 communication sites
- 24 Transmission Line Crews
- 25 Electrician Crews
- 90 Tech Crafts (M&R and EECC)
HEC Background

- Started in our Sierra Nevada Region in 2009
- Use Contractor Supplied Helicopter Services
- Use WAPA Linemen trained in HEC work methods
- Drivers
  - System and Regulatory Constraints
  - Safety issues
  - Environmental Issues
  - Cost Savings
  - Improved efficiency
Why Human External Cargo (HEC)??

- Safety
- Reliability
- Cost Containment
Reasons for adopting Helicopter HEC Procedures

* Safety (from terrain and land-owners)
Rough terrain takes a toll on our heavier equipment, leading to high breakdown costs.
Reasons – Cont.

- Access to Structures; sometimes due to Environmental constraints, Land Use and ROW condition.
Farmers oppose SMUD proposal to add new power lines in Colusa and Sutter counties
Maintenance Activities Performed:

- Replacing or installing aerial marker balls
- Replacing or installing spacers
- Replacing or installing dampers
- Replacing insulators
- Installing guards for wire stringing over energized lines or highway crossings
- Replacing or installing bird diverters
- Repairing damaged conductor mid-span
- Placing linemen at work location on structures and conductor
- Transporting tools and equipment to linemen on structures
- Land conductor carts
- Shield wire repairs
- Installation of aerial number or warning signs
Advantages

- Increased safety by reducing exposure to hazards
- Improved productivity and cost savings
- Less physical strain on personnel
- Reduced outage time
- Less environmental impact
- Quicker response time for tower rescue and/or transport of injured workers from inaccessible areas.
- Improved system reliability
- Improved response time for emergency repairs
Maintenance Procedures
Western’s TLHMP is Limited to:

LONG-LINE...

1. Transferring a worker and tools to and from the helicopter *long-line* to a steel structure
2. Transferring a worker and tools to and from the helicopter *long-line* to a wood pole structure
3. Transferring a hook ladder to and from the helicopter *long-line* to a trans mission line structure
4. Transferring a conductor cart and tools to and from the helicopter *long-line* to the transmission line conductor
5. Transferring a conductor cart and tools around a transmission line structure using a helicopter *long-line*
Mid span work (such as installing marker balls or conductor spacers) on river or canyon crossings where bucket truck access is dangerous.

- Environmentally sensitive areas.
- Farm land inaccessible by ground during certain times of the season.
- Inaccessible Forest Service or private land.
- Where a good business case exists for long line work where several structures need to be accessed. In this case there is more risk setting a bucket truck up 100 times vs. utilizing a helicopter.
Changing Marker Balls Over Canyon
<table>
<thead>
<tr>
<th>Description</th>
<th>SAFETY</th>
<th>ENVIRONMENT</th>
<th>FINANCIAL</th>
<th>RELIABILITY</th>
<th>EXTERNAL GOVERNANCE</th>
<th>Mitigation/Controls</th>
<th>SEVERITY</th>
<th>PROBABILITY</th>
<th>Severity Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confrontation and/or threats from landowners when on ROW.</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Defer to lands office or Law Enforcement.</td>
<td>5</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Traffic accident while transporting aerial lift over the road.</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>Abide by DOT rules/regulations. Defensive driving requirements.</td>
<td>5</td>
<td>4</td>
<td>17.5</td>
</tr>
<tr>
<td>Soft-tissue injury from climbing activities.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Use alternate methods. Western's Fall Protection Program.</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Description</td>
<td>SAFETY</td>
<td>ENVIRONMENT</td>
<td>FINANCIAL</td>
<td>RELIABILITY</td>
<td>EXTERNAL GOVERNANCE</td>
<td>Mitigation/Controls</td>
<td>SEVERITY</td>
<td>PROBABILITY</td>
<td>Severity * Probability</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
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<td>---------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>--------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Staging of equipment on unstable/uneven terrain resulting accidents on ROW.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>Use increased climbing procedures or other equipment methods.</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Operator Error at worksite while workers in the manlift.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>In-service (vendor provided) training. OJT is conducted after delivery and for new hires.</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Manlift fails at worksite while worker(s) in bucket. Probable causes listed below.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Aerial lift annual inspection and worksite inspection as addressed in JHA.</td>
<td>5</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Description</td>
<td>SAFETY</td>
<td>ENVIRONMENT</td>
<td>FINANCIAL</td>
<td>RELIABILITY</td>
<td>EXTERNAL GOVERNANCE</td>
<td>Mitigation/Controls</td>
<td>SEVERITY</td>
<td>PROBABILITY</td>
<td>Severity * Probability</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
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<td>---------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>--------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Serious injury/fatality from climbing activities.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Use alternate methods. Western's Fall Protection Program</td>
<td>3</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Damage to land/crops caused by staging equipment at worksite.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Use alternate methods to access worksite that minimizes/eliminates ground disturbance.</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Multiple worksites and multiple equipment setups of aerial lifts resulting in extended line outages.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Use increased climbing procedures or multiple crews or other equipment methods.</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Description</td>
<td>SAFETY</td>
<td>ENVIRONMENT</td>
<td>FINANCIAL</td>
<td>RELIABILITY</td>
<td>EXTERNAL GOVERNANCE</td>
<td>Mitigation/Controls</td>
<td>SEVERITY</td>
<td>PROBABILITY</td>
<td>Severity * Probability</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>--------</td>
<td>-------------</td>
<td>-----------</td>
<td>-------------</td>
<td>---------------------</td>
<td>--------------------------------------------</td>
<td>----------</td>
<td>--------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Improper vehicle grounding resulting in electric shock.</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td></td>
<td></td>
<td>Grounding training, ground potential rise meter.</td>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>
Conclusions/Recommendations from Risk Assessment

* Long-line TLHMP, when compared to traditional (aerial lift) procedures is determined to be more safe when taking into consideration specific external conditions (i.e. terrain).
* Consider better controls on aerial lift training.
* Continue with PSMM Chapter 19 approval to have further reaching oversight of the program.
* Consider a business case to determine feasibility of certifying a Western pilot for TLHMP procedures.
Barehand Conductor Repair Rod
230KV Double Circuit Structure
Spacer change out, flying in spacer bundles
3 Bundle Conductor Mock-up at Ground Level for Procedure Rehearsal
Use crane to lower and set cart on mock-up of conductor.
Disconnect rope from crane to secondary leg and swing around conductor
Re-attach to crane on other side of conductor
Making attachment to crane hook from conductor
Crane used to lift secondary leg onto conductor
Slack is removed from the sling and ready for disconnect from crane and ready for use.
Spacer change outs, landing carts
Spacer change out, landing carts
Associated Videos

* Energized 500kV Spacer Change out
  - https://www.youtube.com/watch?v=D__KcAXZUsw

* Helicopter Pilot Short Haul Skills Test
  - https://www.youtube.com/watch?v=F6oKX9C96GY

* Lineman Learn To Fly Helicopter Short Haul Style
  - https://www.youtube.com/watch?v=bOoQDF7jnRE

* Helicopter Short-Haul Energized 500 kV
  - https://www.youtube.com/watch?v=Wh0EbMosBnM
Any Questions?
Implementation of OSHA Ruling on MADs and TOV Studies

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Western Area Power Administration

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Transmission Asset Maintenance Manager
Western Area Power Administration
Transient Over-Voltage Studies (TOV)
Why, OSHA, Why?

OSHA was jealous because NERC was having all the regulatory fun?

OSHA wants to prove that they can also drive utility people nuts?

OR
The decision to develop new default values was taken as the previous values originated in a ruling which had been published in 1972 and the provisions were determined to be “out of date and inconsistent with the more recently promulgated general industry standard”.

A legitimate concern, or......
On 11 April of 2014, OSHA published new default maximum over-voltages for use in calculating the minimum approach distances.
<table>
<thead>
<tr>
<th></th>
<th>initial OSHA TOV values</th>
<th>new OSHA TOV values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>nominal voltage</td>
<td>maximum TOV</td>
</tr>
<tr>
<td>&lt; 362-kV</td>
<td>3.0 p.u.</td>
<td>72.6 to 420-kV</td>
</tr>
<tr>
<td>500 to 550-kV</td>
<td>2.4 p.u.</td>
<td>420.1 to 550-kV</td>
</tr>
<tr>
<td>765 to 800 kV</td>
<td>2.0 p.u.</td>
<td>550.1 to 800-kV</td>
</tr>
</tbody>
</table>
Why do we care?

An increase in TOV levels increases MADs (Minimum Approach Distance)

Increased MADS impact the ability to do live line work

A TOV study is required to allow the use of existing MADS
The primary TOV study tool is called EMTP:

**Electro-Magnetic Transients Program**
The Basic Steps

Read the excellent EPRI paper(s) on the subject

*Categorizing Line Transient Overvoltage (TOV) Values For Determining Minimum Approach Distances*

*Application Guide for Determining Maximum Switching Transient Overvoltages of Overhead Lines Rated 100-kV and Above Using Electromagnetic Transients Program (EMTP)*
Decide which lines to study

WAPA studied the longest line in each voltage class ≥ 115-kV

<table>
<thead>
<tr>
<th>Circuit</th>
<th>kV</th>
<th>miles</th>
<th>location/routing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelby 2 – Havre</td>
<td>115</td>
<td>97</td>
<td>Montana</td>
</tr>
<tr>
<td>Hayden – Vernal</td>
<td>138</td>
<td>134</td>
<td>Colorado and Utah</td>
</tr>
<tr>
<td>Kofa – Parker</td>
<td>161</td>
<td>101</td>
<td>Arizona</td>
</tr>
<tr>
<td>Roseville - Cottonwood</td>
<td>230</td>
<td>140</td>
<td>California</td>
</tr>
<tr>
<td>Ault-Craig</td>
<td>345</td>
<td>184</td>
<td>Colorado and Wyoming</td>
</tr>
</tbody>
</table>
Gather data for the system to be analyzed

- Transmission lines
- Transformers
- Sources (real generators and equivalents)
- Surge Arrestors

Of these, T-lines require the most modeling effort
• T-line models for the line of interest must be “frequency dependent” and distributed parameter type

• Ideally adjacent lines at the terminals are represented the same

• EMTP calls these “FD” line models

Once you have the t-line data, it is easy to make an FD model
Building an EMTP model

For t-lines:
Define all circuits on your ROW
Find conductor and OHGW electrical data, and spatial layout
Corridor definition
Tower geometry
**Conductor Data**

<table>
<thead>
<tr>
<th>Phase Conductor</th>
<th>1272 ACSS (54/19) “Pheasant”</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHGW Conductor</td>
<td>½” HS Steel 7-wire</td>
</tr>
<tr>
<td>Bundle Geometry</td>
<td>1-Conductor</td>
</tr>
<tr>
<td>Loading</td>
<td>NESC (Light)</td>
</tr>
</tbody>
</table>

**Sag Data:**

<table>
<thead>
<tr>
<th>Ruling Span (ft)</th>
<th>Phase</th>
<th>OHGW</th>
</tr>
</thead>
<tbody>
<tr>
<td>992.0</td>
<td>986.0</td>
<td></td>
</tr>
</tbody>
</table>
## Conductor Height & Sag

<table>
<thead>
<tr>
<th>Conductor</th>
<th>Height at Tower</th>
<th>Sag at 90 deg F</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHGW Conductor</td>
<td>133.50 ft</td>
<td>145.7 ft</td>
</tr>
<tr>
<td>Phase Conductor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>116.25 ft</td>
<td>25.60 ft</td>
</tr>
<tr>
<td>Middle</td>
<td>99.25 ft</td>
<td>25.60 ft</td>
</tr>
<tr>
<td>Bottom</td>
<td>82.25 ft</td>
<td>25.60 ft</td>
</tr>
</tbody>
</table>
EMTP line data input form

Geometrical and electrical data

Module: Line Model
Units: English
Input option: Standard Conductor data

Conductor Data

Number of conductors (wires): 6

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.0714</td>
<td>1.345</td>
<td>15</td>
<td>136</td>
<td>101</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.0714</td>
<td>1.345</td>
<td>19</td>
<td>108</td>
<td>73</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0.0714</td>
<td>1.345</td>
<td>15</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0.0714</td>
<td>1.345</td>
<td>-15</td>
<td>136</td>
<td>101</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>0.0714</td>
<td>1.345</td>
<td>-19</td>
<td>108</td>
<td>73</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>0.0714</td>
<td>1.345</td>
<td>-15</td>
<td>80</td>
<td>50</td>
</tr>
</tbody>
</table>
additional EMTP line data input

**Skin effect correction**

- **Thick/Diam**: 0.375
- **None**
- **Solid conductor**
- **Galloway Wedepohl**

**Bundled Conductor**

- Number of conductors in the bundle: 3
- Spacing (in): 18
- Angular position (deg): 0

**Relative permeability**: 1
From this input data EMTP builds its internal representation of the line, which doesn’t *look* much like a t-line....
EMTP matrix representation of FD line
And finally
It’s therefore a good idea to build test circuits to verify your model for all the system components.
Positive sequence t-line impedance test circuit
Input data for EMTP transformer model
Power transformer model
Non-linear devices

Transformer magnetizing inductance
Non-linear devices
Non-linear devices

surge arresters
After several days of de-bugging, troubleshooting, and generally trying to figure out why your case doesn’t run....it’s finally time to study TOV
Transient Overvoltages

Transient overvoltages that occur in electric power systems have two primary causes:

Lightning and Switching

Of these, lightning is the most common source.
Transient Overvoltages

Because live line work is not performed during adverse weather conditions, the transient overvoltages created by lightning can be ignored when determining minimum approach distances (MAD)
Transient Overvoltages

Additionally, NESC clearances are based on maximum *switching* overvoltages. Thus, the worst case transient overvoltages considered herein are those created by switching events.
TOV – travelling waves
TOV – travelling waves

Reflection coefficient:

$$\Gamma = \frac{Z_L - Z_S}{Z_L + Z_S}$$
Several $\Gamma$ examples

\[ \Gamma = \frac{Z_L - Z_S}{Z_L + Z_S} \]

Short circuit at load:

\[ Z_L = 0; \quad \Gamma = -1 \]

The incident wave is completely reflected, but inverted
Several $\Gamma$ examples

\[ \Gamma = \frac{Z_L - Z_S}{Z_L + Z_S} \]

Open circuit at load:
\[ Z_L \to \infty; \quad \Gamma = +1 \]

The incident wave is completely reflected, i.e. doubled
Mathematicians, calm down

\[
\lim_{ZL \to \infty} \frac{ZL - ZS}{ZL + ZS} \\
\lim_{ZL \to \infty} \frac{ZL \left(1 - \frac{ZS}{ZL}\right)}{ZL \left(1 + \frac{ZS}{ZL}\right)} \\
\lim_{ZL \to \infty} \frac{ZL \left(1 - 0\right)}{ZL \left(1 + 0\right)} = 1
\]
Several $\Gamma$ examples

\[ \Gamma = \frac{Z_L - Z_S}{Z_L + Z_S} \]

For a typical real system:

-1 \leq \Gamma \leq +1

The incident wave is partially reflected, partially transmitted
While you *could* do these studies by hand, I wouldn’t ....
Figure 5.14 Circuit diagram, lattice diagram, and plot of voltage versus time for Example 5.6 where the receiving-end resistance is 90 Ω.

Figure 5.15 Circuit diagram, lattice diagram, and plot of voltage versus time when the receiving-end resistance for Example 5.6 is changed to 10 Ω.
TOV scenarios

• SLG fault and trip on studied line

• Close into trapped charge on adjacent lines

• SLG fault and trip on mutually coupled lines

• Reclosing is not considered on the studied line due to HLO
TOV statistics

TOV studies use statistical switching since breaker closing times are random.

Fault occurrence relative to point on wave is also random, requiring a statistical approach.

EMTP has statistical switching models and statistical analysis capability
Statistical case setup

- Study type: Statistical with base case
- Time of dice roll: User defined 0
- Number of simulations: 300
- Do all systematic combinations: unchecked
- Seed for random numbers: Random
- Maximum multiple of standard deviation: 3
- Enforce: checked
Statistical switch data

**Phase A Random data law**: Uniform
- **Dependency**: Master
- **Reference switch name**: <blank>
- **Random**: Closing time
- **Mean**: 33.33 ms
- **Standard deviation**: 4.81 ms
- **Number of steps**: 5

**Phase B Random data law**: Gaussian
- **Dependency**: Slave
- **Reference switch name**: CRG_PCBa
- **Random**: Closing time
- **Mean of delay**: 0 s
- **Standard deviation of delay**: 1.3869 ms
- **Number of steps**: 5
SLG fault applied mid-line
TOV measuring circuit

divide by Vtg peak for per unit value
Random data tab for SLG fault switch
MPLOT – min TOVs in per unit for 200 SLG faults
MPLOT - max TOVs in per unit for 200 SLG faults
Maximum TOV isolated from other traces
CDF for maximum TOV – 1.6058 per unit
Summary of results

<table>
<thead>
<tr>
<th>circuit</th>
<th>miles</th>
<th>SLG fault and clear</th>
<th>Energize adjacent line</th>
<th>Energize coupled line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelby 2 – Havre 115-kV</td>
<td>97.23</td>
<td>1.50</td>
<td>1.81</td>
<td>n/a</td>
</tr>
<tr>
<td>Hayden – Vernal 138-kV</td>
<td>134.3</td>
<td>1.76</td>
<td>1.82</td>
<td>2.24</td>
</tr>
<tr>
<td>Kofa – Parker 161-kV</td>
<td>101.5</td>
<td>1.33</td>
<td>1.57</td>
<td>n/a</td>
</tr>
<tr>
<td>Cottonwood – Roseville 230-kV</td>
<td>140.7</td>
<td>1.66</td>
<td>1.70</td>
<td>n/a</td>
</tr>
<tr>
<td>Ault – Craig 345-kV</td>
<td>184.0</td>
<td>1.72</td>
<td>2.08</td>
<td>1.28</td>
</tr>
</tbody>
</table>

Note the maximum TOV found was 2.24, well below the existing 3.0 limit for voltages ≤ 362-kV
In Summation
TRANSIENT OVERVOLTAGE STUDIES AND MINIMUM APPROACH DISTANCES

Impacts to Live Work Procedures
At
Western Area Power Administration
Minimum Approach Distance

- Definition (WAPA) – The closest distance an employee is permitted to approach an energized ungrounded Object.
  - Non-electrical workers (i.e. general public).
  - Electrical workers (engineering and administrative controls in place).
Minimum approach distance for non-electrical worker

Close proximity for electrical worker

Minimum approach distance for electrical worker

Energized part
MAD for Electrical Workers

- Adjustments with altitude.

![Graph showing minimum approach distance at different altitudes for various voltages: 115 kV, 230 kV, 345 kV, and 500 kV. The x-axis represents altitude in feet above sea level, while the y-axis represents the minimum approach distance in feet. The graph indicates an increase in minimum approach distance as altitude increases, with different lines for each voltage level.](image-url)
MAD for Electrical Workers

- Changes with fault duty (arc exposure).

---

### DSW Transmission Lines – Arc Flash (De-Energized Work Procedures)

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Length (MI)</th>
<th>Line Sections (measured in miles from the first line terminal listed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-1</td>
</tr>
<tr>
<td>230.00</td>
<td>12.00</td>
<td>AFB</td>
</tr>
</tbody>
</table>

| Exposure     | 7.34 | 4.42 | 3.18 | 2.50 | 2.08 | 1.79 | 1.58 | 1.43 | 1.31 | 1.22 | 1.15 |

Live (Energized) Work

- Two types of live line maintenance
  - Hotsick (worker outside the MAD).
  - Barehand (worker inside the MAD and energized at system voltage). This could be accompanied with hotstick work depending on the work procedure.
TOV Controls

- Reclosing blocked/disabled.
- Switching on adjacent lines not allowed without first contacting the crew.
- Putting line back in service after a fault not allowed without first contacting the crew.
- No relay testing on line.
Barehand from insulated Boom
Outside Phase
Bare hand from Insulated Boom Inside Phase
Barehand from a Ladder Outside Phase – Inside Swing Access
Barehand from a Ladder Outside Phase – Outside Swing Access
Risk Assessment

- High TOV occurs on the transmission line causing fault on the line.

- High TOV occurs on the transmission line during maintenance procedures requiring no clearance or HLO (line patrol, ROW work, etc.).

- A TOV occurs on the transmission line during live work procedures.
High TOV occurs on the transmission line in during live work procedures, while workers are positioned at the MAD and a + 3 p.u. voltage rise occurs at worksite.

TOV occurs on the transmission line in excess of 3.0 P.U. during live work procedures, while workers are positioned at the MAD and L-G fault occurs at worksite through a worker.
Risk Assessment (Continued)

- Increased risk of injury from modifying work procedures to accommodate rules regarding the increased MADs.

- Receive WECC/NERC violation by delaying or re-scheduling maintenance on a line that has been scheduled for live work.
## Minimum Approach Distances

### Historical – Post 2016

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Historical Values (TOV 3.0 P.U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.6 kV to 121 kV</td>
<td>3.2’</td>
</tr>
<tr>
<td>138 kV to 145 kV</td>
<td>3.6’</td>
</tr>
<tr>
<td>161 kV to 169 kV</td>
<td>4.0’</td>
</tr>
<tr>
<td>230 kV to 242 kV</td>
<td>5.3’</td>
</tr>
<tr>
<td>345 kV to 362 kV</td>
<td>8.5’</td>
</tr>
<tr>
<td>500 kV to 550 kV</td>
<td>11.3’</td>
</tr>
</tbody>
</table>
Live Work Procedures – hot stick
### Minimum Approach Distances

**After January 2016**

<table>
<thead>
<tr>
<th>Voltage Level</th>
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<th>138 kV to 145 kV</th>
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</thead>
<tbody>
<tr>
<td>New Values 3.5 P.U. (January 2016)</td>
<td>3.7’</td>
<td>4.3’</td>
<td>4.8’</td>
<td>6.6’</td>
<td>11.2’</td>
<td>16.6’</td>
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</table>
Live Work Procedures – hot stick
## Allowable MADs for WAPA

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<tr>
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<td>3.3</td>
<td>3.8</td>
<td>4.3</td>
<td>5.6</td>
<td>9.1</td>
<td>11.9</td>
</tr>
<tr>
<td>Allowable Values per TOV Study</td>
<td>3.3</td>
<td>2.8</td>
<td>3.6</td>
<td>5.9</td>
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<td></td>
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Minimum Approach Distances

Historical versus New

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</table>
Questions?
Steel and Wood Pole Fall Protection Implementation

Kip Schuettler
Corporate Safety Manager
Nebraska Public Power District
Wood Pole and Steel Structure Fall Protection

Kip Schuettler, Corporate Safety Manager

Nebraska Public Power District
Always there when you need us
Wood Pole and Steel Structure Fall Protection

DISCLAIMER

This presentation is designed to provide accurate and authoritative information about NPPD’s approach to the subject matter covered. It is provided with the understanding that the presenter nor NPPD is engaged in rendering legal or other professional service, and this presentation should not be relied upon as legal or profession advice. If legal or other expert assistance is required about this subject matter, the services of a competent professional should be sought.
Fall Protection on Wood Poles

- 05/12/2006, A teammate was making his way back down the pole at about 8 feet above the ground his gaffs cutout of the pole and he fell and injured his lower back.

- 09/19/2011, a teammate fell approximately twelve feet while climbing down a pole and fractured his leg.
Fall Protection on Wood Poles

- 12/2011, created a team:
  - Operations, Training and Safety
- Expectation for the committee:
  - Discuss concerns and benefits of NPPD heading down the path of the utilization of fall restraint while climbing wood poles
  - Look for the best options for NPPD
  - Provide suggestions on the smoothest implementation approach
Fall Protection on Wood Poles

Questions and Concerns

- Climbing around poles with steps
- Use on bay-o-nets
- Use around secondaries
- Too much weight and items hanging on the D ring
- Working at night, will you recognize all the hazards of this stuff hanging on your belt.
- Will two sets of D Rings be required?
- Is there an option for the use or not?
- How do we train on them?
- What will be the expectations for when the restraints are required?
Fall Protection on Wood Poles

Decision

- A committee lead by Safety Department benchmarked with other utilities
- Vendors were invited to come in and demonstrate their devices to the committee and employees that had been selected to assist in providing training.
- Types of restraints reviewed:
  - Buckingham Buck Squeeze
  - Bashlin Jelco
  - Sala Cynch-lock
  - Bashlin Lariat
  - Miller Stop Fall
Fall restraints were purchased for crews to try out for 6 months. Sets included:

- Buckingham Super Buck Squeeze
- Sala Cynch-lock
- Bashlin Jelco

Committee was pulled back together to discuss pro’s and con’s.

Rules were created to address concerns.
Fall Protection on Wood Poles

Fall restraint equipment shall be used by employees working at elevated locations more than 2 feet above the ground on wood poles.

The fall restraint equipment must be used in manner to restrict the fall to no greater than 2 foot.

The 2 foot requirement can be achieved by either the use of a fall restraint device or a secondary safety (rope or strap).

- When utilizing the secondary safety, the safety cannot be placed more than 2 foot higher than a fixed device on a pole capable of supporting the climber’s weight.

NOTE: Exception to the 2 foot rule is while working above the x-brace or crossarm on a bayoneted structure, during this time workers can utilize either device to position themselves.
Fall Protection on Wood Poles
Fall Protection on Wood Poles
Fall Protection on Steel Structures

- Transmission Operations worked with Transmission Personal in the field
- Others involved included Vendors, Engineering and Safety
Fall Protection on Steel Structures
Step Safe
“For use on ¾” tower bolts only
Fall Protection on Steel Structure

Buckingham Combo Yard
Fall Protection on Steel Structure

• Fall arrest equipment, work positioning equipment, or travel restricting equipment shall be used by employees working at elevated locations more than 4 feet above the ground on towers, or similar structures if other fall protection has not been provided.

• When utilizing fall arrest equipment in no case shall lanyards be of a length that allows for a free-fall of greater than 6 feet.

• The selected lanyards shall be as short as possible to limit the fall arresting force on the wearer’s body following a fall.
When attaching fall arrest equipment to the tower or structure the anchorage point shall meet one of the following requirements:

• Capable of supporting at least 5,000 pounds per individual employee attached, or

• Installed and used as part of a complete personal fall arrest system (shock absorbing lanyard or retractable lanyard and full body harness) which maintains a safety factor of at least two.
Fall Protection on Steel Structure

Fall protection equipped with frontal attachment:

• Shall be located within the sternum (breastbone) area of the body.
• Used only in rescue, work position, and rope access.
• Shall limit the maximum free fall distance to two feet and maximum arrest force to 900 pounds.
Step Bolts:

• When utilizing fall arrest equipment to scale the tower, the steps of the tower may be used as the attachment point.

• When attaching to the steps of the tower, the lanyard shall be attached as close as possible to the structure.
The Buckingham may be used on 5/8 and ¾ step bolts as long as it is kept as close to the tower as possible.
Not acceptable practice

Buckingham Tower clamp
Has been proof tested and accepted practice with Buckingham
Acceptable practice with Buckingham
Conclusion

• Took time getting buy in
  “Real men don’t need this protection”
  “Going to take too much time”
• Communicate Continually
• Management/Supervisors Support
• Plan for the future (New Hires)
Conclusion

• Complaining has stopped
• No Injuries to Date!!
Questions?
Fall Protection

Will Schnyer
Rocky Mountain Region Safety & Occupational Health Manager
Western Area Power Administration
Transmission Operations and Maintenance Conference

Western Area Power Administration Fall Protection Program Information
Western’s Geographic Territory:

- Western operates and maintains more than 17,100 miles of transmission lines, 320 substations and other related facilities.
Western’s Fall Protection Program Philosophy:

- The elimination of falls is Western’s goal. To be successful, employees who climb shall be designated climbers, receive proper training, meet proficiency requirements and have access to, and use, proper equipment. Western continually evaluates structure design and work procedures to eliminate the potential for falls.

- Manufacturer’s recommendations on fall protection equipment is followed.
Western’s Fall Protection Committee Role:

The Fall Protection Committee (FPC) establishes the Western-wide Fall Protection Program to achieve consistency and standardization in fall protection processes and procedures. We developed an initial and refresher training program for all designated climbers. We update Western’s Power System Safety Manual (PSSM) and the Power System Maintenance Manual (PSMM) as needed to ensure our Fall Protection Program remains up to date with current Occupational Safety and Health Administration (OSHA) and applicable industry standards.
Western’s Fall Protection Committee

Members:

Western’s Fall Protection Committee membership includes safety and maintenance co-chairs, maintenance manager representative, structural engineer, IBEW liaisons and Regional Fall Protection Specialists (craftsmen) who represent Western’s Linemen, Electrician and Communication trades. The primary purpose of the Committee is to provide leadership, planning, development, assist in the implementation, and promote continuous improvement processes to Western’s fall protection program.
Fall Protection Training:

- Western’s designated climbers are trained on fall prevention, arrest principles and equipment use prior to working at elevations that are four (4) feet or more above the ground. Designated climbers complete training modules and written tests, demonstrate proficiency of fall protection principles and climbing skills, care and use of fall protection equipment, and complete rescue training. Rescue is practiced by designated climbers on a regular basis (at a minimum annually).
Mead Substation Fall Protection
Training Yard
Step bolts fitted with attachment rings
A lineman using an SRL as part of the fall protection system
A lineman performs self-rescue
Scaffold erected over a circuit breaker
Electricians using a fall arrest tower for a rescue from a transformer
Communication Tower Equipment:

Ladder safety climbing device

Ladder mounted rescue device
Questions?
Key Provisions of New Regulations Governing Rights-of-Way on Indian Lands

David A. Mullon, Jr.
Counsel
Venable LLP
NEW BIA RULE ON RIGHTS-OF-WAY ON INDIAN LAND

June 23, 2016

David A. Mullon Jr.
Venable LLP
damullon@Venable.com
202.344.4519
Caveat:

This is a broad overview of the new ROW Regulations. It is *not* legal advice.
The Final Rule on ROWs on Indian Land is long and complex.

Determining how or whether Final Rule may apply to a particular ROW requires careful analysis of all ROW documents and numerous factual and legal considerations.

Do not make decisions regarding your ROW or your planned ROW based on this presentation.

In all cases: Seek advice of counsel!
What’s in the New Rule?

**THE SIX SUBPARTS**

<table>
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<th>Purpose, Definitions, General Provisions</th>
</tr>
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<tbody>
<tr>
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</tr>
<tr>
<td>Subpart C</td>
<td>Obtaining a Right-of-Way (Application, Consent, Compensations, and the Grant of a ROW)</td>
</tr>
<tr>
<td>Subpart D</td>
<td>Duration, Renewals, Amendments, Assignments, Mortgages</td>
</tr>
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<td>Subpart E</td>
<td>Effectiveness</td>
</tr>
<tr>
<td>Subpart F</td>
<td>Compliance and Enforcement</td>
</tr>
</tbody>
</table>
Overview of (Just) Some Key Provisions

► What was the effective date?
► What does the Final Rule apply to and who may be affected?
► What about preexisting ROWs?
► Service line agreements
► What does it say about new uses of existing ROWs?
► Does the Final Rule address applicable law, jurisdiction and/or taxation?
► New bonding requirements
► New landowner consent requirements
► Are there new compensation rules?
What was the Effective Date?

APRIL 21, 2016
What Does the Final Rule Apply to?

**SECTION 169.003**

• Rule applies to “Indian land” and “BIA land”

• Indian land: surface estate of a tract of land owned in trust or restricted status by –
  • Indian tribe
  • Tribal corporation organized under the Indian Reorganization Act
  • Individual Indian

• BIA land: surface estate of tract owned by BIA (not Indian land)

• Final Rule treats Indian land owned by Indian tribes vs. individual Indians differently in some important respects
Who and What Easements May be Affected?

Sections 169.004 and 169.005

Federal, state, local political subdivisions (e.g., roads, highways, trails...)

Telecommunications

Utility companies (electrical, water supply, wastewater, storm sewer)

Oil and gas producers and pipelines (pipeline easements, pumping stations, access roads, etc.)

Electrical transmission

Some railroads
What About Preexisting ROWs?

Section 169.007

- Many provisions of Final Rule apply to both new and preexisting ROWs
- Basic question: Is the provision *procedural* or *substantive*? (More about that later…)
- Special requirements for holders of ROWs who acquired ROWs *by assignment* before effective date
Document Pre-Effective Date Assignments

SECTION 169.7(D) (AS EXTENDED)

By August 16, 2016:

• Holders of ROWs acquired by assignment prior to the effective date must provide BIA with “documentation” of assignment by August 16, 2016, or request an extension of time.

• Documentation: show chain of title from original grant, but BIA may accept other proof. See BIA FAQs at page 6:
  

• Consequences of failing to comply? BIA says it may initiate trespass action (see FAQs, page 6).

• Form ROW clause in BIA’s ROW Handbook: This ROW may be terminated for failure to comply with “any term or condition of the grant” or “applicable regulations”.)
Service Line Agreements

169.51 ET SEQ. (S U B P A R T B )

- Final Rule has special provisions that apply only to *service* lines on Indian land (Subpart B)
- The line must meet the definition/requirements of Subpart B, including 169.51 and 169.52
- **Guidelines** indicate that the Final Rule will be applied prospectively to service lines
- **BUT:** **Guidelines** have a caveat that if a preexisting service line is not in compliance with prior regulations, there may be a trespass under the Final Rule
What About New Uses Within or Overlapping An Existing ROW?

**SECTIONS 169.127 AND 169.128**

• If you are the grantee:
  • If new use is **not** “specified” in the original grant and is **not** within the “scope” of use specified in grant, Final Rule says grantee must amend the ROW or apply for a new ROW:
    • **Amend** if new use does not involve “ground disturbance”
    • **Apply for new ROW** if new use involves “ground disturbance”

• If you are **not** the grantee:
  • New use specified in grant or within scope of use specified in grant requires that grantee obtain assignment to new user
  • If use is neither specified in grant nor within scope of specified use, you must apply for a new ROW
Applicable Law, Jurisdiction, and Taxation

Sections 169.9, 169.10, and 169.11

• **Tribal Law**: ROWs “approved under this part” are subject to Federal and Tribal law (unless latter is inconsistent with Federal law) but are not subject to State Law

• **Tribal Jurisdiction**: Secretary’s grant of a ROW “will clarify that it does not diminish to any extent” tribal jurisdiction over land, persons, activities; tribal power to tax land, improvements, persons or activities; tribal civil jurisdiction over non-members; or Indian Country status of the land

• **Taxes**: For ROWs “approved under this Part”, permanent improvements, activities and ROW interests are not subject to State/political subdivision taxes, fees, assessment, etc., but are subject to tribal taxation

(See BIA Procedural vs. Prospective Guidance Document and WEA vs Dept. of Interior)
New Bonding Requirements

Sections 169.103, 169.104, and 169.305

- Bonding provisions much more detailed than corresponding provisions of old rule
- Application for a new ROW must include “bonds, insurance, or other forms of security” to cover:
  - Any periodic rentals required by grant
  - Damages caused by construction of permanent improvements
  - Estimated cost of remediation of damage caused by release of contaminants, explosives, hazardous waste
Landowner Consent Requirements

Landowner consent generally required for:
  • New ROWs (169.107 and 169.109 owners of remainder interest)
  • New uses within an existing ROW (169.127)
  • Renewals (169.202)
  • Amendments (169.204, except technical corrections)
  • Assignments (169.207)
  • Mortgages (169.210)

See BIA *Procedural vs. Prospective Guidance* Document
Compensation for Grant of Row

Sections 169.110-169.122

- Final Rule includes 13 separate sections addressing various compensation issues.
- Most of these sections deal with the initial grant of the ROW.
- Generally, Final Rule gives Indian tribes broad authority to negotiate compensation, but BIA retains more oversight for individual Indian lands.
- On individual Indian lands, generally not less than FMV, except under certain specified circumstances.

See BIA Procedural vs. Prospective Guidance Document.
How the New Rule Affects Existing vs. Future Rights-of-Way

New rule may affect both existing and future ROWs (granted under Final Rule):

– **Existing ROWs**: Procedural provisions only
– **ROWs granted under Final Rule**: Almost all provisions
How the New Rule May Affect *Existing* ROWs

• Procedural vs Non-procedural:
  • Procedural provisions apply unless inconsistent with terms of the grant or the law authorizing the grant
  • What is procedural? Is that clear?
  • Some examples in Preamble, but see BIA Guidance, “What are Procedural Provisions of the Final Rule?”:

• Some examples from the BIA Guidance....
Rules for Obtaining a New Row  
25 CFR 169.101 ET SEQ.

• **Guidelines** say most provisions addressing requirements for obtaining a new ROW after the effective date are “prospective”: contents of application, obtaining landowner consent, compensation, process for BIA to follow, contents of the ROW grant, provisions relating to permanent improvements, among others...

• **BUT:** **Guidelines** state that the Final Rule will apply to requests for renewals, amendments, assignments & mortgages of pre-existing ROWs that are submitted after the effective date (appears to treat these actions as “procedural”)

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Duration, Renewal, Amendment, Assignment, Mortgage

169.201 ET SEQ. (SUBPART D)

• **Guidelines** state that new duration provisions of Final Rule (169.201) are prospective only

• **Guidelines** state that Final Rule provisions relating to renewal, amendment, assignment & mortgaging ROWs are “procedural” and will generally apply to preexisting ROWs (when request to renew, amend, assign, or mortgage the ROW is made after effective date of Final Rule)

• However, law authorizing or terms of the original grant may control
Compliance and Enforcement

169.401 ET SEQ. (SUBPART F)

• **Guidelines** state that most of the operative provisions of this Subpart of the Final Rule are “procedural” and therefore will apply to pre-existing ROWs.

• However, **Guidelines** state that “negotiated remedies” are prospective (169.403).
Negotiated Remedies

• **169.403**: Tribe and grantee on tribal land may negotiate remedies for violations, abandonment, and non-use

• Negotiated remedies are stated in the tribal consent document and then incorporated into the grant itself

• These provisions only apply **prospectively** (not to preexisting ROWs)
The New Rule: Engagement of Tribal Governments and Individuals at Key Points

- New Rule provides for notice to and/or consultation with the governing Indian tribe at a number of key points, even when a proposed BIA action involves individual Indian land:
  - Generally encourages greater landowner (including individuals) participation in most important decision-making throughout process
  - From now on, Tribes and individuals will be more involved with both existing and future ROWs
Consent Requirements Revisited

Landowner consent generally required for:

- **New ROWs**: Section 169.107 and 169.109 (owners of remainder interest)
- **New uses**: Within an existing ROW: 169.127
- **Renewals**: 169.202
- **Amendments**: 169.204 (except technical corrections)
- **Assignments**: 169.207
- **Mortgages**: 169.210
Implication of Consent Requirements

• New rule encourages tribal/landowner participation
• Tribal consultation and notice to landowners in key stages of ROW processes
• Consent provisions of Final Rule will require negotiation with landowners
• When the ROW holder wants to renew, amend, assign, or mortgage a ROW (including a preexisting ROW), what will be on the negotiation table?
• Answer: Probably everything—compensation, duration, right to inspect for compliance, non-user/abandonment, negotiated remedies, specific events of default, and more…
Western Energy Alliance v. Department of the Interior
U.S. District Court for N.D. (Filed March 2016)

• WEA action was a broad “facial” challenge to the Final Rule
• Alleged that Final Rule exceeds authority under 25 USC 323-328, is contrary to law and arbitrary/capricious, and violates NEPA
• Court denied WEA’s request for a preliminary injunction:
  • A facial challenge must show “no set of circumstances under which the Final Rule would be valid”
  • Any harms must be addressed “when they actually occur”
• Court footnote: Final Rule appears “ill-advised... will result in a never-ending invitation to future litigation.”
Conclusion

✔ Do you have a ROW on Indian land?
✔ Will you be seeking an ROW on Indian land for future projects?
  • If yes: Read the Final Rule, Preamble, BIA Guidelines & FAQs
✔ Was your pre-existing ROW was acquired by assignment before the effective date?
  • If yes: Remember the documentation deadline: August 16, 2016
✔ Speak to legal counsel!!
For questions please contact:

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