A Modern Approach to Protecting Wayside Railroad Equipment from Lightning Damage

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Legacy System Railroad Tracks

- Use railroad tracks as signal paths
- DC, AC, or AC/DC energized
- Crossing signals
- Shared right-of-way

Photo source: EPRI Power System and Railroad Electromagnetic Compatibility Handbook
Legacy System Railroad Tracks
Track Circuit

- Transmitter/receiver
- Electrically isolated block of track
- Signal and communication control

Legacy System Railroad Tracks Shunt Circuit

- Train detection
- Track resistance
- Ballast variation
- Track isolation problems

Wayside bungalows and panels are used as concentrators for signal circuits, protection circuits, communication circuits, power requirements, etc. Bungalow circuits are susceptible to failure due to direct or indirect lightning strikes, current surges, etc.
Legacy System
Typical Wayside Bungalow
Legacy System
Typical Wayside Bungalow
Legacy System
Typical Panel
Legacy System
Internal Bungalow Wiring Practices
Legacy System
Internal Bungalow Wiring Practices
Legacy Technology
Lightning Protection
Legacy Lightning Protection Methods
Present Day Example

- Signal line protection has been provided by the use of spark-gap-based product
Legacy Technology
Mechanical Characterization

Spark Gap Surge Protection element

Isolation Nut
14-24 Nut (typ)
Isolation Bracket

14-24 binding posts (typ)

CASE wire (blue)
FIELD wire (Orange)
Legacy Technology
Electrical Characterization

- **Electrical characteristics**
  - Surge protective device technology: spark-gap based
  - Operating voltage: 0 to 50 V DC
  - Breakdown voltage: 700 to 1000 Volts
  - Discharge current: $50 \, kA_{\text{max}}$
  - Let-through voltage $= 2500 \, V_{\text{nom}}$
Legacy Technology
Typical Use Slide

- Spark-gap-based technology is used in the bungalow environment, as shown on the right.
Positive Train Control (PTC)

- High-profile accidents
- Rail Safety Improvement Act of 2008
- “Each Class I railroad carrier and each entity providing regularly scheduled intercity or commuter rail passenger transportation shall develop ... a plan for implementing a Positive Train Control system by December 31, 2015, governing operations on—
  - “(A) its main line over which intercity rail passenger transportation or commuter rail passenger transportation ...;
  - “(B) its main line over which poison- or toxic-by-inhalation hazardous materials ... are transported; and
  - “(C) such other tracks as the Secretary may prescribe by regulation or order ...
- The railroad carrier shall Implement a Positive Train Control system in accordance with the plan.”
- The rest (“Class I railroad, a railroad carrier that has inadequate safety performance (as determined by the Secretary), or a railroad carrier that provides intercity rail passenger or commuter rail passenger transportation”) have until December 2018 to implement PTC.
Positive Train Control – Generic Example

◆ Safety Functionality
- Prevent Train-to-Train Collisions
- Enforce Speed Restrictions
- Protect Roadway Workers Operating Under Specific Authorities
Present Day Technology
MOV-Based Device

- The MOV-based device consists of a two piece design:
  - A base element that contains wire and base attachment features, testing features, and an available remote monitoring feature.
  - A removable product plug that can be designed for different applications, including track circuits, track equalizer circuits, relay circuits, and digital circuit applications.
Present Day Technology
Base Element

- Z-axis tool actuation
- Very simple disconnect
- Field wire (orange) on top
- UT16 rising cage clamp
- Case wire (blue) on bottom
- UT10 rising cage clamp
- Bridging
- Mechanical hold-down feature
Present Day Technology
Surge Protection Plug

- **Electrical Characteristics**
  - Hybrid MOV and Gas Tube Technology
  - Operating Voltage (Un): 100 VDC
  - Breakdown Voltage: 1.4 KV
  - Discharge Current (I_max): 20KA
  - Let Thru Voltage: 450V
Present Day Technology
Surge Protection Plug

- Advanced Design Features
  - A *thermal disconnect*, to prevent a thermal runaway condition in the case of a product fault condition
  - A *visual fault indicator*, to facilitate the removal of a failed plug in the case of a product fault condition.
Legacy and Present Day Technology
SPD comparison

Legacy Technology

Present Day Technology
Legacy and Present Day Technology Application Comparison
Present Day Technology
Application Illustration
Present Day Technology
Application Illustration
Present Day Technology
Application Illustration
Issues to be Resolved
Wayside Bungalow Lightning Protection

- No industry consensus on a method to protect wayside signal circuitry from damage due to lightning strikes.
  - Independent companies
  - Track circuits & legacy methods.
Issues to be Resolved
Wayside Bungalow Lightning Protection

- Various protection schemes have been evaluated with varying results
  - Faraday cages
  - Wire separation and length minimization
Issues to be Resolved
Wayside Bungalow Lightning Protection

- Various protection schemes have been evaluated with varying results.
  - Costs associated with existing installations
  - Cost demands of PTC implementation
Conclusion

This presentation has:

✓ Reviewed the legacy method of protecting railway signal lines against lightning strikes.
✓ Presented a state of the art method of protecting signal lines from lightning strikes.
✓ Discussed issues that will need to be addressed to further reduce the effects of lightning damage within the bungalow structure.
Thank You !