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10 Best Practices to Reduce the Risk of Power Line Wildfires

Executive Summary

Wildfires caused by transmission and distribution lines impact insurance rates, customer/public relations, and electric utilities' bottom line. As wildfires ignited by faulted power lines are becoming more litigious, electric utilities need to demonstrate that they are quickly working to address and reduce risks.

Over the last decade, lawsuits and settlements from these types of wildfires have cost electric utilities billions of dollars. In 2024, insurers increased rates for wildfire coverage by 200% to 300% based on prior year losses.

This paper provides ten low-cost, immediate actions that every electric utility can implement to reduce the risk that a wildfire will be ignited by faults on a transmission or distribution line. **All ten of these actions can be implemented in less than a year, as none require the installation of new components.**

The first step is to designate a Wildfire Awareness Manager who oversees wildfire awareness preparations and fault response teams that include utility personnel and contractors. Next steps include analyzing prior year data, documenting burnable material areas, assessing environmental conditions, understanding burnable material ignition and energy deposition, enhancing operations, and specifying post fault actions.

Addressing concerns about this year's wildfire season cannot be done through costly, long-term solutions, such as replacing overhead distribution lines with underground distribution lines. Instead, electric utilities would benefit from an in-depth wildfire risk assessment performed by Prescient Transmission Systems. This assessment provides a comprehensive review and analysis of overhead power lines to determine their risk of igniting wildfires and outlines cost-effective changes to reduce wildfire risk along power lines. Prescient also develops procedures for an ongoing wildfire awareness plan that electric utilities can implement every year.

Introduction

Wildfires ignited by faulted power lines occur every year across the United States, from the Pacific Northwest to Texas, California to Hawaii. The risks of power lines igniting wildfires are expanding across the central and eastern US as summers grow hotter and dryer.

Every electric utility should have a plan of action for high and extreme wildfire risk days, with documented procedures developed well before a wildfire occurs. Creating this proactive wildfire mitigation strategy will increase grid reliability and resilience within their service area, improve customer trust, and demonstrate to insurers that the utility is dedicated to reducing wildfire risk.

Prescient's Ten Best Practices

This whitepaper outlines ten specific actions that electric utilities can implement to significantly reduce the risk of transmission or distribution lines igniting wildfires in their service areas. Prescient Transmission Systems helps electric utilities implement these best practices through our Wildfire Risk Assessment service.

1. Designate a Wildfire Awareness Manager

Electric utilities need to designate a Wildfire Awareness Manager who establishes and oversees an ongoing wildfire awareness plan. The Wildfire Awareness Manager must be an individual who focuses on the prevention and impacts of wildfires ignited by faulted power lines, rather than someone who focuses on transmission line and distribution line design, customer outages, and other traditional electric utility focus areas.

The Wildfire Awareness Manager will be responsible for representing the utility to regulating agencies, to insurance companies, at public forums and to the news media. They will be the public face of your company on wildfire issues, so they must be comfortable discussing burnable organic material ignition while discussing the frequency and duration of power outages. During a calendar year in the Pacific Northwest, the Wildfire Awareness Manager would be accountable for the following:

October and November:

- Analyze the prior year's wildfire data to identify successful actions, near misses, and lessons learned.
- Ensure that activities that were implemented to minimize the possibility of wildfire ignition in high risk areas were effective.
- Assess wildfires within the utility' service area, and in other areas, to understand the experiences of all electric utilities.

December:

- Present an effectiveness review to the Executive Committee, identifying successful actions, near misses, lessons learned, and future enhancements.
- Include a discussion of wildfires in other areas in this presentation.
- Request authorization and funding to implement short term projects/activities that will further reduce the possibility of wildfire ignition.

January, February, and March:

- Work with utility teams (Transmission, Distribution, Protection, Vegetation Management, and System Operations) to ensure that short term projects/activities that have been authorized by the Executive Committee are completed as planned.
- Establish contracts with fault response teams to ensure that eyes are on a transmission or distribution line fault within 15 minutes of a trip out during high risk wildfire conditions.

April and May:

- Maintain an awareness of ongoing projects/activities. Work with utility teams to ensure the wildfire mitigation strategy is set for wildfire season.
- Conduct and oversee a wildfire awareness drill.
- Upon completion of the wildfire awareness drill, inform the Executive Committee of the status of authorized projects/activities and readiness for the wildfire season.

June through September:

- Oversee monitoring of environmental conditions and prepare to initiate special actions when the risk of wildfires is high.
- Activate fault response teams as needed.

The Wildfire Awareness Manager must also establish a fault response team that launches whenever a fault occurs on a transmission line or a distribution line during high risk wildfire conditions. The fault response teams should include electric utility personnel and contractors that are familiar with the area where the fault occurred.

2. Establish a Baseline

As more development occurs in remote areas and more energy production facilities are constructed in remote areas, greater expanses of distribution and transmission lines are being built through wildfire-prone locations. The majority of new transmission lines are being constructed as overhead facilities because these can be built in less time and at lower cost than underground facilities.

By establishing a baseline of parameters, electric utilities can better understand the risks of igniting wildfires in their service areas. Some parameters include:

- Total miles of transmission and distribution lines.
- Miles of transmission and distribution lines located in wildfire risk areas.
- Number of transmission and distribution line trip outs that occur each year.
- Number of days that high risk wildfire conditions occur each year.

The established Wildfire Awareness Manager will oversee details such as prior year data, the location of burnable organic material, and environmental condition alert levels. Protective relaying practices should also be considered as part of the baseline of parameters.

3. Analyze Prior Year Data

As wildfire ignition is an ongoing issue, lessons will be learned by reviewing prior year wildfire data for your utility and for other utilities. Prior year data should be categorized as First Order Fire Data (1FD), Second Order Fire Data (2FD), and Third Order Fire Data (3FD).

Internal data should be inclusive, confidential, and available. Other utility data, while laundered and delayed, can provide useful insights.

First Order Fire Data (1FD)	Second Order Fire Data (2FD)	Third Order Fire Data (3FD)
Number of faults. Outages that occurred during high risk conditions. Environmental conditions (ambient temperature, wind speed, etc.) when a wildfire occurred. Findings of fault response teams. Actions taken to suppress any wildfires that were ignited.	Actions taken to reduce wildfire risk for both: • Faulted transmission lines. • Faulted distribution lines. Actions completed by utility teams in support of wildfire risk reduction.	Information about wildfires in other areas. Actions that were implemented by other utilities.
Basis for immediate remedial action	**Basis for future actions**	**Noteworthy, but not actionable**

Prior year data reviews should include an assessment of faults that occurred throughout the year with a focus on what would happen if the same sequence of events occurred on a day when the risk of wildfire ignition was extremely high.

Reviewing other utility data can uncover commonalities and actions to further reduce the possibility that wildfires will be ignited by faults on transmission and distribution lines. Your subject matter experts should be prepared to interpret information about other utilities that is accessible via the internet and provide guidance to improve system performance at your electric utility.

For example, if plaintiffs' attorneys publicize the fact that twenty-seven distribution line trip outs occurred on the afternoon that a wildfire was ignited, your subject matter experts should consider the possibility that numerous trips will occur on your system during high risk conditions and provide guidance to reduce the number of trip outs to your system operators.

4. Document Burnable Material Areas

Most electric utilities have thousands of miles of transmission lines that are shown on plan and profile drawings, and thousands of miles of distribution lines that are shown on primary operating maps. The location of burnable organic material zones (dry grass, leaves, hay, duff, peat, rotten wood, etc.) should be added as a layer on all transmission line and distribution line maps and drawings. Reclosers, with wireless communication to control centers, should be noted when they are placed near burnable organic material boundaries when distribution lines are routed from low risk area through high risk areas.

Peripheral clearance zones should be added as a layer on all maps and drawings that show transmission line and distribution line routes. Peripheral clearance zones are areas where trees are tall enough to contact transmission lines and distribution lines when trees fall towards the line. Peripheral clearance zones contain tall, healthy trees that can be toppled by high wind gusts, such as the tree in this image.

Near transmission lines, peripheral clearance zones can be minimized by topping trees near the right of way and removing trees that are up slope in mountainous areas. Near distribution lines, minimizing peripheral clearance zones is challenging because homeowners do not want electric utilities to trim trees that beautify their properties.

Fire stations, staging areas, and other details that are important to the Wildfire Awareness Manager should be included as another layer on each drawing or map.

5. Assess Environmental Conditions

Environmental conditions affect dry material ignition and wildfire spread. Increased ambient temperature, low humidity, days without rain, and solar radiation increase the possibility that a faulted electric transmission or distribution line will ignite a wildfire. High winds will increase the rate of wildfire spread.

Dry lightning that strikes transmission line and distribution line structures and poles can create flashovers, which result in arcs that radiate energy to nearby burnable material. High winds can blow trees, tree limbs, and a wide variety of objects into transmission and distribution lines. These objects create faults that radiate energy to nearby burnable material.

Electric utilities must monitor environmental conditions and have procedures with actions that are implemented when environmental conditions increase the possibility of a transmission line or a distribution line fault igniting a wildfire. The procedures should include guidance for operations during low, moderate, high, or extreme wildfire risk.

6. Understand Burnable Organic Material Ignition

Dry vegetation (burnable organic material) ignition time can be calculated when material type, thickness, density, temperature, etc. are known.

Three key factors are understanding:

1. The type of dry vegetation in the area around transmission lines and distribution lines.
2. The amount of energy that is deposited on nearby dry vegetation when arcing faults occur.
3. The amount of energy that can be conducted through trees when trees fall onto transmission lines or distribution lines.

Thin Material Ignition Time

$$t_i = \rho c L_o \frac{(T_i - T_o)}{q}$$

Where:

t_i = Ignition time

T_i = Ignition Temperature

T_o = Material Temperature

q = heat flux

ρ = density

c = specific heat capacity

L_o = thermal resistance

- Dry vegetation ignition during arcing faults is calculated using thin material equations.
- Dry vegetation ignition during tree fall conditions is calculated using thick material equations.
- The difference between thin materials and thick materials is that thin materials have a high surface to volume ratio:
    - Thin material is less than 1/8 inch thick.
    - Thick material is more than 1/8 inch thick.

Thick Material Ignition Time

$$t_i = \frac{\pi}{4}\rho c k \frac{(T_i - T_o)^2}{q^2}$$

Where:

t_i = Ignition time

T_i = Ignition Temperature

T_o = Material Temperature

q = heat flux

ρ = density

c = specific heat capacity

k = thermal conductivity

7. Understand Energy Deposition

Energy is released from transmission and distribution lines when insulation degrades or when branches or trees contact conductors. Insulators are nonconductive (mega ohms per inch). Metals are very conductive (micro ohms per inch). Most materials are poor conductors (hundreds of ohms per inch).

Arc Flash

Arc flashes occur when insulators crack, when branches bridge the distance across an insulator, and when lightning strikes nearby. The amount of energy deposited on burnable organic material when an arc flash occurs is calculated using the following equation:

$$\text{Arc Flash Energy Deposition} = \frac{\text{Energy Released}}{\text{Surface Area}} = \frac{I^2 R_{arc} t}{4\pi r^2}$$

Energy released is a function of I^2Rt, where I is arc current, R is arc resistance, and t is fault clearing time.

Surface area is a function of distance from the arc. Surface area is assumed to be the surface of a sphere several inches away from the arc where r, the radius of a sphere, is the distance from the arc to burnable material. Energy released is quantified in watt-seconds per square inch. This is comparable to arc flash calculations where energy deposited on a surface is calculated in calories per square centimeter.

Accidental Contact

When a tree falls on a transmission or distribution line, energy is released along the length of the tree, from the transmission line or distribution line conductors to earth, calculated using the following equation:

$$\text{Accidental Contact Energy Deposition} = \frac{\text{Energy Released}}{\text{Surface Area}} = \frac{\mathrm{I}^2\mathrm{R}_{tree}\mathrm{t}}{\frac{1}{4}L}$$

The amount of energy deposited on burnable organic material when an accidental contact occurs is calculated using I^2Rt where I is current conducted through the tree, R is tree resistance, and surface area is calculated by multiplying tree length in inches by ¼ inch which is the arc width.

8. Enhance Operations

In wildfire prone areas, electric utilities should have three modes of operation: Standard, Balanced, and Enhanced. Standard operations are applicable when the risk of wildfire ignition is low. Balanced operations are applicable when the risk of wildfire ignition is moderate. Enhanced operations are applicable when the risk of wildfire ignition is high or extreme.

Standard Operations	Optimize protective relaying schemes to minimize customer interruptions when a fault occurs. Enable automatic reclosing to automatically return transmission and distribution lines to service after transient faults caused by lightning strikes and other temporary phenomena are cleared.
Balanced Operations	Set protective relaying schemes so that a limited number of customers are interrupted when a fault occurs. Reset automatic reclosing so that only one automatic reclosure is allowed in ten minutes. Allow manual closing *only after* fire watch personnel have patrolled the area. Note, **some miscoordination will be introduced** and some performance indicators (such as SAIDI) may be impacted.
Enhanced Operations	Set protective relaying schemes for maximum sensitivity. Block all automatic reclosing. Ensure fire watch personnel patrol the line before manual reclosing is allowed. Note, **miscoordination is both allowed and expected.**

As electric utilities do not have enough staff to patrol distribution lines within fifteen minutes of a trip out, contract personnel who are trained as fault response team members should be available.

9. Patrol Lines Post Fault

Electric utilities should patrol every line that trips out during high or extreme wildfire risk conditions within fifteen minutes of the trip. This would allow immediate identification of wildfire ignition and allow the fire to be extinguished before it spreads.

To meet the need for trained fault response team members without hiring new staff, electric utilities should copy the approach of other industries when responding to urgent incidents. For example, in 2016, Samsung issued a safety recall on certain top-load washers that required expedited in-home repair. Recognizing that they did not have the staff to complete the necessary repairs in a timely manner, Samsung arranged for Dish Network, the satellite communications company, and other service partners to support them.

Similarly, electric utilities can contract with a variety of workers, such as traffic control flaggers, delivery drivers, or rideshare drivers, to create fault response team members. Ideal candidates frequent the wildfire-prone area and will rapidly respond to alerts sent to their mobile devices.

Fault response team members can be trained in as little as four hours and should be provided with inspection protocols for their specific locations. When notified of an incident, their responsibility is to patrol a designated area looking for downed conductors, fallen trees, wildfire smoke and other indicators. They report their findings to the utility's Wildfire Awareness Manager. Fault response team members are only expected to observe and notify. If no anomalies are uncovered, they should perform a second patrol. If any indicators of wildfire are detected, they should notify first responders and evacuate the area to avoid endangering themselves.

10. Perform Wildfire Reviews

Shortly after a wildfire has been contained, confidential reviews should be initiated by the legal department and completed with attorney/client privilege. These reviews need to be focused on what happened, why it happened, and how to sustain strengths and improve on weaknesses. These reviews must be conducted after every wildfire in the service area of every electric utility — regardless of whether the wildfire was ignited by faulted transmission or distribution lines. Reviews can be used as a tool to:

- Identify and discuss effective and non-effective performance.
- Provide insights into strengths and weaknesses from various perspectives.
- Provide feedback and insight critical to actions that were performed.
- Document lessons learned and how to apply them in the future.

Conclusion

Wildfires ignited by faulted power lines can be prevented. Updates to protective relaying schemes and design practices, as well as power line construction, operation, and maintenance practices, can significantly reduce the risk of wildfires. But first, electric utilities must gain a deeper understanding of burnable material locations and ignition times, energy deposition, and environmental conditions.

A wildfire mitigation strategy prepared with the help of Prescient's experts will demonstrate to insurers and customers alike that the electric utility is dedicated to reducing wildfire risk.

About Prescient's Services

As part of our consulting services for electric utilities, Prescient Transmission Systems offers an industry-leading Wildfire Risk Assessment and Analysis service. Our staff analyzes power line characteristics and right of way (ROW) conditions, and uses a proprietary algorithm to determine the risk of a specific power line igniting a wildfire. Our algorithm takes many factors into account, including protective relay settings, distance from substations, environmental conditions, and more. By changing variables in the algorithm, Prescient can identify enhancements that provide the greatest risk reductions.

Having a comprehensive understanding of how protective relay settings influence vegetation ignition time is essential. Our staff can help determine strategic enhancements that will provide the most impact to reduce wildfire risk. As part of an assessment, Prescient provides ideas for cost-effective, concrete solutions that minimize wildfire risk. Prescient also develops procedures for an ongoing wildfire awareness plan that our clients can implement every year.

Our multidisciplinary team of electrical engineers, environmental scientists, and material scientists understands all aspects of wildfires started by power lines, from protective relaying schemes to fire ignition principles and vegetation management best practices. Our goal is to provide a technical basis for enhancing the design, construction and operation of transmission and distribution lines and associated components so that clients achieve industry-leading wildfire safety standards.

Learn more about Prescient's Wildfire Risk Assessment and other electric utility services on our website, prescientelectric.com. Our areas of expertise include renewable energy integration, electric vehicle integration, system modeling, energy balancing, and physical security.