Scheduling, Optimum Cycle and the Cost of Deferring Maintenance – a white paper

Introduction

Utility vegetation managers have always faced the challenge of determining the optimum frequency of maintenance operations for the control of trees and brush growing near the electric system. One must balance the cost of maintenance with the cost and impact of doing nothing or deferring action.

On March 5 and 6, 2014, 45 utility vegetation managers from throughout North America gathered in Fort Worth, Texas to share their experience and to identify general best practices as they related to scheduling work and balancing the many factors to identify and optimum maintenance frequency. The managers that participated had over 700 years of combined experience in the electric utility industry. They represented 31 companies and together manage the vegetation on over 1,000,000 miles of distribution lines and transmission corridors that provide electricity to over 53,000,000 customers.

The framework for extensive discussions was laid by two subject matter experts.

Mr. John Goodfellow (BioCompliance, Inc.) provided insight into how past research informs an industry searching to understand costs, risks and liability associated with determining the optimum maintenance cycle. While there is lots of anecdotal evidence, there is a shortage of empirical data. Most of the data available comes from research that is 20-30 years old and did not consider contemporary practices (e.g., new mixes, rates, application techniques).

Mr. Rafael Estevez (Duke Energy) discussed the strategies employed by Duke, which serves over 7,000,000 customers in six states.

This white paper is the result of the subsequent discussions.

Impacts of Deferred Maintenance

The longer vegetation is allowed to grow in and around electric utility infrastructure, the greater the impacts. Increases can be expected in the following:

1. Risk to safety of the public, and to tree and line workers;
2. Liability costs;
3. Number and duration of interruptions of power delivery ;
4. The time and cost to restore power;
5. Risk of wildfire;
6. Cost when the work is completed (more difficult to do the work, more biomass to deal with, more limited treatment options, etc.);
7. Internal and external customer requests for work;
8. Regulatory fines and oversight;
9. Exposure during catastrophic events (ice, snow, wind, fire, etc.).

While the aforementioned items increase in frequency and severity as maintenance is deferred, customer perception and satisfaction diminishes. If utilities do not frequently and visibly exercise their rights, those rights are less recognized by the public. This issue is exacerbated by the fact that when the work is finally performed, it is much more noticeable and therefore, more likely to generate a negative response by the public.

When considering the various impacts of deferring tree maintenance, it is important to note that some things are less important than often perceived. For example, at distribution voltages, incidental tree contact with the conductors does not result in significant line loss nor pose a high risk of a ground-to-conductor fault.

Key Factors in Determining Frequency of Maintenance

"Deferred maintenance" is well-known, often used terminology within the utility vegetation management industry. It refers to a delay in maintenance beyond its optimum timing. Unfortunately, what constitutes optimum timing is not well understood and is very difficult to quantify.

Goodfellow (2013)[1] reviewed six models for solving the question of what is optimum timing. If one strictly considers cost of maintenance, vegetation maintenance would be deferred indefinitely. Utilities, however, must approach vegetation management from a risk management perspective rather than strictly rely on the cost of maintenance activities.

Key factors that should be considered when determining the optimum frequency of maintenance include:

1. Regulatory compliance (federal, state, environmental, etc.)
2. Vegetation Conditions
    - Vegetation type and species
    - Growth rates
    - Density
    - Clearance before and after work
    - Sustainability (i.e., what is the desired long term conditions)
    - Available tools and techniques (e.g., technology, herbicides, etc.)
    - Past practices
3. Location
    - Population density (urban/rural)
    - Line voltage and significance
    - Ownership, rights, and right-of-way width
4. Environmental considerations
    - Changing environmental conditions (disease and pest infestations)
    - Climatic factors (drought)
5. Risk tolerance and consequences
    - If a tree fails, what portion of the infrastructure will it affect?
    - What is the extent of possible damage?
    - What are the consequences of that damage?
    - What are the societal and indirect costs (cost to brand image, cost of restoration, lost sales, regulatory and liability exposure, etc.)?
6. Budget (amount and consistency)

[1] Goodfellow, John W. and Kayihan, Arkan. 2013. Case for Scheduling Utility Vegetation Management on a Preventive versus Corrective Maintenance Bases: Phase 1 & 2.

Best Practices

Beginning in the 1970s, electric utilities began transitioning from hotpot (hotspot?) or corrective maintenance model to programs based on fixed cycles. Since that time, the distribution system has changed significantly. It has been upgraded to higher voltages, aging infrastructure, greater regulation, particularly on the transmission system, and industry and the public have become more dependent on a constant and consistent supply of electricity and are more sensitive to environmental issues. Furthermore, in recent years the industry has experienced more frequent and more destructive natural events such as storms, Emerald Ash Borer (EAB) and bark beetle infestations.

In limited situations, a fixed maintenance cycle remains the best choice for a utility. This is generally the case only where required by state or other government regulatory mandates. Otherwise, having the same schedule to do the same work everywhere is not built on any scientific basis. A more sophisticated approach is based on taking into account varying biological systems and assessing risk exposure and consequences.

Scheduling Distribution Line Maintenance

Best practice utilities recognize that all distribution lines are not the same and the various vegetation conditions encounter present diverse levels of risk. Optimal scheduling practices are dependent upon circuit-by-circuit or segment-by segment risk profiles with a strategy of condition-based vegetation maintenance. These utilities may adopt a fixed cycle but that cycle triggers inspection of the line rather than the automatic scheduling of crews. A "backstop" or maximum cycle, however, should be integrated into the overall strategy to minimize public concerns.

These utilities often include a mid-cycle inspection. This allows them to extend the overall frequency of maintenance by enabling them to take limited but targeted action such as addressing "cycle buster" trees (i.e., fast growing or limited clearance tree).

Other recognized best practices for distribution line clearance include:

1. Risk-based hazard tree program (targeted based on line significance);
2. Economically-based incentive programs for tree removals;
3. Robust quality assurance program;
4. Data intensive monitoring of performance including cost and reliability;
5. Ongoing use and/or evaluation of advanced technology and tools (LiDAR, TGR, Work Management Systems, data mining, and biological and financial modeling).

Scheduling Transmission Rights-of-way Management

Integrated Vegetation Management (IVM) is a recognized as a best management practice on transmission rights-of-way. IVM relies on detailed inspection protocols. Maintenance is only triggered when a predefined condition threshold is observed. The response is based on site-specific conditions and the availability of a diverse collection of maintenance techniques (e.g., manual, mechanical, chemical and biological).

Best practice utilities are no longer solely focused entirely on the conditions within the corridor borders. The identification of and mitigation of high-risk trees located off the right-of-way is a desirable practice.

The use of advanced or new technologies, particularly LiDAR, is also a recognized as a best practice, particularly on the most critical components (e.g., NERC regulated lines). Of course utilities must understand that although LiDAR provides more extensive and accurate inventory data, that information brings with it a certain increased risk. This risk includes greater liability and regulatory exposure. More precise measurement may identify trees that have unknowingly exceeded a specified threshold. This knowledge may necessitate immediate scheduling to mitigate the concern. Utilities must be prepared to address these concerns without deferring routine maintenance activities.

Other activities recognized as best practices include frequent inspection of work, a robust quality assurance program, use of GIS-based work management system, and an emphasis on conversion of incompatible plant populations to low-growing sustainable plant communities.

Distribution and Transmission Vegetation Management

The overarching requirement of a best practices vegetation management program is consistent funding at appropriate levels. Vegetation managers must obtain, maintain, and analyze comprehensive data from all aspects of their vegetation management operations and reliability performance to establish and justify an appropriate budget. They should also engage other internal operations to educate them and build support for their vegetation management programs. This might include involvement during the planning stages of new rights-of-way, line construction, upgrades, and other projects.

Finally, best practice utilities are evaluating pending threats and proactively making appropriate plans so that the number of disruptions to their operating plans is minimal. This involves studying the experiences of peers that have already faced game-changing events. Learning from other utilities' experiences like in the Midwest and West, which have seen tree populations devastated by EAB and pine bark beetle infestations is vital. Vegetation managers network with other utilities that have faced snow and ice storms, hurricanes, fires and other natural disasters to learn and incorporate best practices. Finally, best practice utilities evaluate their own system and considering how it might be changing too. For example, some cities have a history of planting a high number of the same tree species within the same time interval. As a result, utilities are confronted with an increase in their tree workload due to the tree population facing end-of-life deterioration simultaneously.

Summary

A best practice utility will:

1. Develop a sophisticated system of scheduling work when feasible: unequal tree risks and consequences across a system;
2. Have condition-based and reliability driven scheduling with maximum time-based backstops;
3. Adopt industry best practices (i.e., IVM, tree pruning, tree risk assessment, closed chain of custody);
4. Evaluate beyond the easement or right-of-way to address outside threats;
5. Develop a comprehensive communications (internal and external) plan for informing and educating key stakeholders;
6. Leverage advanced and new emerging technologies (e.g., LiDAR, TGR);
7. Create well-crafted incentives to drive the program (e.g., tree removal, safety, performance);
8. Implement an robust QA program;
9. Monitor performance against goals and use the results for continuously program improvement;
10. Support the industry's need to move from reliance on mere anecdotal evidence to a scientific basis for decision-making.