Facility Ratings Assurance
Best Practices –
White Paper

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Preface

The North American Electric Reliability Corporation (NERC) is a not-for-profit entity whose mission is to ensure the reliability of the bulk power system (BPS) in North America. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the BPS through system awareness; and educates, trains, and certifies industry personnel. NERC’s area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC is the electric reliability organization (ERO) for North America, subject to oversight by the Federal Energy Regulatory Commission (FERC) and governmental authorities in Canada. Entities under NERC’s jurisdiction are the users, owners, and operators of the BPS, which serves more than 334 million people.

The North American BPS is divided into several assessment areas within the eight Regional Entity (RE) boundaries, as shown in the map and corresponding table below.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>FRCC</td>
<td>Florida Reliability Coordinating Council</td>
</tr>
<tr>
<td>MRO</td>
<td>Midwest Reliability Organization</td>
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<tr>
<td>NPCC</td>
<td>Northeast Power Coordinating Council</td>
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<td>RF</td>
<td>ReliabilityFirst</td>
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<td>SERC</td>
<td>SERC Reliability Corporation</td>
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<td>SPP-RE</td>
<td>Southwest Power Pool Regional Entity</td>
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<td>Texas RE</td>
<td>Texas Reliability Entity</td>
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<tr>
<td>WECC</td>
<td>Western Electric Coordinating Council</td>
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**Introduction**

**FAC Alert Project**

Transmission line facilities historically were designed and built for long-term sustainability. The design of transmission lines has not been reviewed in light of current field conditions, and there is no outstanding requirement for such an analysis. As man-made developments and vegetation growth persist, the construction of transmission lines starts to deviate from their “as designed” status, which causes clearance violations between the lines and their surroundings.

While there were clearance buffers built into the original transmission line design, natural and man-made elements significantly contributed to reducing those buffers, which are invisible to the naked eye. Utilities have successfully maintained the vegetation growth in rights-of-way (ROWs) and easements. The “man-made elements,” like underbuilds, road signage, street lights, and ground-line grade changes, have proven difficult to prevent or regulate. As a result, the compromised transmission line clearances could potentially violate current facility standards and the original design assumptions, leading to increased risk to reliability of the BPS.

In October 2010, after an internal analysis indicated a reliability risk in facility clearances, NERC issued the *Facility Ratings Alert* (FAC Alert) as a recommendation to industry to determine the extent of the condition and address and mitigate issues with transmission line clearances. The FAC Alert project\(^1\) contains recommendations that entities divide their circuits into high, medium, and low priorities for assessment and mitigation, to be completed by year-end 2013. This provided a structured means for entities to address this project and report the progress to their respective Regional Entities. The Regions submitted the data to NERC and ultimately NERC reported\(^2\) the progress to FERC. NERC staff conducted webinars\(^3\) for industry after each report was posted. Participation in the FAC Alert project required significant amounts of time, resources, and finances for all involved. The entities that participated developed a good methodology for addressing the relevant reliability risks. While the obligation for entities to report to NERC has concluded, many entities will continue remediation efforts for the next few years. As well, some have put maintenance practices in place to help preclude the recurrence of similar issues and minimize the reliability risk posed to the BPS.

**Background**

The electric utility industry has a heightened awareness of transmission line clearance design—particularly ROW vegetation—since the 2003 Northeast blackout, as vegetation contact with a transmission line was one of the blackout’s initiating causes. As a result of the 2003 blackout, the industry shifted its focus to ROW/vegetation maintenance and transmission line clearance issues. Many transmission owners re-evaluated their programs and started assessing their transmission line designs versus as-builts. This report will highlight one entity’s successful efforts to proactively implement a risk-based approach to addressing transmission line clearance issues, prior to the issuance of the FAC Alert in October 2010. The entity (referred to in this report as “Entity”) has upwards of 15,000 miles of overhead facilities, with expansion projects planned that will develop an additional 1,000-plus miles of overhead facilities in the near future. The Entity assessed its transmission line maintenance program and found only a 95 percent confidence level in its existing program. The Entity’s enterprise organization thus determined to create a comprehensive program to address transmission line design and clearance issues in the transmission service territory while adhering to the Entity’s culture of compliance.

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\(^1\) Facility Alert Project - [http://www.nerc.com/pa/rrm/bpsa/Pages/Facility-Ratings-Alert.aspx](http://www.nerc.com/pa/rrm/bpsa/Pages/Facility-Ratings-Alert.aspx)


Assessment

Prior to the issuance of the FAC Alert, the Entity experienced a transmission line outage due to vegetation contact. After careful evaluation, it was determined that the clearance buffer between the line and vegetation had been compromised since the original design and construction. This prompted the Entity to closely monitor its ROW lines and implement a targeted program to assess and mitigate line clearance issues. In its assessment of the system and its intended design, the Entity found the documentation was less than adequate. For example, the design documents for ROW transmission lines didn’t show vegetation in and around the ROW. This made it difficult to assess the clearance settings of the transmission lines in the field and created the need to reassess all lines using cutting-edge technology like LiDAR. In 2009, the Entity decided to evaluate, assess, and document its design for transmission lines using LiDAR and continued using LiDAR to determine ratings uprate or derate. One of the best practices the Entity adopted was identifying the limitation for each span of the transmission line by using LiDAR data. As a result of this practice, each span was assessed and documented properly.

Transmission line ROWs are physically visible to other utility companies and the public, which makes them attractive for underbuild construction. The underbuilds on transmission ROWs had been documented on the Entity’s design documents only if the underbuilds were present at the time of the transmission line construction. Thus, the Entity had to document underbuilds (distribution lines, traffic lights, street lights, etc.) and distribution line crossings. According to the Entity, approximately 60 percent of the clearance issues that arose were from distribution crossings. The remaining clearance issues included, but were not limited to, vegetation, grading, material left under ROWs, ROW encroachment, and underbuilds. When the FAC Alert was published toward the end of 2010, the Entity was well underway in assessing its facilities. The FAC Alert merely prompted the Entity to expedite the LiDAR assessment process and start mitigation. Instead of following NERC’s advisory, which suggested assessing and mitigating transmission lines per priority (i.e., high, medium, and low), the entity adopted the concept of assessing all lines. They mitigated any discrepancies for each year in the three-year assessment period for NERC’s FAC Alert and refined the LiDAR parameters with each assessment. The Entity’s transmission engineering department worked closely with its substation engineering group and the Regional Entity transmission operator to lay out the plan to go forward; this included cooperation from all key players.

Survey

While LiDAR is a mature technology, assessing clearances for transmission lines proved to be an iterative process for the Entity. This is because LiDAR requires exact parameters that had to be tailored to and perfected for the Entity’s system. As an example, the pulse density used by the tool had to be tweaked on a repetitive basis, because it identified certain wire reflection locations that were above the real wire location and the transmission structure. Another example of a parameter issue was the angle depth to determine if the transmission structure was located in a swamp or wetland. Other parameter issues include the temperature of the wire, wind speed, and phase loading. Thus, multiple surveys conducted on one transmission line yielded different results, essentially forcing the Entity to perfect the survey tool until reproducible results were achieved. These results were verified by ground and manual surveys that further improved the quality of LiDAR surveys and results. In addition, in-house experts at the Entity used remote sensing technology that proved highly successful for developing a good survey product.

Modeling

The Entity used PLS-CADD™ (Power Line Systems - Computer Aided Design and Drafting) software to integrate its survey results and model the transmission lines. This advanced technology enabled the Entity to successfully document the design of its transmission lines capturing not only vegetation, but also crossings and underbuilds. One of the challenges the Entity faced was determining creep factors for the wires; creep factors varied based on temperature and loading of the line at various points in time. While working in coordination with PJM, the Entity

4 LiDAR technology is a remote sensing technology that measures distances by illuminating a target with a laser and analyzing the reflected light.
was also responsible for providing the second-most limiting conductor span. Use of LiDAR survey along with PLS CADD and robust in-house expertise allowed the Entity to accurately model transmission line designs. As mentioned above, the survey tool needed iterative tweaking, which was mainly discovered during the modeling phase. That essentially required modelers to verify data and mitigate errors by using either LiDAR again or using a ground survey. The clearances measured were then compared to the required clearance. The required clearances were based on the current National Electrical Safety Code (NESC) with the addition of a 6-inch buffer.

Mitigation
Completion of design, documentation, and modeling enabled the Entity to start planning its mitigation efforts in coordination with the Regional Entity transmission operator on a weekly basis. The Entity produced a mitigation “tool kit” for generic problems that were uncovered by the survey (i.e., for each issue, the Entity identified a specific mitigation technique). The safety of the public and Entity personnel, along with the reliability of the BES, were primary concerns for the Entity during all mitigating actions. Notably, the Entity adopted a risk-based approach. When a public safety concern was raised and confirmed, the Entity chose to man the ROW area of the line until clearances were mitigated or the line was derated. After issuance of the FAC Alert, the Entity heavily involved its project management team, which initially caused some drain on resources. The Entity worked closely with its real estate department in determining easements and ROW limits. The real estate department utilized an online SharePoint tracker for these facilities. Early in the mitigation efforts, the Entity was unsuccessful in obtaining a blanket waiver from the state Public Service Commission (PSC) for construction permits. The state defined “construction” in a broad term, which challenged the Entity’s efforts to mitigate clearance issues. Eventually, the Entity presented the state PSC with additional data and the scope of its work, which enabled the Entity to mitigate construction efforts more swiftly.

The Entity mitigated the transmission line clearance discrepancies by derating facilities as needed. And in coordination with PJM, it initiated taller construction of towers and insulators, lowered underbuilds, graded soil, removed public property improperly placed at the ROW, and mitigated line crossings with the distribution company. The Entity emphasized the need to coordinate with the Regional Transmission operator and its Reliability Coordinator—outages were not easily available on transmission lines at all times, and derating the lines worked well on a temporary basis for some cases.

Sustainability
The NERC FAC Alert project increased awareness of transmission line design and how it can impact the operation and reliability of the BPS. While addressing and mitigating discrepancies is a crucial piece of day-to-day operations, there is also merit in creating a sustainable assessment and mitigation program for any such project (e.g., the Entity decided to continue using LiDAR for vegetation management and line ratings calculations following the expiration of the NERC FAC Alert). Generally, procedures related to transmission line facility design and ratings were updated to incorporate all assessment and mitigation items. The future rerating process was significantly improvised to include the latest assessment and mitigation plans and procedures. This was a lesson learned for the Entity, as information regarding its easements was either unavailable or unclear at the beginning of the FAC Alert project. The Entity permanently adopted its tool kit concept and integrated it into its procedures. One major achievement in the Entity’s goal of institutionalizing the processes and procedures adopted for the FAC Alert was bringing awareness and educating the distribution company on facility rating standards and requirements.

Distribution companies and departments build their infrastructures under transmission facilities mostly by estimating clearance requirements based on NESC code. This results in a compromised transmission line clearance buffer as opposed to that established and built by the transmission company. The Entity in this case diligently worked with its distribution company to establish a new design philosophy and associated procedures on how, when, and why to approach the transmission company and real estate representatives to accurately document the design and as-builds for facilities.
Another example of process implementation is the Entity’s transmission engineering groups’ coordination efforts. One of the FAC Alert project’s major impacts was the immediate and temporary effect on operations and the reliability of the BES when lines were derated. The Entity’s operations, planning, and engineering departments worked closely with the Regional Entity transmission operator to coordinate outages and capital projects and ensured that the integrity of the BES remained intact. The Entity also realized the impact of derating and taking out facilities on neighboring entities. Awareness and institutionalizing knowledge drove the Entity to robustly address the FAC Alert and create a sustainable program that preserves reliability long term.

**Lessons Learned**

A significant hurdle for the Entity was perfecting the analysis methods using the LiDAR data. In the initial stages of the FAC Alert, LiDAR technology—even though significantly developed—needed to be perfected for transmission line applications. As previously mentioned, some parameters required an iterative process to perfect them for survey needs. Various conditions can play a role in the survey results of a transmission line by LiDAR, including conductor temperature, phase loadings, etc. The assessment phase of the project was lengthened by the need for redundant LiDAR surveys accompanied by ground surveys for verification. There is a clear need for improving LiDAR technology for electric utility applications.

Another issue emerged regarding non-utility encroachments. Public awareness of ROWs and their use needs to be addressed on a broader scale, as many parties use transmission line ROWs for equipment and other storage needs, which affects safety and reliability. This issue could be coordinated well with state PSC personnel.
Conclusion

NERC implemented the FAC Alert project after an internal analysis indicated a reliability risk in facility clearances. NERC issued the FAC Alert recommendation to determine the extent of the condition and address and mitigate issues with transmission line clearances. This allowed the industry to address facility ratings issues on their systems in an orderly fashion, with ample time, and without significant regulatory implications. The sole purpose for the manner in which the FAC Alert project was implemented was to preserve BPS reliability while addressing an industry-wide issue.

Prior to issuance of the FAC Alert, the Entity mentioned in this paper decided to address all the transmission facilities at the same time and mitigate any discrepancies while constantly improving their internal processes. The FAC Alert project increased the Entity’s awareness and realization of how important transmission line ROWs are to the reliability of the BPS. As a result, the Entity developed sustainable programs that will assist the Entity in future rerating and design processes. The Entity did an exemplary job in responding to the FAC Alert and cooperating with NERC and regional regulatory bodies.