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NERC Facility Ratings Alert Reveals Need for Enhanced Asset Data and Standardization of Work Management Processes

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SUMMARY

Ensuring the maintenance of safe electrical clearances between transmission facilities and distribution facilities in accordance with the National Electrical Safety Code (NESC) is an ongoing challenge for utilities across the nation. This challenge was emphasized by the conclusions drawn from the Facility Ratings Alert initially issued on October 7, 2010 by the North American Electric Reliability Corporation (NERC). "Transmission Owners" reported to NERC a total of 50,827 discrepancies (between actual field conditions and as-designed conditions), each representing a location with the potential to initiate an undesirable event on the bulk power system. Although unspecified in published reports, it is possible that up to 24% of these discrepancies involved relative clearances between transmission facilities and distribution facilities. The Tennessee Valley Authority (TVA) came to a more disconcerting conclusion: 52% of its "first-priority" discrepancies involved clearances to distribution conductors and/or supports, remediation of which was estimated at $2.0 million.

In response to these findings, and in acknowledgement of the absence of consistent documentation and historical asset data, TVA has implemented a new work management process that includes job-duty realignments, revised application and approval processes, and LiDAR-based as-built verifications. Previously, local power companies (LPCs) in TVA's service territory had submitted Foreign Line Crossing (FLC) applications and/or Joint-Use of Right-of-Way (ROW) applications to a regional Transmission Service Center (TSC). Whereas this process required evaluations to be performed by dispersed personnel and in a variety of fashions, the recently implemented work management process is aimed at centralization and standardization:

- The TVA ROW Department, which has historically managed vegetation encroachments, is now also tasked with collecting, processing, and coordinating all FLC and Joint-Use applications. TVA ROW utilizes the work management capabilities of SharePoint to initiate, assign, document, and track aspects of each application.
- TVA Transmission Line Engineering is assigned to the review and approval of applications. Reviews are conducted with the aid of PLS-CADD transmission line models, a library of which resulted from the Facility Ratings Alert and associated aerial LiDAR inspections.

- If approved and constructed, TVA Transmission and Operations Surveys is requested to obtain ground-based LiDAR of the as-built distribution facility.
- The LiDAR survey is then delivered to Transmission Line Engineering in order to determine acceptability and congruence with the design set forth in the FLC application. This determination is achieved by overlaying the ground-based LiDAR survey in the PLS-CADD transmission line model, and using finite-element wire models to predict conductor clearances under maximum operating conditions.
- If discrepancies between the submitted application and the as-built facility result in a clearance encroachment, the LPC is notified to make prompt modification.

The process summarized above evolved from TVA's response to the Facility Ratings Alert. Prior to the Alert, TVA had not leveraged ground-based LiDAR technology in this fashion. Now, in addition to supporting external LPC applications, TVA has adopted this technology to support internal capital expenditure projects in instances where knowledge of as-built conditions is critical to implementation.

The corrective actions detailed in this paper represent an investment effort by TVA to maintain the facility ratings that were determined during the Facility Ratings Alert, and to improve integration with the LPCs that captain an ever-changing distribution system in the Tennessee Valley service territory.

KEYWORDS

NERC, Facility Ratings Alert, Work Management Process, Clearance, LiDAR, PLS-CADD, Crossing

1. INTRODUCTION

Ensuring the maintenance of safe electrical clearances between transmission facilities and distribution facilities in accordance with the National Electrical Safety Code (NESC) is an ongoing challenge for utilities across the nation. Prior to the NERC Facility Ratings Alert, it was a challenge that was slowly coming into focus for the Tennessee Valley Authority (TVA), a public utility serving the residents of Tennessee and parts of six border states. By 2010, TVA was in year five of a twenty-five year program to increase the facility ratings of its transmission lines constructed prior to 1977. To support this "Uprate Program", TVA contracted the acquisition, and thermal assessment, of approximately 5,900 circuit miles of LiDAR survey between the years 2004 and 2006. It was becoming clear as each assessment was reviewed, project-by-project, that transmission-to-distribution clearance conflicts were not isolated occurrences. The industry itself was soon to arrive at a similar realization with the issuance of the Facility Ratings Alert ("the Alert") on October 7, 2010 by the North American Electric Reliability Corporation (NERC).

Responding to the Alert, officially titled *Recommendation to Industry: Consideration of Actual Field Conditions in Determination of Facility Ratings*, registered "Transmission Owners" identified and reported to NERC a total of 50,827 discrepancies (between actual field conditions and as-designed conditions), each representing a location with the potential to initiate an undesirable event on the bulk power system. It is possible, although unspecified in published reports, that up to 24% of these discrepancies involved relative clearances between transmission facilities and distribution facilities [1]. After completing its response efforts, TVA came to a more disconcerting conclusion: 52% of its "first-priority" discrepancies (a subset representing the worst discrepancies) involved clearances to distribution conductors and/or supports. Remediation of these discrepancies was estimated at $2.0 million.

During and after its response to the Alert, TVA developed a new work management process and other corrective actions to address the findings that pointed to a disconnect in coordination with its local power companies (LPCs; i.e., customers/distributors). In doing so, TVA relied on the standardization of processes and the leveraging of enhanced asset data. This paper details the evolution and implementation of these corrective actions.

2. TVA UPRATE PROGRAM

In 1977, provisions were added to the NESC under "Section 23. Clearances" that required utilities to consider the "maximum conductor temperature for which [a] supply line is designed to operate" in the assessment of conductor clearances [2]. Previously, the NESC had only required an "increased clearance" above the "basic clearance" that accounted for increased conductor sag up to a conductor temperature of 120°F (49°C) [3]. Because of this new requirement, and the growing power demands of the Tennessee Valley region, TVA began initiating "uprate" projects to accommodate higher conductor temperatures (increased facility ratings), as early as the 1980s. It was the U.S.-Canada blackout of August 14, 2003, however, and anticipation of subsequent mandatory standards, that compelled TVA to create an Uprate Program that would rely on aerial LiDAR survey.

In 2003, approximately 44% of TVA's 13,400-mile transmission system (161-kV and above) consisted of facilities designed prior to the 1977 NESC revision. This set of 5,900 circuit miles would be the primary focus of the Uprate Program. LiDAR acquisition of every program line was contracted between the years of 2004 and 2006, dispersed between four surveying contractors. In conjunction, 3-D modelling and thermal assessment by PLS-CADD was dispersed between three engineering contractors and TVA itself. In the thermal assessment of each circuit, model-predicted conductor clearances were checked relative to surveyed obstacles for compliance with the NESC. Conductor temperatures corresponding to both the existing facility rating, and the potential future rating were considered. Assessment results were provided to TVA Transmission Planning for review, and prioritization of project "in-service" dates, which would range from 2005 to 2030.

Although State-of-the-Art at the time, there were still deficiencies in aerial LiDAR survey circa 2005. It was quite common for a transmission survey to fail to acquire sufficient data on some foreign line crossings (FLCs) composed of smaller cable diameters. Black-jacketed cables and rusted cables were also difficult to acquire due to their low reflectivity. As a result, TVA's project process for each program line included engineering "walk-downs" to identify missing line crossing data and to supplement the aerial survey. Engineers obtained field measurements on undefined line crossings using cable height meters, and, if needed, developed a "Survey Request Package" for total station measurements by TVA surveyors. To assist in planning walk-downs, engineers would often reference a line's "Plan and Profile" drawing (TVA's primary record of easement and transmission design details) to compare historically documented line crossings with those captured by aerial survey. However, based on the results of LiDAR surveys and project walk-downs, it became clear after some time that the design documentation, and thus the design itself, did not always account for actual field conditions, in particular the as-built condition of FLC facilities. In numerous cases, these discrepancies between "as-designed" and "as-built" conditions resulted in transmission-to-distribution clearance conflicts.

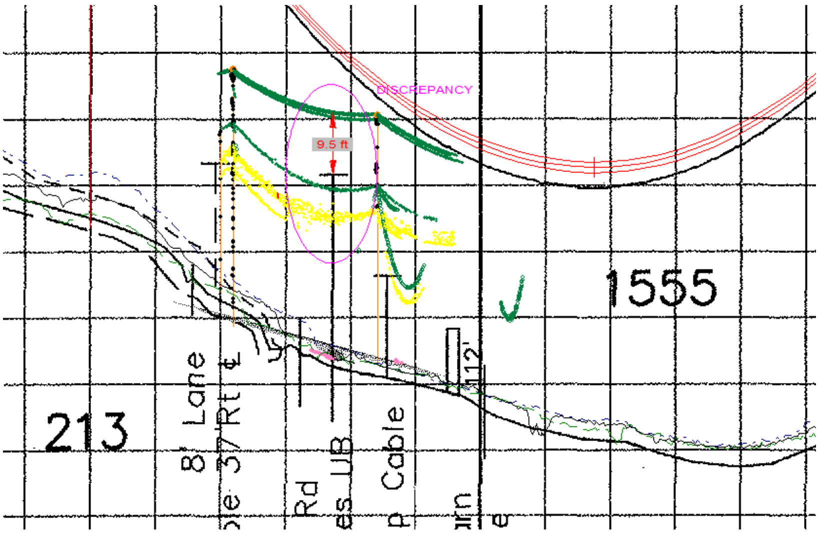

Figure 1: Aerial LiDAR Overlay on a TVA Plan and Profile Drawing Showing a 9.5-foot Elevation Discrepancy on an FLC

3. NERC FACILITY RATINGS ALERT

NERC became concerned about the potential for design/field discrepancies in 2007 when a utility self-reported two separate line outages, most likely caused by vegetation.

3.1. ALERT BACKGROUND

The outage events mentioned above occurred approximately one year after NERC was certified as the nation's "Electric Reliability Organization" by the Federal Energy Regulatory Commission (FERC). Given NERC-delegated authority, Regional Entities investigated the outages and found the utility to be in violation of Reliability Standards FAC-003-1, R2, pertaining to vegetation management, and FAC-009-1, R1, pertaining to facility rating methodologies. The utility proposed LiDAR survey and analysis as one of many remedial actions during the subsequent settlement agreements [4][5]. According to a preliminary summary of results publicly filed by NERC in April 2010, this effort identified 122 spans (out of 7,306 spans studied) with inadequate conductor-to-ground clearance [5]. These findings were enough to prompt NERC to issue the Facility Ratings Alert in October 2010.

In its official *Recommendation to Industry*, NERC stated:
Although vegetation caused the [aforementioned] fault, the subsequent evaluation indicated that the conductor-to-ground clearance was less than expected. This was due to substantial inconsistencies between the actual topography within the easement and the design of the line…NERC and the Regional Entities are concerned that Transmission Owners and Generator Owners have, in some instances, not considered existing field conditions when establishing facility ratings for transmission facilities, including transmission conductors. [6]

3.2. TVA RESPONSE TO THE ALERT

TVA, along with every other Transmission Owner in the U.S., was given three years to assess all circuits above 100-kV, identify any discrepancies, and develop remediation plans. TVA proposed the following action plan to NERC:

- Year 1 "High-Priority" (HP) assessments would include pre-1977 construction classified as 500-kV or otherwise critical to system operations.
- Year 2 "Medium-Priority" (MP) assessments would include the remaining lines constructed prior to 1977.
- Year 3 "Low-Priority" (LP) assessments would include lines constructed or upgraded after 1977.
- Remediation of any identified discrepancies, referred to internally as "Points of Interest" (POIs), would be scheduled according to severity:
    - "First-Priority" POIs, those displaying severe clearance conflicts and representing threats to system reliability and operability, would be remediated within one year of identification.
    - "Second-Priority" POIs, those failing to meet NESC requirements by more than one foot, would be remediated within ten years of identification.
    - "Third-Priority" POIs, those having clearances within one foot of NESC requirements, would be remediated in coordination with future capital and/or maintenance projects.

Fortunately, in executing its action plan, TVA had 5,900 miles of usable LiDAR data from the Uprate Program that would assist in completing the vast majority of Year 1 and Year 2 assessments; still, this left approximately 7,500 circuit miles that required aerial inspection. In addition, because of the improvement in assessment tools and methodologies that had occurred since initiation of the Uprate Program, TVA decided to revisit the assessments previously completed under that program. Assessments were once again divided between contract partners and TVA due to the enormity of the undertaking; and, while regulatory in nature, an additional benefit of such efforts would be an updated library of PLS-CADD line models that would assist in countless future engineering activities.

3.3. TVA FINDINGS

TVA completed the entirety of its assessments in December 2014, gaining a one year extension after sustaining severe storm damage in April 2011. Throughout the assessment process, data compilation and review was focused heavily on First-Priority POIs (FP POIs) due to their short remediation schedule. In total, TVA identified 342 FP POIs on 190 individual circuits; 178 of the total 342 were classified as discrepancies involving distribution facilities. **Table A** below presents a more detailed break-down of TVA's findings. The results of the NERC Alert emphasized to TVA that changes were necessary to improve coordination with its local distributors.

Table A: Table Break-Down of TVA Alert Findings with Emphasis on "First-Priority" Points of Interest (FP POIs) involving Local Power Company Facilities (i.e., Distribution Crossings)

	Lines	Miles	First-Priority POIs	Internal FP POIs	External FP POIs	LPC FP POIs	LPC % of FP POIs
Y1 (HP)	98	3,183	41	19	22	20	48.8%
Y2 (MP)	166	4,469	93	41	53	46	49.5%
Y3 (LP)	405	6,467	208	55	153	112	53.8%
TOTAL	669	14,119	342	115	228	178	52.0%

4. CORRECTIVE ACTIONS

In response to its Alert findings, TVA developed several corrective actions pertaining to transmission-distribution coordination, each of which evolved from the experiences garnered during the Uprate and NERC programs. Arguably one of the most significant of these, is the new work management process pertaining to Foreign Line Crossing and Joint-Use of Right-of-Way Applications ("FLC Process"). Albeit, the FLC Process itself is an accumulation of other changes and developments that preceded it. For this reason, the Process is presented below in sections correlating to broader corrective actions.

4.1. REVISED ROLES AND RESPONSIBILITIES

In a retroactive sampling of seventy-four (74) FP POIs involving distribution facilities, approximately 50% of the facilities were either absent from the TVA Plan and Profile drawing or were depicted in a manner significantly different than the as-built condition. Due to the historical decentralized approval process, it was difficult to discern how many of these 74 installations were constructed/modified without TVA consultation; an unfortunate reality that called for internal and external collaboration to ensure future compliance. TVA Customer Service Engineers (CSEs), who maintain direct contact with LPC personnel, have since been encouraged to frequently communicate the importance of submitting FLC applications for TVA review and approval. Optimistically, the Alert has brought visibility to the potential consequences of unapproved installations. On the other hand, it is possible that some of the undocumented crossings were indeed reviewed by local TVA Transmission Service Centers (TSCs) and never added to the design documentation due to inadequate internal processes. The historical practice utilized by LPCs was to present crossing plans to the local TSC using a dated "Foreign Line Crossing Form". TSC personnel were then requested to review and approve the applications. While TSC personnel generally had the necessary skills to perform such tasks, the best tools and asset data were not at their immediate disposal, and the central Transmission Line Engineering Department was engaged only on exceptional occasions. For the new FLC Process, revised roles and responsibilities were established to ensure proper management of this critical activity.

In conjunction with a company-wide review of organizational structure in 2014, TVA's Transmission Right-of-Way (TVA ROW) Department was designated with governance, oversight, and execution of all civil-easement activities, including foreign line crossings. TVA ROW was heavily involved in the remediation of NERC FP POIs through supporting construction-access identification, property-owner notifications, and visual verification of external modifications. Thus, the department was greatly aware of the challenge set before them. While geographically dispersed in a manner similar to the TSCs and CSEs that had previously managed line crossings on a local basis, TVA ROW sought to centralize and standardize the FLC Process. To this end, the following workflow was developed:

1) TVA ROW collects, processes, and coordinates all FLC and Joint-Use applications.
2) TVA Transmission Line Engineering (TL ENGR) reviews and approves/denies applications with the aid of PLS-CADD transmission line models.
3) TVA ROW notifies the LPC of approval/denial of application.
4) If construction of the distribution facility is approved, the Transmission and Operations Surveys Department (TVA Survey) obtains a ground-based LiDAR survey of the completed (as-built) distribution facility and delivers the survey to TL ENGR.
5) TL ENGR determines the acceptability of the installation, and congruence with the design set forth in the FLC application.
6) If discrepancies between the submitted application and the as-built facility result in a clearance encroachment, TVA ROW notifies the LPC of remediation requirements. Work steps 4 through 6 are repeated as necessary.

The primary tool utilized in the management of the above workflow: Microsoft SharePoint.

4.2. BETTER DATA AND WORKFLOW MANAGEMENT

TVA compiled little metadata during the Uprate Program to assist in the interpretation of assessment results. For this reason, the course of identifying and developing corrective actions was drawn-out. Assessment results during the Uprate Program were generally isolated to an individual spreadsheet summary for each program line. Annual cost estimates were the only avenue in which efforts were made to assemble the broader impacts of the findings.

NERC reporting requirements for the Alert worked to encourage better data compilation and management during TVA's response efforts. High-level spreadsheets were developed to track the dates/details corresponding to: assessment statuses and results, discrepancy types and owning entities, action items and responsible personnel, cost accounts and estimates, along with other pertinent information. In compliment to these records, Microsoft SharePoint was also leveraged to organize and share line-specific results and supporting documents. This was a tremendous improvement over former attempts that revolved largely around e-mail and compact disc storage. All contributing departments within TVA were given the capability to access, view, update, and supplement the same central information.

These improvements in the creation and handling of data allowed TVA to recognize and quantify instances of unsuccessful transmission-distribution coordination, and thus were instrumental in addressing the issue. As such, the FLC Process has also adopted the use of SharePoint. In addition to utilizing the organization and sharing aspects of SharePoint, the FLC Process takes advantage of its XML forms and work management features.

Attached as Appendix A is the standard form that is used alongside each submitted FLC application. Generated within SharePoint, the XML form is initiated by TVA ROW. It allows the local "ROW Forester" to (a) record contact information for the requesting LPC, (b) identify the location of the proposed FLC, (c) assign TVA personnel to the required support activities, (d) upload LPC crossing plans, and (e) track the status of individual work steps. Assigned personnel can be automatically notified by SharePoint through e-mail, and reminders can be customized to ensure assigned tasks are completed and marked on the electronic form. Effectively, SharePoint can be leveraged to *manage* the work *management* process.

Understandably, external distributors are managed less effectively by the tools above. In order to facilitate better working relationships its customers, TVA has focused on improving communication.

4.3. IMPROVED COMMUNICATION

It became apparent during the early stages of TVA's Alert efforts that communication between TVA and its LPCs required much improvement, in both directions. As previously mentioned in Section 4.1, TVA CSEs have continued to emphasize two-way communication and other lessons learned since the Alert. One item that TL ENGR stressed to CSEs for greater attention was the concept of thermal travel. Thermal travel is the sag increase in a conductor as it heats and elongates while approaching the maximum operating temperature that corresponds to the circuit's facility rating. LPCs, accustomed to designing distribution lines with average span lengths on the order of 200 feet and single-digit conductor sags, found it difficult to account for the thermal travel of an overhead TVA facility. A transmission conductor spanning approximately 1000 feet might have 35 feet of ground clearance when measured in the field by an LPC, but only 25 feet when modelled at the conductor's maximum operating temperature. It appeared that a greater understanding of this concept may have prevented many of the clearance conflicts that were identified during TVA's line assessments.

When a transmission-to-distribution clearance conflict was identified during an assessment, there existed much room for improvement in the manner which TVA requested distribution facility modifications. "LPC Modification Requests" generated under the Uprate Program were quite inconsistent: some were generated by Transmission Line Engineering, some were generated by Transmission Planning; some were very detailed, some were limited to a few sentences in an e-mail, such as "between TVA Structures 1 and 2, lower distribution crossing by five feet". The lack of direction on TVA's part resulted in LPC modifications that sometimes solved one clearance conflict, yet created another. On more than one occasion it was determined that in order to achieve a TVA requested wire elevation, an LPC installed a new pole support within the wind-displaced clearance envelope of a TVA conductor. TVA quickly standardized its LPC Modification Request memorandum and called upon TL ENGR to include detailed descriptions of conflicting facilities and appropriate recommended solutions. **Figure 2** below is an excerpt from a Modification Request representing the expected instructional content, which must be supplemented by illustrations and/or photographic imagery.

> The crossing of interest is comprised of three phase conductors and a neutral. It is proposed that the local power company (LPC) take one of two recommended courses of action:
>
> Option A) Lower the circuit by 6 ft at the point of interest, such that:
>
> - the circuit is no higher than 30 ft above ground below the west TVA phase, AND
> - the circuit is no higher than 32 ft above ground below the east TVA phase (one method of achieving this would be simply lowering the wire attachments on the western pole (Pole 1) to an elevation no higher than 27 ft above ground;
>
> OR
>
> Option B) Bury the circuit across the entire width of the TVA circuit.
>
> If the LPC requires that new pole structures be installed to accomplish this request, the location of such should be coordinated with, and approved by, the TVA personnel listed below. The LPC should ensure that their modifications do not create an additional clearance issue with the TVA conductors.

Figure 2: Excerpt from an Actual Modification Request Memorandum from TVA to a Local Power Company (LPC)

The standards of communication reflected in **Figure 2** have rolled into the new FLC Process, as well. LPCs are requested to provide a similar attention to detail (including sketches or drafted plans) in submitting FLC applications. The more information an LPC provides in its application, the more likely TVA can handle the application expeditiously. Additionally, if a crossing application is denied due to TVA clearance limitations, or if as-built survey verification reveals a problematic discrepancy, a memorandum congruent with the above is produced as shown in **Figure 3**.

Our recommendation to remediate the crossing plan "**NOT APPROVED**" is to (a) revise and resubmit the proposal such that the 14.4-kV circuit crosses perpendicular to the TVA centerline at a location within 50 feet of TVA Structure 557, in accordance with the comments on **CED-1321, Sheet 2**; OR, (b) place the 14.4-kV circuit underground.

Figure 3: Excerpt from an Actual TVA Response to a Foreign Line Crossing (FLC) Application

TVA has noted success in its effort to improve LPC communications as indicated by the annual "Voice of the Customer" survey. Each year LPCs are asked to rate TVA on numerous criteria using a ten-point scale. In April 2014, sixty-nine percent (69%) of LPC customers gave TVA a "9" or better for "Communications", despite TVA being in the midst of conducting Low-Priority NERC assessments *and* remediating FP POIs identified during the Medium-Priority assessments. Only 53% of LPCs provided such scores the year prior. In April 2015, further improvement was noted as 77% of LPCs rated TVA as "9" or better.

A particular element that aided TL ENGR in the provision of effective communications during this timeframe was enhanced asset data.

4.4. ENHANCED ASSET DATA

The LiDAR survey acquired between 2004 and 2006 gave TVA unprecedented insight into the state of its transmission system. It allowed TVA to model its transmission supports and conductors with great accuracy while also providing three-dimensional definition of many of the obstacles present on TVA easements. However, as discussed in Section 2, there was still room for improvement.

In order to conduct thermal assessments for Low-Priority NERC lines, TVA acquired aerial LiDAR survey on approximately 6,200 circuit miles between the years 2012 and 2014. Predictably, this batch of surveys proved to be a great advancement over those acquired for the Uprate Program. Technological advancements provided increased density, detail, and extent to acquired LiDAR data. As one point of reference, TVA's LiDAR specifications during the Uprate Program typically stipulated a survey point density of fifteen points-per-square-meter (15 ppsm); specifications used for Low-Priority acquisitions required 25 ppsm, with many contractors exceeding the value significantly. Additionally, contractors were able to acquire wider corridors of data than in the past, which was particularly beneficial in defining crossing wire attachment points on supports located outside of the TVA easement. Knowledge of such attachment configurations was instrumental in communicating clear and accurate recommendations within an LPC Modification Request.

The increased definition of modern LiDAR provided TL ENGR with a more complete picture of its own physical assets, and of the physical obstacles located on TVA easements. It also improved confidence levels in the determination of less tangible critical attributes, such as conductor tensions, clearances, and facility ratings. Maintaining confidence in these attributes, however, requires recurring survey activities to ensure the availability of valid data in an ever-changing environment.

In 2015, TVA Survey justified the purchase of a second ground-based LiDAR unit as an investment in facility ratings. With a second unit available, as-built verifications, specifically of distribution facilities, had become not only possible but practical. The difficulty with conducting survey verifications with traditional instrumentation was the fact that it required the surveyor to possess knowledge of the exact field changes in order to determine the necessary targets; unfortunately, LPCs did not always communicate this information, nor did they always execute TVA's exact recommendations. In contrast, a LiDAR scan provides a panoramic point-cloud defining every unobstructed feature (within range) relative to the instrument's perspective. So, to keep the recently developed line models up-to-date, TVA Survey performed LiDAR scans on many of the LPC modifications requested for Low-Priority NERC lines (see **Figure 4** for example). Out of eighty-eight (88) field verifications conducted by TVA Survey on FP POIs, nine (9) were not modified in accordance with TVA requirements and required additional attention.

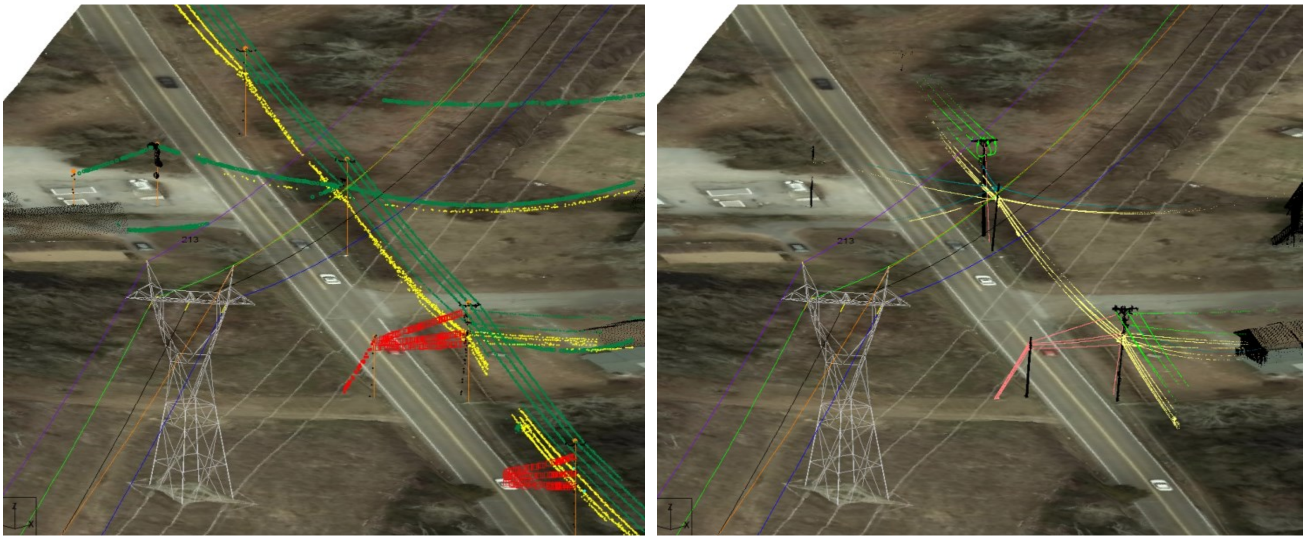

Figure 4: 3-D PLS-CADD Model Views of a TVA Span; Aerial LiDAR Survey (Left) Used for Modelling and Assessment, and Ground-Based LiDAR Survey (Right) Acquired after LPC Modification of Conflicting Distribution Facility

Stemming from the Alert response efforts above, the practice of LiDAR-based as-built verification has become the cornerstone of TVA's new FLC Process. It is an effort to obtain an accurate basis for documentation on design drawings. It is also, and primarily, an effort to confirm that external construction variances do not create a reliability or safety concern for the bulk electric system. Past experience has proven as-built verifications to be critical, as well as simply a matter of good practice. Indeed, NERC highlighted such verifications in a December 2015 publication titled *Maintaining Transmission Line Ratings Consistent with As-built Conditions: Good Utility Practices* [7].

5. CONCLUSION

Transmission line rights-of-way are a dynamic entity; change is inevitable. TVA recognized that its recent investments in aerial LiDAR survey could quickly depreciate if certain changes weren't properly accounted for. In particular, TVA's Uprate Program and Alert response efforts made clear that transmission-distribution coordination was a significant problem area. In reaction, TVA focused on corrective actions pertaining to (1) revised roles and responsibilities, (2) better data and workflow management, (3) improved communication, and (4) enhanced asset data, all of which contributed to the development of a new work management process for Foreign Line Crossing and Joint-Use of Right-of-Way Applications.

The process, initiated in 2015, has thus far seen 235 total application submissions, with 55 relating to LPC foreign line crossings. The remainder of these applications pertain to items such as joint-use proposals, underground crossings, land developments, etc.; basically any external activity that might compromise transmission facility ratings. Historically, none of these applications would be available in a central location, and each might be addressed with a non-standard workflow. The new FLC Process is a means of centralization and standardization.

Arguably, the most important aspect of the FLC Process is as-built survey verification. Experience has proven that design reviews are simply not enough to ensure adequate installations. Construction variances are inevitable and their documentation is critical. In this case, TVA is employing ground-based LiDAR units to define newly constructed/modified distribution facilities and supplement existing asset data. Meanwhile, TVA is continuously seeking new solutions and other applications for this "good utility practice".

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APPENDIX A

Transmission & Power Supply - ROW

Foreign Line Crossing and Joint Use Request

DESCRIPTION

UNIQUE KEY	REQUESTED NEED DATE	REQUESTOR	FISCAL YEAR	TYPE OF CROSSING
00236		Select...	Select...	Select...

REQUESTOR CONTACT INFORMATION

NAME	COMPANY	ADDRESS

PHONE	EMAIL ADDRESS

LOCATION

ROW REGION	REGIONAL FORESTER	SECTOR FORESTER
Select...		

LINE NUMBER	SEGMENT NUMBER	NERC ALERT (Y/N)
		Select...

FALLS BETWEEN				
	RELATIVE STRUCTURE		and	
	MAXIMO LOCATION		and	

TRACT #	LATITUDE	LONGITUDE

STATE	COUNTY

REVIEWS NEEDED

LINE ENGINEERING REVIEW NEEDED?	☐	CONTACT		
TSM/SYSTEM ENGINEERING REVIEW?	☐	CONTACT (TSM)	CONTACT (SE)	CONTACT (SE2)
IS SURVEY VERIFICATION NEEDED?	☐	CONTACT		
PLANNING REVIEW NEEDED?	☐	CONTACT		

OGC REVIEW COMPLETED

IS OGC REVIEW REQUIRED? Select... OGC REVIEW COMPLETED? Select...

COMMENTS

ATTACHMENTS

ATTACHMENTS? ☐

APPROVAL & VERIFICATION

PLANS STATUS	DATE	COMPLETION	VERIFICATION TYPE	VERIFIED BY	DATE
Select...		☐	Select...	Select...	