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A Rapid Response to the NERC Facility Rating Methodology Alert

WHITE PAPER

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INTRODUCTION

The United States has more than 373,000 miles of 100 kV or higher electrical transmission serving more than 300 million people. It is one of the finest engineering achievements of the 20th century and the single largest machine ever built. Operating that machine comes with inherent challenges and is a function of manpower, technology and politics.

On August 8, 2005, politics impacted the machine when President George W. Bush signed the Energy Policy Act of 2005 (EPAct) into law. The Electricity Title (XII) of the EPAct calls for the development of an Electric Reliability Organization (ERO) reporting to the Federal Energy Regulatory Commission (FERC) and the implementation of mandatory and enforceable electric reliability standards. The National Electric Reliability Council, founded in 1968 in the aftermath of the major 1965 blackout in the northeast United States, was an industry-sponsored, voluntary organization responsible for coordinating guidelines for operating and planning the North American transmission system. It became the North American Electric Reliability Council in 1981 in recognition of Canadian participation. When the EPAct became law, the council submitted the sole application to become the congressionally mandated ERO and was certified the new ERO by FERC on July 20, 2006. The North American Electric Reliability Council became the North American Electric Reliability Corp. (NERC) in 2007.

A NERC investigation of a recent outage revealed widespread discrepancies between the allowable operating temperatures of conductors related to line clearances and the actual line clearances in the field. These discrepancies compelled NERC to issue a Facility Ratings Methodology Level 2 Alert[1] on October 7, 2010, to all electric utility industry transmission planners, owners and operators. This alert requires the identification of possible discrepancies between the design and actual field conditions of all transmission assets over 100 kV. The time frame to plan and execute the work was aggressive and was subsequently modified to require plans by January 18, 2011[2]. The assessment and report of discrepancies is due to NERC on a prioritized (high, medium and low) basis by the end of 2011, 2012 and 2013, respectively. Field remediation, if any, is to follow each prioritized assessment within one year unless otherwise allowed by the regional entity (regional transmission organization or independent system operator). NERC expects to review each transmission owner's facility ratings methods and tolerances verifying line clearances based on actual field conditions to assess the full extent of discrepancies that could impact system reliability. NERC's goal is to systematically identify the scope of the potential problem, prioritize corrective action to best maintain reliable system operation, and raise overall industry understanding and awareness of the need for continuous knowledge of accurate field conditions to include vegetation, encroachments, design deviations and other issues as they relate to conductor clearances and, ultimately, maximum operating temperatures and line ratings.

A rapid response to the alert entails several phases of work:

- A plan by January 18, 2011
- A prioritized assessment due at the end of each year from 2011 through 2013
- Subsequent remediation within one year through 2014 (or beyond)

This white paper proposes a project approach for each work phase in an attempt to provide a responsible framework for a compliant response to NERC.

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1 http://www.nerc.com/fileUploads/File/PressReleases/PR%20Facility%20Ratings%2007%20Oct%2010.pdf
2 http://www.nerc.com/files/Facility-Ratings-2-112910.pdf

THE PLAN

The preparation of a plan for compliance should be based on the transmission asset owner's current construction and maintenance practices. Construction practices that include well-documented inspections and accurate as-built drawings can form the basis of a reasonable plan for submittal to NERC. The plan should state that a prudent initial investment to verify that transmission line construction is in accordance with design plans and specifications gives the owner a great measure of confidence in the accuracy of line clearances and resultant thermal ratings.

Further, a strong vegetation management program and regular aerial or climbing inspections should give the utility and NERC a fair degree of confidence in the accuracy of line clearance ratings. Finally, many utilities have recently engaged in thermal re-rates of transmission lines for economic and reliability purposes. This re-rate work should be highlighted for NERC.

However, these elements might be logical criteria for selecting assets to be analyzed and verified for compliance:

- Failure to locate any physical drawings
- Lack of **accurate** as-built drawings
- No previous Light Detection and Ranging (LiDAR) history
- Very old assets (over 50-60 years)
- Changes in construction management practices
- Specific knowledge of issues with certain circuits, line segments or conductor types
- Areas of heavy urban encroachment
- Areas prone to heavy vegetation

Once the body of data is evaluated and line assets to be verified for compliance are determined, the utility might consider a random sample check of those assets excluded from the work plan to prove the validity of the asset selection process. The random sample would include a fair mix of line age, location, voltage, ruling span and conductor type representing no more than 1 percent of the excluded circuit miles.

Once satisfied that the plan contains strong justification for the assets selected and not selected for analysis, the asset owner must prioritize the assets into high, medium and low categories. This prioritization will demonstrate to NERC the lines or segments most likely to impact the next season's reliability and where resources will be focused. The asset owner should leverage all it knows about the assets, including previous outage history, line loading patterns, site access (entry permits), planned facilities upgrades, system operations practices, and inspection and maintenance records. Transmission system planners may contribute to this process by identifying critical lines and operational contingencies that make some lines obvious choices for higher priority attention. Once the plan is submitted, the utility can analyze the highest priority assets. Burns & McDonnell has developed a rigorous plan that may make sense for transmission line asset planners, owners and operators.

THE PRIORITIZED ASSESSMENT

Once the overall plan and system prioritization has been developed, the challenge of implementing the assessment program begins. There are many initial implementation considerations and strategies that each transmission asset owner will have to address at the beginning of this process, such as:

1. **Internal vs. External Resources**
   Depending on the size of the transmission system, survey procurement, deliverables management, line modeling, and analysis and reporting of results can require significant staffing. Each transmission asset owner will analyze staff availability to determine whether external resources are required to meet NERC requirements.

2. **External Partnership Strategies**
   If external resources are required, a plan for contracting these services should be established. Because of the unique market conditions and a finite capacity of surveying and engineering resources, it can be beneficial to establish an industry partnership. As a partnership, the owner, surveyor and engineering components can work together to tailor an implementation strategy to meet the specific needs of the transmission asset owner. With this approach, staffing commitments can be made in advance and rates can be negotiated to ensure they are within the owner's goals.

3. **Initial Remediation Strategy**
   Although the initial focus has been on the assessment, when developing an implementation strategy, the transmission asset owner must also address violation remediation. The NERC recommendation states that violations should be resolved within one year of identification. Because the extent of necessary remediation is unknown before the assessment, it is not possible to initially establish a detailed plan. However, a partnership may offer the team commitment and pricing strategy to immediately transition committed resources into violation remediation. An initial engineering evaluation can even be incorporated into the assessment activities to assist in planning and transitioning to the remediation phase to accommodate the NERC timeline.

Upon final selection of a project team, it is necessary to promptly establish a comprehensive project approach. This approach should be tailored to meet both NERC requirements and the owner's established objectives. It should, at minimum, include these steps:

1. Finalize a project schedule and detailed staffing plan to meet the owner's established line prioritization requirements. The schedule should outline all necessary deliverable dates to ensure the project team remains engaged. Critical schedule tasks include receipt of required line design data from the transmission asset owner, receipt of processed survey data, development of required PLS-CADD models, quality control, and analysis and reporting activities.

2. Establish a comprehensive design criteria report to govern the required survey and engineering analysis. This criteria should be defined with close coordination between industry- and owner-established requirements and shall include:
   a. National Electric Safety Code and General Order 95 requirements
   b. Owner-specified clearance requirements
   c. Survey specifications defined by the project team
   d. Specific line segment design criteria, such as voltage class, conductor data and line ratings
   e. A template for the assessment report based on NERC reporting requirements and owner preferences

   This design criteria report will serve as a consistent basis for all required surveying, modeling and engineering efforts.

3. Procure a survey contractor to provide a LiDAR survey along all required transmission corridors. The contractor shall acquire and process survey data according to the project

schedule and established design criteria. Depending on owner preference, this can be completed by the engineering contractor or by the owner. Regardless of procurement responsibilities, the owner, engineering contractor and surveyor should be in regular contact to coordinate project requirements and progress updates. When selecting a survey contractor, it is critical that the project team review and confirm potential risks areas:

   a. Availability of required data acquisition and data processing staffing to support project schedule requirements
   b. Confirmation of project-specified survey requirements, including necessary survey control activities, "ground truthing" or data verification activities, and feature code requirements
   c. Identification and definition of all additional survey risk areas that have potential to affect the project schedule or budget, including weather limitations.

4. Obtain regular deliveries of processed LiDAR survey data in PLS-CADD format as defined in the project schedule. The intermediate deliverables are essential for streamlining the assessment and keeping the project team engaged.

5. Establish a PLS-CADD model for each line segment. This model should be established based on the developed project design criteria and obtained survey data.

6. Model PLS-CADD Method 1 structures along each studied transmission line route to simulate wire attachment heights and structure locations based on survey data. Detailed finite structure models are not required for this NERC assessment. If directed by the transmission asset owner, this level of modeling would further define the structural reliability of the existing line segments based on existing conditions.

7. Model conductor catenaries in PLS-CADD for each transmission line. This effort is to be based on survey information about the conductors, conductor design information and circuit loading information provided by the asset owner. This loading information should be obtained at the time of flight and can be collected on an information form.

8. Conduct a quality review of the developed models through an independent, qualified engineer. This step is critical to ensure that the developed models and ensuing analysis accurately reflect the survey conditions and established design criteria.

9. Analyze each line segment for desired thermal loading conditions and determine any clearance violations under the established design criteria. Clearance violations should be identified and assessed to determine their extent and cause.

10. Report line performance under the approved temperature/weather scenarios and provide maximum operating temperature for the line based on surveyed line condition, calculated sag and required clearances. A report will be generated based on the report template established with the owner to summarize the findings from this analysis.

11. Provide these deliverables for each line segment based on asset owner needs:
   a. PLS-CADD model for each line segment
   b. Summary report outlining the line performance and violations for each line segment
   c. Plan and profile drawings, as required
   d. Any other details required to meet owner-specific NERC objectives

12. Develop a detailed engineering approach for remediating applicable clearance violations and/or engineering drawing inconsistencies.

Because of the effort required to satisfy this process, owners should take measures to fully realize the value and potential of the information. Although shortcuts exist, focusing on the accuracy and thoroughness of the survey, in addition to the quality of modeling, will allow the owner to come away from this process with a complete, up-to-date inventory of transmission facilities. This information is not only useful to streamline future line engineering activities, it can be extremely valuable across the organization for planning, line routing, environmental permitting, land ownership records, public involvement comments, design, construction access, and inspection and maintenance records.

To make this information more readily accessible outside the framework of PLS-CADD, existing plans and profiles can be updated to reflect existing conditions. The data can also be made available through mapping and/or geographic information system (GIS) applications. One tool that capitalizes on GIS is Burns & McDonnell's patented OneTouchPM®.

OneTouchPM® integrates engineering design information into a 3D virtual model based on a Google Earth interface. By pulling information from several systems and combining them in a single, easy-to-use interface, OneTouchPM® delivers critical information to decision makers and project stakeholders. The Google Earth proprietary method of streaming large amounts of geospatial data allows remote users to access information in near real-time. It integrates data from ArcGIS, PLS CAD, MicroStation, AutoCAD, Primavera and Expedition with the Google Earth interface.[3] OneTouchPM works well for large-scale, multiyear efforts like the NERC alert compliance response.

REMEDIATION

The planning , assessment and remediation for the alert will be a major, multi-year effort for some transmission asset owners. Remediation work may include reconductoring, taller structures, removal of distribution crossings, removal of encroachments, target vegetation management, conductor monitoring, strategic switching or line re-rating. Dollars spent may be considered O&M or capital, and the remediation plan should carefully consider the difference. Fundamentally, three methods can deliver major projects (or programs), each with several variations to match with the owner's needs and corporate culture:

- Design-bid-build
- Engineer-procure-construct (EPC)
- Program management

Design-Bid-Build

The design-bid-build process is often referred to as the traditional approach or the multiple-contract approach. Multiple construction contracts are bid and awarded as lump sum projects based on plans and specifications prepared by an engineer. The project owner hires the design engineer, purchases equipment directly and hires one or more contractors to perform the construction under separate contracts. The contracts are structured to allow multiple specialty contractors to perform the trade-related work in an effort to minimize subcontracting and reduce contractor markups. The engineer may help to pre-qualify contractors and may make recommendations on contractor selection.

[3] For more information, see www.burnsmcd.com/onetouchpm.

EPC

The terms EPC, design-build and turnkey are generally synonymous in the transmission industry. They describe a project delivery approach in which the owner defines the project and hires a contractor with total responsibility for the detailed engineering, procurement, construction and coordination of all project work. The owner pre-qualifies bidders based on related project experience, bonding capability, safety record, etc. The owner prepares a specification for bid by three to five pre-qualified EPC teams. The bidder performs conceptual design and preliminary engineering to estimate the material quantities required for the project and obtains prices for equipment from suppliers. Construction pricing may be from the contractor's own experience or from quotations from potential subcontractors. The EPC contractor selects the equipment and construction subcontractors who provide the best value to the project from the EPC contractor's perspective while still meeting the requirements of the owner.

The EPC contractor self-performs the detailed design or subcontracts it to an engineering firm. The EPC contractor is the *general* contractor. Typically, the contractor's strategy is to purchase equipment and material directly from the supplier, eliminating subcontractor markups. The EPC contractor will contract directly with specialty contractors for the construction work not performed by its own personnel. The scope of each subcontract is defined as clearly as possible to reduce the likelihood of change orders from the EPC contractor. The final project cost from the EPC contractor to the owner will include fees and expenses for providing the overall project management, accepting and managing project risks, and recovering the substantial cost of preparing the initial EPC proposal(s) to the owner.

Program Management

The program management approach provides for meeting all of an owner's project delivery needs related to a large and complex effort involving the construction of multiple facilities over several years. The owner may choose to use internal resources for program management or, if the owner has limited resources, the owner may hire an outside resource as program manager. The program manager can be a construction general contractor or a consulting engineer, in which case, the program manager is commonly referred to as the owner's engineer. The program manager is an agent of the owner and serves as a single point of management for the entire process of completing the project(s).

The program manager provides detailed managerial support and added technical value to the owner and is normally involved in the earliest stages of a project. A program manager offers current planning methodologies, public involvement and testimony capabilities, design expertise, knowledge of construction methods and pricing, an understanding of competitive market conditions, and effective scheduling and cost control systems. Program management is successful when the project's planning, permitting, design and construction phases are effectively integrated into a single process. The program manager can deliver a project(s) with consistently successful results in several areas of measurement over the course of several years by developing an overall master plan for the project(s).

The remediation effort(s) may use several methods of project delivery. Each method may have advantages or disadvantages with regard to scope, schedule and budget and each must be evaluated in the context of the NERC deadlines for compliance.

CONCLUSION

NERC has very clear expectations and goals for the Facility Ratings Methodology Alert. A plan, a prioritized assessment and a multi-year remediation effort will require significant time and funding for transmission asset planners, owners and operators already facing the challenges of providing safe, reliable, affordable electric power in a compliant manner.

Future design and asset management practices must recognize the advancements in LiDAR technology, design criteria and GIS tools such as OneTouchPM® for the value they bring in meeting such challenges. Future construction practices must recognize the methods of project delivery available to transmission asset owners that facilitate the completion of complex, long-term and broadly scoped projects in a safe, timely and cost-effective manner.

Burns & McDonnell leads the industry in the application of these technologies and construction practices and is prepared to support an owner's alert compliance efforts as the need arises.

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About Burns & McDonnell: Founded in 1898, Burns & McDonnell is a full-service engineering, architecture, construction, environmental and consulting solutions firm. With the multidisciplinary expertise of 3,000 employee-owners in more than 20 offices, Burns & McDonnell plans, designs, permits, constructs and manages facilities worldwide with one mission in mind — to make our clients successful.

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