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Mr. Chairman, Commissioners, FERC Staff, and other guests. Thank you for the opportunity to participate in today's panel on emerging industry issues. As others have already, or will comment, the pace and extent of changes impacting the electric system is without precedent. These impacts include, but aren't limited to: changing generation resource mix, heightened emphasis on system resiliency, regulation changes, industry workforce demographics, and grid modernization / increasing use of advanced technology.
My observation is that there are at least three emerging issues worthy of added focus arising as derivatives of several of these more macro grid impacts. Those emerging issues are:

1. *Criticality of effective knowledge transfer*
2. *Increasing importance of human error reduction*
3. *Limiting risks associated with adoption of new technologies*

I'll touch on salient points of several macro impacts, and describe the potential confluence giving rise to the above emerging issues.

Generation Resource Mix. As cited by numerous sources, the generation resource mix continues to evolve rapidly with retirement of many large fossil units and an increasing fraction of generation from natural gas and renewables. These changes have the potential to alter the electrical grid's basic response to various casualties through effects such as system inertia, reactive voltage control, dispersion of requisite generating units, and availability and location of reliable black-start units. Beyond the actual changing "physics" of the grid, the extent and pace of these changes pose a growing challenge to electrical engineers and operators to accurately predict system response and modify procedures accordingly.

System Resiliency. Emphasis on system resiliency is rightfully increasing, based on growing concerns from threats such as cyber and physical security, severe weather, geomagnetic disturbance, and electromagnetic pulse. And, broad resiliency impacts have the potential to stress operator performance in non-traditional ways, warranting vigilant review of operating procedures and comprehensive drills. Considerable industry resource – both intellectual capital and dollars - are being dedicated to improving grid resilience. However, various constituencies are arguing for faster and broader action on individual resiliency aspects (selected hazards) that could drive piece-meal action. Further complicating the situation is uncertainty regarding what constitutes a "prudent" investment to address a hazard that is not yet fully defined. Maintaining a holistic, "all hazards" approach, is essential - especially in the context of effective operator response. Absent a deliberate measured approach, the net result could be that new resiliency efforts – while critically important – could distract or challenge maintaining day-to-day grid reliability.

Regulatory Changes. Movement continues towards more risk-based regulation which is, in total, extremely positive. And, there is some sense that standards changes (new standards and significant revisions) may begin leveling off. However, understanding of risk-based approaches and "compliance" with standards continues to consume significant industry focus. Further, some standards changes – such as related to PRC-005 – may incite rapid transition to advanced technologies (digital relaying to better enable required testing) that could have unintended negative consequences – such as increased errors during associated modifications and testing, as well as introduction of potential uncertainties regarding new cyber or EMP vulnerabilities.

Workforce Demographics. The energy workforce is aging and replenishment is not keeping pace. Many workers in critical positions including line-workers, technicians, operators, and engineers are reaching "ready-now" status with respect to retirement. The pending loss of this "intellectual capital" is significant, especially when considering the volume of industry changes underway – we are anything but "steady-state". In particular, the loss of seasoned operator experience needed to manage through or efficiently restore from significant casualties is worrisome absent effective methods institutionalize that knowledge.

Adoption of Advanced Technology. Many industries and enterprises already have, or are currently on a fast-track to capitalize on advanced technology to bring people, processes, and information together. This influence on the electrical industry will likely be profound through factors including efficiency improvements and altered load profiles as more and more devices, down to the appliance level, become programmable and remotely accessible. The use of advanced technology will likely provide tremendous reliability benefits – such as more precise protective relaying and diagnostic capability from devices - including phasor measurement units (PMUs). However, adoption of advanced technology is not without risk. The increased opportunity for human error - such as in setting protection devices, and from cyber-security risks - such as malicious access to electrical grid control devices comes with those technology advances.

Conclusion

In light of these extensive industry impacts there are at least three emerging issues I believe warrant continued focus and evaluation.

1. Criticality of effective knowledge transfer

Given the potential significant loss of industry expertise, continued focus is needed to capture institutional knowledge in operating procedures, establishing effective pipelines for new personnel, and ensuring requisite training – with an emphasis on positions deemed reliability critical. NATF is focusing on these elements through a variety of means including our System Operations and Training practice groups.

2. Growing importance of human error reduction

Human error is a significant contributor both to event initiation and increased consequences. Techniques to reduce both the frequency and consequences from human error is an area of significant, ongoing focus by the NATF. We are broadening our focus to place special emphasis on human errors involving system protection (setting digital relaying) and in the modification processes (design and testing).

3. Limiting risks associated with adoption of advanced technologies

Advanced technologies offer tremendous reliability benefits. But, those benefits are not without risk. For example, a Dell Security report indicated that the number of SCADA attacks doubled from 2013 to 2014. The NATF is working to help ensure members reap the benefits from adoption of advanced technology while ensuring rigorous cyber security controls (superior practices) are adopted. We are also placing considerable focus on increasing member awareness of cross-industry threats via distribution of operating experience reports.

I appreciate your time and attention. I'd welcome any questions.