

The logo for NERC, consisting of the letters "NERC" in a bold, white, sans-serif font. A thick white horizontal line is positioned directly below the letters.

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

2021 Annual Report

February 2022



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Letter from the NERC President and CEO

While the pandemic continued throughout 2021, the Electric Reliability Organization (ERO) Enterprise team—made up of NERC and the Regional Entities—adapted to the changing dynamic of the world around us and successfully accomplished our mission of assuring the reliability, resilience, and security of the bulk power system (BPS). I'm sure all of us are ready to turn the page on the pandemic and 2021 as we look forward to a new and improved 2022. But first, we should take the time to be proud of what we have achieved under challenging conditions and of the relationships we continue to strengthen within the ERO Enterprise, industry, and our government partners.

2020 and 2021 brought significant clarity to two major risks facing the BPS. The first is our vulnerability to climate change-driven weather events with more extreme temperatures, longer durations, and wider impacted areas than the industry has typically planned for. Winter Storm Uri in February 2021 showed the tragic consequences that result from long-duration outages under terrible weather conditions. The second was the steady discovery of supply chain vulnerabilities, starting with the SolarWinds compromise that was discovered in December 2020 and, more recently, the Apache Log4j vulnerability that was identified by the Department of Homeland Security's Cybersecurity and Information Security Agency in December 2021. In between, we had multiple high-profile ransomware events and inverter-based resource performance issues. As the power grid continues to transform into more decentralized, decarbonized, and digitized structures, we must all be mindful that preserving reliability, improving security, and strengthening resilience need to continue to be top priorities for all of us in the ecosystem.

Our *2021 Long-Term Reliability Assessment* shows a sobering reliability outlook for many areas of North America and highlights that the pace of change needs to be carefully managed. This, coupled with the ever increasing attack surfaces associated with the digitization of the resource base and the expansion of industrial control systems picture, suggests that we all have our work cut out for us in the coming years.

Importantly, we are at a historic moment. Our model was developed during a time when risks were well known and the grid was evolving at a measured pace; we are now in a time where significant risks are emerging, they are new and unfamiliar, and the grid is transforming at a significant pace. We have requested that industry share ideas on how the best of our existing model—with its focus on engagement, deliberation, and reflection—can be made more agile such that we can get ahead of emerging risks and avoid catastrophes like we saw in the February event or with the Colonial Pipeline attack in June.

One key focus for NERC in 2021 was weatherization—made even more important with the addition of new technology coming on-line that is more susceptible to extreme weather. Three Reliability Standard modifications to address issues identified in our 2018 inquiry, including unit performance and coordination between Balancing Authorities and Reliability Coordinators, were approved and will go into effect in April 2023. In response to the February 2021 cold weather event, the Federal Energy Regulatory Commission (FERC), NERC, and the Regional Entities produced the *FERC-NERC-Regional Entity Staff Report: The February 2021 Cold Weather Outages in Texas and the South Central United States*, highlighting issues surrounding the need for natural gas and electric coordination as well as how these two critical industries interface going forward. The joint report identified 28 recommendations to improve the resilience of the electric system to cold weather events, including stronger winterization standards, improved understanding of fuel risks and mitigation approaches, and enhanced modeling of risks to transfer capability from neighboring systems. I am committed to seeing these recommendations through.



Jim Robb
President and CEO

Inverter-based resources continue to be a concern during times of system instability—a topic we’ve been working on since the Blue Cut Fire in 2016. An important lessons learned report on an August disturbance in Odessa, Texas, highlighted once again the need for inverter-based resources to “ride through” system disturbances and not amplify them. I am pleased that the Inverter-Based Resource Task Force has developed a standards authorization request to tackle this need that will only grow as more and more solar photovoltaic generation and battery storage resources are deployed on the system.

I am especially proud of Electricity Information Sharing and Analysis Center (E-ISAC) and its response to a steady drum beat of cyber and physical security threats. Following the SolarWinds compromise in December 2020, vulnerabilities were identified with the Microsoft Exchange on-premise version, the Pulse Connect Secure VPN platform, Kayesa products, the Blackberry/QNX operating system (particularly noteworthy as it was the first major operational technology (OT) system compromise identified), and the Apache ubiquitous Log4j tool. These compromises also underscore the value of NERC’s Critical Infrastructure Protection (CIP) Electronic Security Perimeter Reliability Standard requirements, which would have effectively mitigated the activation of most—if not all—compromises if they traversed into the operating systems.

I am also very pleased with the strong partnership with the U.S. and Canadian governments that provided the E-ISAC with critical information to rapidly cascade to its membership. Our work with the Department of Energy (DOE) on the 100-day sprint to deploy OT monitoring tools, coupled with the Cybersecurity Risk Information Sharing Program (CRISP), has the potential to be a real game changer in our ability to detect malware and remove it before harm is done to the BPS.

We also hosted two widely successful security events, GridSecCon in October and GridEx in November. Both events took place virtually for the first time. GridSecCon, which was canceled in 2020, had more than 900 attendees, reflecting the quality of the program and training offered as well as the importance the sector’s security community places on this conference. This was NERC’s sixth time hosting GridEx with more than 700 planners leading their organizations’ efforts to exercise their response and recovery plans in the face of coordinated cyber and physical attacks. The exercise was followed by an executive tabletop, which brought together industry and government executives to focus on strategic and policy-level issues raised during the exercise. The conclusions are still being reviewed, and a full report will be released in Spring.

These are just a few of the highlights of many, and I encourage you to read NERC’s *2021 Annual Report* with pride in what we have achieved in such a short time. The ERO Enterprise is strongly committed to remaining aware of the challenges that our industry faces while keeping our eye on the reliability, resilience, and security of the grid—nearly 400 million North Americans are depending on us.

Best,

A handwritten signature in blue ink, appearing to read "Jim Bell".

ERO Enterprise Vision | Mission

The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable and secure North American BPS. Our mission is to assure the effective and efficient reduction of risks to the reliability, resilience, and security of the grid.



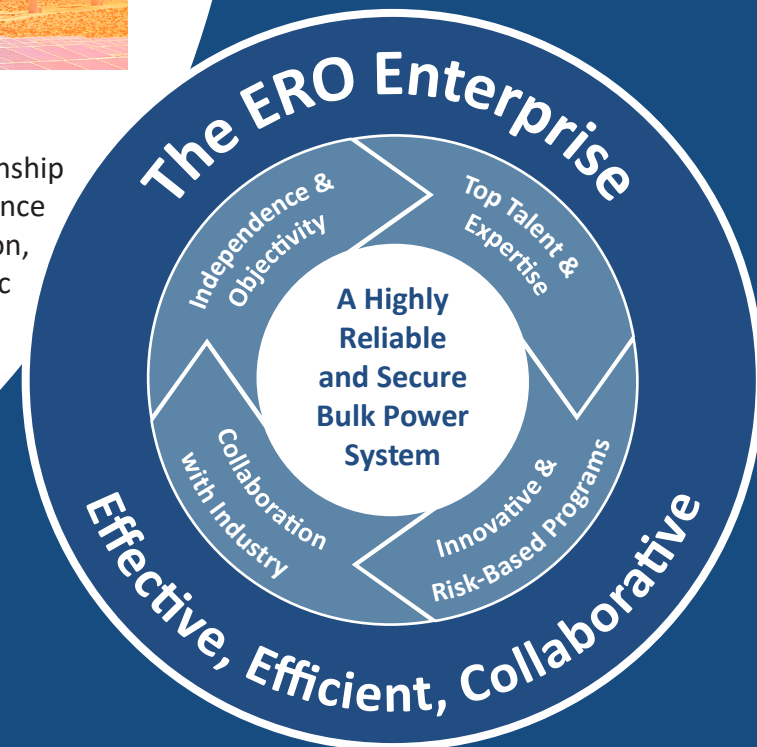
Transformation

With the concept of transformation at the forefront, NERC and the Regional Entities (collectively the ERO Enterprise) continue to evolve, becoming an organization that has undergone significant structural and social change in order to anticipate, adapt, and respond to the changing reliability and security ecosystem while identifying new risks and complexities as well as their mitigations. With substantial policy and technical forces driving rapid change in how electricity systems are designed, planned, operated, and secured, BPS resilience remains the central focus—a focus that forms the critical, collective mission and vision of the ERO Enterprise.



ERO Enterprise

The ERO Enterprise entered 2021 with the strongest, most productive, and collaborative relationship in its history. The ERO Enterprise model relies on many pieces working in unison: from heavy reliance on stakeholder expertise to develop standards, guidelines, lessons learned, risk identification, assessments, and regional compliance and enforcement structures that recognize geographic differences to strong, independent, and highly credible management and oversight by NERC. This complex model is working incredibly well, which is crucial as the reliability ecosystem changes daily, major threats from cyber and physical attack occur, severe weather risks threaten the grid, and the rapid decarbonization of the BPS and growth in distributed generation changes the resource mix. While it is impossible to eliminate all risk, NERC, the Regional Entities, and industry are well positioned to succeed.





Over the course of 2021, the ERO Executive Committee (ERO EC) reinforced its commitment to transformation by holding two Enterprise-wide town halls.

During the first town hall, the ERO EC shared the ERO Enterprise Transformation road map, which identified three overarching aspirations:

- Our critical mission is widely recognized and embraced.
- Our model brilliantly leverages expertise and balances differences across the ERO Enterprise and North America.
- We develop processes that ensure our sustainability.

The second town hall brought together more than 600 ERO Enterprise team members to share examples of the transformation in action. The town hall highlighted many of the leaders across the ERO Enterprise through video recordings and live presentations as they shared their thoughts and experiences around the ERO Enterprise's critical mission, brilliant model, and sustainability. The transformation allows ERO Enterprise members to look ahead to understand how to capture new growth opportunities; look inside, within the ERO Enterprise, to find ways to reconfigure operations to accelerate the mission; and look around for opportunities to further leverage their expertise in support of a highly reliable and secure North American BPS.

ERO Enterprise Commitment

- Work together as one team and honor each role
- Actively support activities and eliminate unnecessary duplication of work
- Collaborate to develop clear and consistent guidance
- Share information, knowledge, and resources
- Develop and share harmonized messages across communications
- Support innovation, initiatives, and the sharing of best practices

2021 ERO Enterprise Executive Committee



Jim Albright
President and CEO
[Texas Reliability Entity](#)



Jason Blake
President and CEO
[SERC Reliability Corporation](#)



Manny Cancel
Senior VP, NERC
CEO, E-ISAC



Charles Dickerson
President and CEO
[Northeast Power Coordinating Council](#)



Melanie Frye
President and CEO
[WECC](#)



Tim Gallagher
President and CEO
[ReliabilityFirst](#)



Kelly Hanson
Senior VP and Chief
Administrative Officer
NERC



Mark Lauby
Senior VP and
Chief Engineer
NERC



Sonia Mendonca
Senior VP, General
Counsel, and Corporate
Secretary
NERC



Sara Patrick
President and CEO
[Midwest Reliability Organization](#)
2021 ERO EC Co-Chair



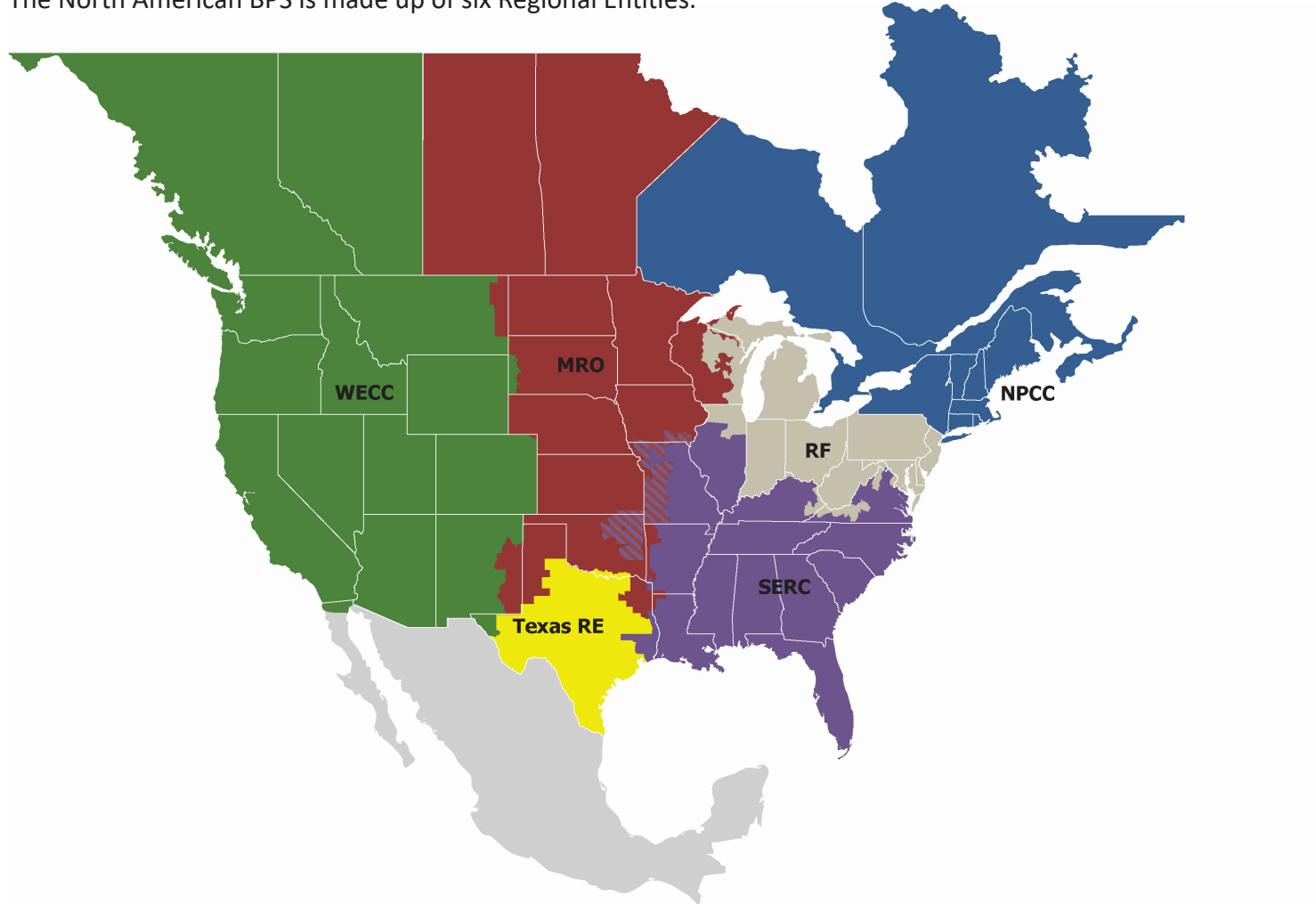
Jim Robb
President and CEO
NERC
2021 ERO EC Co-Chair



Janet Sena
Senior VP,
External Affairs
NERC

Regional Map

The North American BPS is made up of six Regional Entities.



[Midwest Reliability Organization \(MRO\)](#)

[SERC Reliability Corporation \(SERC\)](#)

[Northeast Power Coordinating Council \(NPCC\)](#)

[Texas Reliability Entity \(Texas RE\)](#)

[ReliabilityFirst \(RF\)](#)

[WECC](#)

Pandemic Response

Over the past two years, NERC stakeholders have demonstrated remarkable resilience in navigating the myriad challenges to reliability posed by the global COVID-19 pandemic. While the full impact of the pandemic will not be known for some time, there is no evidence to suggest that it adversely affected BPS reliability in 2020 or 2021. Instead, there is ample evidence to suggest that a keen focus on risk and advance planning as well as consistent execution of these plans were highly successful in addressing unprecedented reliability operating challenges. In addition, the careful coordination between industry participants and government partners allowed for continuous communication on how best to approach and resolve issues caused by the pandemic.

Over the year, NERC interfaced closely with its U.S. and Canadian government partners, including the North American Transmission Forum, the U.S. DOE, the Electricity Subsector Coordinating Council (ESCC), and FERC to provide regulatory relief to industry as the pandemic continued. The ERO Enterprise extended the temporary expansion of the Self-Logging Program and deferment of on-site activities several times in 2020 and 2021. NERC continued in its work-from-home posture and hosted its meetings, including the quarterly Board of Trustees and committee meetings, virtually.

NERC 2.0 | Invented Future

In 2021, NERC launched an initiative known as “NERC 2.0 | Invented Future,” which encompasses a variety of different efforts intended to build an engaged culture within the company. “NERC 2.0” identifies the company’s activities going forward as its next version—the new and improved NERC. “Invented Future” recognizes that the future hasn’t happened yet and that NERC employees have the opportunity to innovate and create the future they want to have for themselves every day.

The first piece of these efforts was a transformational leadership training that focused on empowering employees to see themselves as leaders and provided opportunities to improve emotional intelligence and communication skills. Additionally, NERC’s Engagement Team launched a NorthStar peer-to-peer recognition program, which allows employees to recognize each other for innovative work and exemplifying NERC values. NERC’s Engagement Team also launched three employee resource groups (ERGs).

To further assist with the development of the culture, NERC created the new role of Vice President, People and Culture, which is responsible for executing a series of strategies developed by the NERC executive team over the past two years to help make the Invented Future and revitalized culture a reality. This position will further the development of people strategies, including diversity and inclusivity initiatives, performance management, talent management, acquisition and retention, succession planning, and engagement, among other areas.

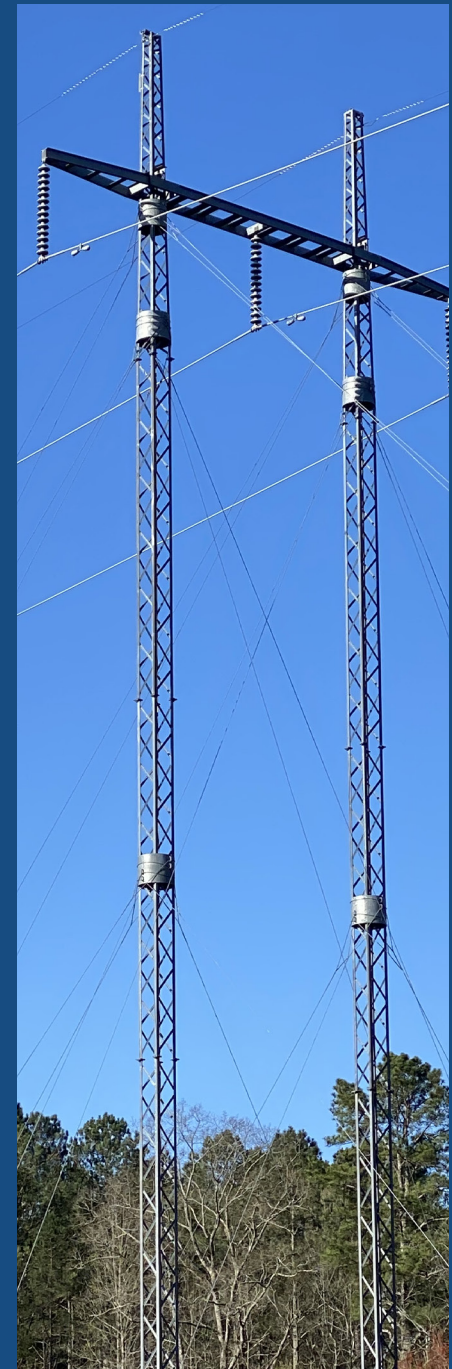


Photo taken by Mark Lauby



The second main component of NERC 2.0 is the Connected Workforce model, NERC's new flexible work model that was created after hearing feedback from employees. The Connected Workforce model classifies roles as onsite (roles that are best performed in the NERC offices), local (most responsibilities may be performed at a home office), and virtual (roles may be performed on an exclusively remote basis). This new approach gives staff more flexibility and supports a better work-life balance while investments in new technology and processes ensure that employees are able to engage and stay connected with each other. Additionally, NERC has procured a new D.C. office space. This re-imagined office space has a smaller footprint and will serve as a collaboration space—a place to facilitate connections, enable learning, and foster an innovative culture.

NERC Employee Resource Groups

- The Black and African-American ERG aims to advance a diverse and inclusive work environment through meaningful representation. This ERG undertakes activities to attract, retain, empower, and inspire employees to be their whole selves.
- The Elevate ERG highlights the diversity of the women in our workplace by creating a safe space to connect, collaborate, and celebrate the unique contributions women bring to the workforce. This ERG empowers women to reach their full potential within the company through visibility and impact.
- The Caregiver ERG brings together employees with caregiving responsibilities for children, family members, and loved ones. The group assists one another in managing work, family, and other responsibilities by sharing resources, experiences, guidance, and encouragement. This ERG helps shape NERC's culture by seeking forward-thinking ideas that can assist in the development and rollout of new benefits and programs that foster a supportive community.

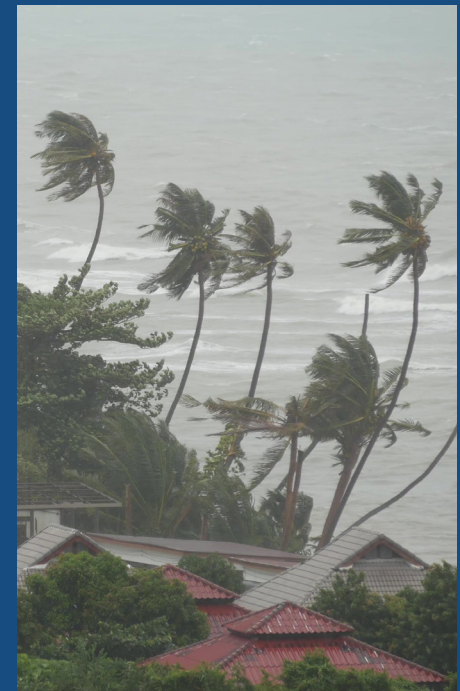
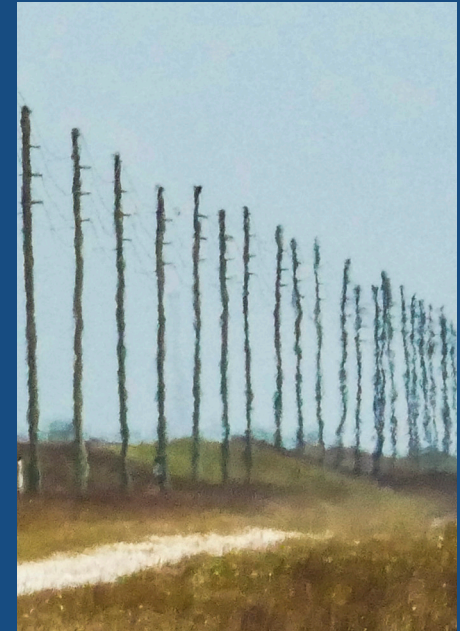


Photo taken by Mark Lauby

The Grid

Transformational Events

As emphasized in NERC's comments for the [Climate Change, Extreme Weather, and Electric System Reliability Technical Conference](#) and in the [FERC-NERC-Regional Entity Staff Report: The February 2021 Cold Weather Outages in Texas and the South Central United States](#), extreme events are having greater impacts on BPS reliability, and these impacts are largely attributable to the impact of extreme weather on the rapidly transforming grid. NERC's most recent assessments have warned of the potential for the loss of large amounts of generating resources due to severe weather in winter and summer as well as the potential need for grid operators to employ operating mitigations or energy emergency alerts to meet energy and peak demand. The ERO Enterprise has consistently signaled the need to be cognizant of reliability issues during the transition to a cleaner energy future and the need to manage the pace of change. Amid this rapid transformation, security threats continue to evolve in sophistication, frequency, and scope as well as pose ever-increasing risks to reliability, resilience, and security. In what can only be described as extraordinary, the past year has seen the manifestation of each of these risks, all while industry continues to navigate the challenges of the ongoing global pandemic. The importance of electricity to the lives of nearly 400 million North Americans is also ever increasing, being a fundamental enabler of their way of life.





Extreme Weather Events

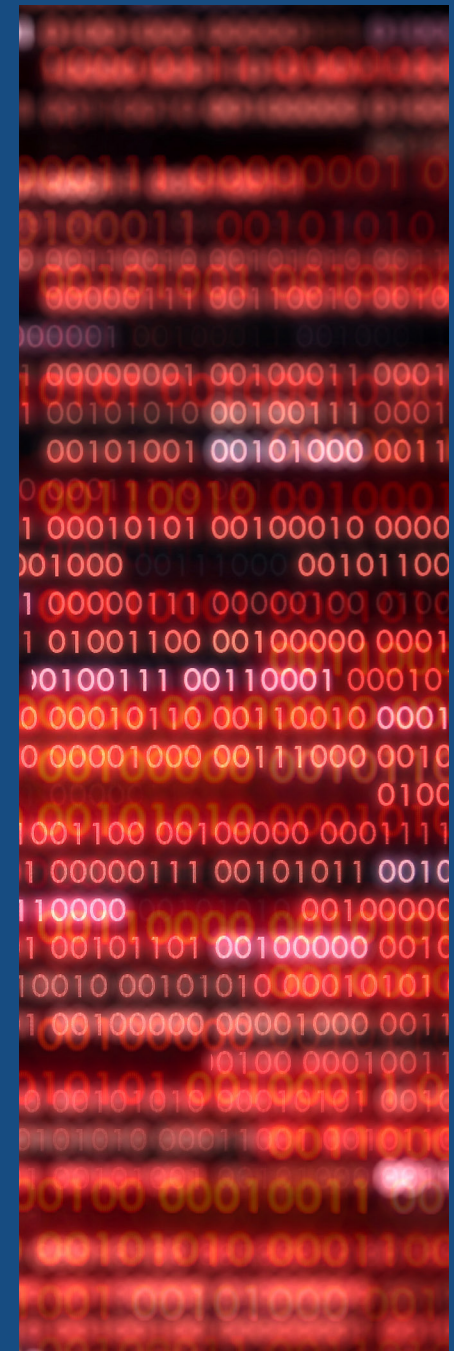
The past year was marked by several extreme weather events as highlighted in this section. Prior to the February 2021 cold weather event, extreme cold weather events caused substantial reliability and resilience impacts in 2011, 2014, and 2018. The fact that four such events occurred over the past decade demonstrates that these events can no longer be treated as rare. Furthermore, in the past decade, the generation fleet has transformed to one that is more sensitive to weather with extreme temperatures:

- **February Cold Weather Event:** In February 2021, a severe cold weather event—also known as Winter Storm Uri—caused numerous outages, derates, or failures to start at electric generating plants in the Midwest and South-Central states. The Texas grid operator (Electric Reliability Council of Texas, or ERCOT) ordered a total of 20,000 MW of rolling blackouts in an effort to prevent grid collapse; this represents the largest manually controlled load shedding event in United States history. More than 4.5 million people in Texas lost power—some for as long as four days. Tragically, the loss of electricity caused the deaths of numerous people. A joint inquiry team comprised of FERC, NERC, and the Regional Entity staff examined in detail what happened during the freeze. The resulting report, discussed in greater detail in the [2021 Cold Weather Operations](#) section of this report, outlines a series of recommendations, including mandatory electric Reliability Standards, to prevent an event like this from reoccurring.
- **Northwest Heat Dome:** From late-June through mid-July, an extreme heat wave affected much of Western North America. This 1,000-year weather event affected Northern California, Idaho, Western Nevada, Oregon, and Washington in the United States as well as British Columbia, and (in its latter phase) Alberta, Manitoba, the Northwest Territories, Saskatchewan, and Yukon areas in Canada. Temperatures reached 121 degrees Fahrenheit in some areas, and the prolonged event ultimately lead to the loss of more than a thousand lives across the United States and Canada.
- **Western U.S. and Canadian Wildfires:** As of December 7, 2021, the National Interagency Fire Center reported a total of 54,350 wildfires across the United States that had burned more than 6.8 million acres. The Canadian Interagency Forest Fire Centre similarly announced that 6,317 wildfires had burned 10.34 million acres. Historically, Canada and the United States have shared wildland fire fighting resources, including personnel, vehicles, helicopters, and airplanes. However, due to the sudden onset and severity of the 2021 wildfire season, neither country was able to share resources as they fought multiple devastating wildfires within their respective borders simultaneously.

Security Compromises

The cyber security landscape continues to evolve, guided by geopolitical events, new vulnerabilities, changes in technologies, and increasingly bold cyber criminals and hackers. Over the past several years, NERC has observed a large increase in the frequency and sophistication of malicious cyber activity. In 2021, NERC's E-ISAC observed supply chain compromises and ransomware attacks, malware, and phishing activity. The pandemic has required an increased remote cyber security attack surface due to increased telework, requiring greater sharing and collaboration by the E-ISAC with all levels of the electricity industry, U.S. and Canadian governments, and partners than ever before. Several major security compromises are highlighted below:

- **SolarWinds Compromise:** In December 2020, threat actors compromised the widely used SolarWinds Orion network management tool through a supply chain attack, gaining access to the SolarWinds production environment and pushing malicious code to customers to gain remote access. The actors used the initial access to gain network privileges on the victim's system and manipulate identity and authentication mechanisms in Microsoft's 365 and Azure Cloud environments. The E-ISAC, in cooperation with key government partners at DOE, the Department of Homeland Security, the Cybersecurity and Infrastructure Security Agency, and industry partners analyzed information to assess the potential impacts of the attack and provided support through calls and webinars, summarizing the threat and mitigation actions. The E-ISAC and the ESCC formed an industry Supply Chain Compromise Tiger Team of industry security professionals that produced materials and facilitated webinars aimed at improving overall industry response. During this period, the E-ISAC authored 97 portal postings related to the supply chain and Microsoft Exchange compromises and held a critical broadcast program call. NERC also issued a non-public Level 2 NERC alert on December 22, 2020.
- **Microsoft Compromise:** In March of 2021, Microsoft announced the detection of multiple zero-day exploits being used to attack on-premise versions of the Microsoft Exchange Server, an attack that they attributed to a Chinese state-sponsored adversary. Successful exploitation of vulnerabilities may have allowed (among other things) remote unauthorized access and potential exfiltration of data on vulnerable Exchange servers. On March 5, NERC issued a non-public Level 1 alert, "Microsoft Exchange On-Premise Product Vulnerability Exploitation by Advanced Persistent Threat Actor." On July 6, 2021, E-ISAC and FERC staff published a joint white paper, [*SolarWinds and Related Supply Chain Compromise: Lessons for the North American Electricity Industry*](#), that was focused on the significant and ongoing cyber events related to the SolarWinds Orion platform and the related Microsoft 365/Azure Cloud compromise. The paper addresses vulnerabilities in several other products, highlights the need for continued vigilance by the electricity industry related to supply chain compromises and incidents, identifies key elements of adversary tradecraft, highlights specific malwares and tools to remediate, and recommends actions to ensure the reliability, resilience, and security of the BPS.





- **Colonial Pipeline Cyber Attack:** The Colonial Pipeline ransomware attack, which disrupted petroleum markets in the Eastern United States for several days in May 2021, was an ominous reminder of the potential for cascading impacts due to cross-sector interdependencies. Although the attack itself had significant impacts on a system with substantial local inventories, a similar disruption to a major natural gas pipeline—where in-market inventories are much less prevalent during severe winter weather—could have even greater impacts on electric generation performance. In addressing potential cross-sector threats, the E-ISAC collaborates directly with other ISACs and government partners to share threat and mitigation strategies. In the case of the Colonial Pipeline attack, the E-ISAC worked directly with the Cybersecurity and Infrastructure Security Agency to share situation reports on the ransomware attack for member situational awareness.

NERC and industry must maintain a continued focus on improving defenses by increased sharing with the E-ISAC. Industry must also adapt to a threat landscape where adversaries adopt new tactics, new vulnerabilities are exploited, and the magnitude of potential impacts are changing as the grid evolves and cross-sector interdependencies increase.



Photo taken by Mark Lauby



2021 and 2022 Work Plans and Focus Areas

In light of the dramatically changing industry landscape, the [ERO Enterprise Long-Term Strategy](#) concentrates on five focus areas around which NERC aligned its performance management. This *2021 NERC Annual Report* is structured using the same focus areas:

- Expand risk-based focus in standards, compliance monitoring, and enforcement
- Assess and catalyze steps to mitigate known and emerging risks to reliability and security
- Build a strong E-ISAC-based security capability
- Strengthen engagement across the reliability and security ecosystem in North America
- Capture effectiveness, efficiency, and continuous improvement opportunities

Within these focus areas were several key objectives that set the table for the work performed in 2021. The [2021 ERO Enterprise Work Plan Priorities](#) addressed a transforming industry in which NERC needed to remain agile to take on any emerging risks that presented themselves.

At its November meeting, the Board approved the [2022 ERO Enterprise Work Plan Priorities](#), identifying key priorities for the coming year. Moving into 2022, the ERO Enterprise will focus on addressing the following four risk elements:

- Improve Bulk Electric System (BES) resilience for widespread, long-term, and extreme temperature events
- Deepen planning and operating focus beyond capacity adequacy toward energy sufficiency
- Enhance the structure of the CIP standards, including review and improvement of the bright-line risk criteria
- Expand the impact of the E-ISAC through information sharing, communications, and monitoring of critical security threats

The ERO Enterprise's mission ultimately exists to serve the public interest, and it must serve that interest by continuing to lead industry in reliability, resilience, and security initiatives for known and emerging risks.

Expanding Risk-Based Focus in Standards, Compliance Monitoring, and Enforcement

The ERO Enterprise has shifted from a primarily compliance-focused approach to one that incorporates a more holistic, risk-based approach in pursuit of continuous improvement, innovation, and value-driven efforts. Compliance with Reliability Standards remains fundamental to the collective mission to maintain reliability, resilience, and security. By maintaining and expanding a risk-based focus in its operations, the ERO Enterprise is able to apply resources to the most significant reliability risks and better respond to emerging risks. As the resource situation continues to become more complicated and dependent on other critical infrastructures and weather conditions, the ERO Enterprise must be prepared to take necessary action to prepare the system for the most critical reliability risks, particularly extreme weather events and supply chain vulnerabilities, in addition to continuing to align and streamline routine compliance and enforcement activities.

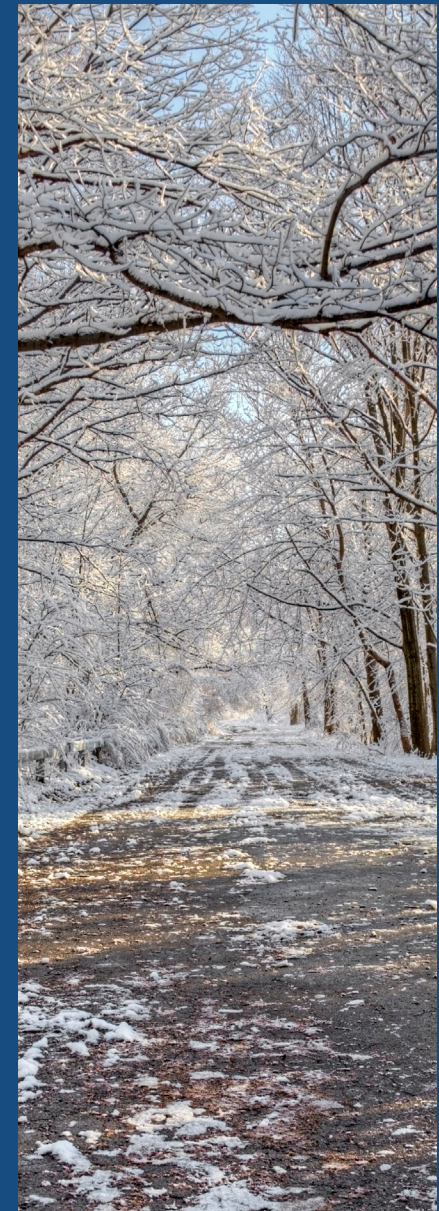
2021 Cold Weather Operations and the FERC–NERC–Regional Entity Staff Report

Extreme weather is an acute reliability risk, threatening the lives and well-being of nearly 400 million North Americans. This very real and urgent risk was highlighted again at the beginning of the year with the unprecedented power outages to millions of people that occurred during the February 2021 freeze in Texas, the Midwest, and other South-Central states.

In February, NERC and FERC announced an inquiry into the event that involved coordinating with federal agencies, states, Regional Entities, and utilities to identify problems with the performance of the BPS as well as, where appropriate, solutions for addressing those issues. The inquiry stretched over nine months with the direct involvement of more than 50 subject matter experts. The [*FERC–NERC–Regional Entity Staff Report: The February 2021 Cold Weather Outages in Texas and the South Central United States*](#), a 300-page analysis that was released in November, underscored the preliminary recommendations that were released in September. The report provided additional details that pertain to the need to strengthen cold weather preparedness rules and coordination as well as recommendations for avoiding such situations in the future.

February 2021 Freeze

The February 2021 freeze triggered the loss of 61,800 MW of electric generation, as 1,045 individual generating units experienced 4,124 outages, derates, or failures to start. It severely reduced natural gas production—with the largest effects felt in Texas, Oklahoma, and Louisiana—where combined daily production declined to an estimated 20 billion cubic feet-per-day. That is a reduction of more than 50% compared to average production from February 1–5.



FERC–NERC–Regional Entity Staff Report: Key Recommendations for Reliability Standards Revisions

In response to the continued failures of generating units due to freezing issues, the inquiry team recommended revising the mandatory Reliability Standards to require the following:

- Generator Owners to identify and protect cold-weather-critical components
- Generator Owners to retrofit existing generating units, and when building new generating units, to operate to specific ambient temperatures and weather based on extreme temperature and weather data, and account for effects of precipitation and cooling effect of wind
- Generator Owners/Generator Operators to perform annual training on winterization plans
- Generator Owners that experience freeze-related outages to develop Corrective Action Plans
- Generator Owners/Generator Operators to provide the Balancing Authority with the percentage of the total generating unit capacity that they can rely upon during the “local forecasted cold weather”
- Generator Owners to account for effects of precipitation and accelerated cooling effect of wind when providing temperature data to Balancing Authorities

In conjunction with the launch of the FERC–NERC–Regional Entity inquiry, the Project 2019-06 Cold Weather Standards Drafting Team developed revisions to three Reliability Standards to improve generator preparedness for cold weather and to enhance situational awareness in cold weather conditions as recommended in the *July 2019 FERC–NERC Staff Report*. In August, NERC’s Board of Trustees adopted the new cold weather Reliability Standards that received FERC approval shortly thereafter. These standards—EOP-011-2, IRO-010-4, and TOP-003-5—require Generator Owners to implement plans to prepare for cold weather and provide certain generator cold weather operating parameters to the Reliability Coordinator, Transmission Operator, and Balancing Authority for use in their analyses and planning. Additionally, NERC opened nominations for the drafting team members for the Project 2021-07—Extreme Cold Weather Grid Operations, Preparedness, and Coordination Standard Authorization Request (SAR). This followed a resolution issued at the November Board meeting that stated that a new cold weather operations, preparedness, and coordination standards project be included in the *2022–2024 Reliability Standards Development Plan* as a high-priority item to address the recommendations of the FERC–NERC joint inquiry. In recognition of the urgency to address this pressing reliability issue, the Board directed that the project be completed in stages with the completion of the first stage due to the Board by September 2022 and the second stage due to the Board by September 2023, which is consistent with the time lines recommended in the joint inquiry.



While standards are just one part of the solution, the ERO Enterprise pursued several efforts beyond unit winterization to evaluate industry preparedness for the 2021–2022 winter season. These efforts included the following things:

- Webinars, conferences, and workshops that were focused on cold weather preparedness
- On-site or virtual visits from Regional Entities to registered entities to better understand the extent of conditions
- A [Level 2 NERC alert](#) to gauge actions being taken to prepare for the upcoming winter as well as specific mitigations from existing guidelines and lessons learned being implemented along with their status and completion dates
- A Compliance Monitoring and Enforcement Program (CMEP) Practice Guide to help CMEP staff engage with and understand how registered entities are managing the risk to reliability related to cold weather preparedness in preparation for, and during the implementation of, the cold weather Reliability Standards
- The release of the *2021–2022 Winter Reliability Assessment* that focused on extreme winter weather preparation, energy management planning, and expected operational conditions

Industry must act with urgency on concrete risk-informed mitigation measures to address cold weather to maintain the reliability, resilience, and security of the grid.

Supply Chain Risk Mitigation

The criticality of supply chain risk mitigation, which has been a NERC priority since 2016, has been highlighted even further over the past two years by a marked increase in supply chain compromises perpetrated by nation-state actors. Without trusted suppliers working with asset owners and operators, industry will struggle to increase or maintain reliability while directly addressing the ever-increasing security threats to the grid.

In March, FERC approved CIP-005-7–Cyber Security–Electronic Security Perimeter(s), CIP-010-4–Cyber Security–Configuration Change Management and Vulnerability Assessments, and CIP-013-2–Cyber Security–Supply Chain Risk Management (collectively known as the Supply Chain Standards), which will go into effect on October 1, 2022. FERC also directed NERC to conduct a study to assess the implementation of CIP-003-8–Electronic Access Controls and determine whether the controls provide adequate security. In conducting the [Electronic Access Controls Study](#), which NERC submitted to FERC in June, the ERO Enterprise found registered entities’ electronic access controls that applied to assets containing low-impact BES cyber systems were generally effective in providing adequate security and identified opportunities to strengthen registered entities’ implementation of electronic access controls. NERC also formed a low-impact criteria review team to examine the degrees of risk presented by low-impact BES cyber systems.

Other 2021 ERO Enterprise supply chain mitigation efforts included the joint FERC–NERC [SolarWinds and Related Supply Chain Compromise](#) white paper, which highlighted the lessons learned from recent supply chain compromises and recommended a series of specific cyber security mitigation actions to better ensure the security of the BPS; a Level 1 alert; and continued partnerships with the DOE on vendor work and the North American Transmission Forum on certifications. A supply chain pilot project that seeks to understand the pervasiveness of equipment manufactured by Chinese telecommunication companies is also underway. The pilot project, based on the joint FERC–NERC white paper, will provide a better understanding of the potential risks to the reliability and security of the grid. Other activities include evaluating standards for supply chain effectiveness and gap identification, addressing system-to-system communications, and implementing virtualization. NERC remains fully committed to its focus on supply chain risk and will continue to coordinate activities across the industry to mitigate known and emerging supply chain risks to the BES.



Compliance Monitoring and Enforcement Activities

In 2021, the CMEP and Organization Registration and Certification Program activities throughout the ERO Enterprise reflected the continued implementation of a risk-based approach and program alignment.

Pandemic-Related Compliance and Enforcement Action

Over the course of the year, NERC continued to work closely with FERC and Canadian provincial authorities to provide regulatory relief to industry during the COVID-19 pandemic. The ERO Enterprise extended the temporary expansion of the Self-Logging Program and deferment of on-site activities several times in 2020 and 2021. The final extension moved the expiration date of the temporary expansion of the Self-Logging Program and the deferment of on-site activities to December 31, 2021. Additionally, the ERO Enterprise continued to perform compliance monitoring and certification engagements off-site by using video and audio conference technologies.

Program Alignment and Practice Guides

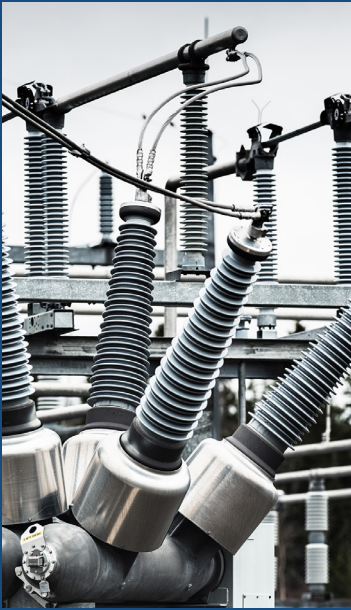
The ERO Enterprise also focused on improving the alignment of CMEP activities under a broader ERO Enterprise Program Alignment Process, which is intended to enhance efforts to identify, prioritize, and resolve alignment issues across the ERO Enterprise. This is a repeatable, transparent process that registered entities (or other relevant industry stakeholders) may use to report any perceived inconsistency in the approach, methods, or practices implemented and executed by the Regional Entities. Over the course of 2021, NERC staff resolved several alignment issues reported through the anonymous Consistency Reporting Tool and developed seven CMEP practice guides that provide direction to ERO Enterprise CMEP staff on approaches to carry out compliance monitoring and enforcement activities.

2021 CMEP Practice Guides

- [*CMEP Practice Guide: Cold Weather Preparedness*](#)
- [*CMEP Practice Guide: Evaluating Blackstart Documented Procedures*](#)
- [*CMEP Practice Guide: Network Monitoring Sensors*](#)
- [*CMEP Practice Guide: Application of the BES Definition to BESS and Hybrid Resources*](#)
- [*CMEP Practice Guide: Virtual Network*](#)
- [*CMEP Practice Guide: Virtual Storage*](#)
- [*CMEP Practice Guide: Virtual Systems*](#)



Photo by taken Mark Lauby



Centralized Organization Registration ERO System Technology Project

The Centralized Organization Registration ERO System (CORES) technology project was established to take the core registration functions previously managed in three systems and move all registration functions to a single, secure, and consolidated system. This tool provides consistency and alignment across the ERO Enterprise for registration activities. CORES is a platform that allows entities to manage their registration information, contact information, and entity affiliate information from one location, making it easier for the ERO Enterprise and registered entities to collaborate on registration information.

In preparation for the implementation of [Align](#), the ERO Enterprise enabled additional functionality in CORES that allows registered entities to make changes to their registered entity contact roles directly in the platform, effective March 8, 2021. By enabling this additional functionality, CORES became the official system of record for registered entities to maintain their contact information. It is essential to keep current and accurate registered entity contact roles in CORES because the data is needed in the Align tool. The ERO Enterprise will continue to operate in both the legacy systems and the ERO Portal with CORES until the transition to Align is fully completed in 2022.



ERO Enterprise Launches Compliance Podcast

In February, NERC and ERO Enterprise staff launched a compliance podcast. Hosted by ERO Enterprise subject matter experts (SMEs), “[Currently Compliant](#)” is intended to be a quick way to bring attention to frequently asked questions on which the SMEs have some clear insights to share. While there are multiple places to look for compliance material, “[Currently Compliant](#)” is intended to be viewed like a Q&A session after a workshop or catching up with the experts over an appetizer and beverage at a reception.

Episode 1: [PRC-019-2 R1](#) 

Episode 2: [PRC-027-1 R2 and Supply Chain Risk Management](#) 

Episode 3: [Cold Weather Practice Guide and CIP-008-6](#) 

Assessing and Catalyzing Steps to Mitigate Known and Emerging Risks to Reliability and Security

As a core element of its mission, the ERO Enterprise works closely with industry, forums, government, and other organizations to perform ongoing analyses of significant known reliability risks to the BPS. The ERO Enterprise also collaborates with subject matter experts and other stakeholders as appropriate to assess emerging risks that result from grid transformation, extreme natural events, cyber and physical security vulnerabilities, and critical infrastructure interdependencies. Lastly, the ERO Enterprise collects substantial amounts of data and information on the ongoing performance of the BPS along with projected system conditions. The evaluation of early indicators of risk that is supported by data and analysis drives action across industry that support BPS reliability.

2021 ERO Reliability Risk Priorities Report

NERC's [2021 ERO Reliability Risk Priorities Report](#) provided a holistic view of the risk landscape that faces the BPS now and in the future and serves as a road map for the identification of key emerging risks and potential mitigating activities to address those risks. The report presented the results of the Reliability Issues Steering Committee's (RISC) efforts to strategically define and prioritize risks to BPS reliability and identified four significant, evolving, and interdependent risk categories; the most significant—grid transformation—has broad implications as it can be a catalyst for additional changes. The report also examined three additional risk categories in detail: security; extreme natural events; and critical infrastructure interdependencies, such as the ability to deliver natural gas to generating units supporting the reliability, resilience, and security of the BPS. The report addressed recommendations that the ERO Enterprise and industry should take to enhance reliability, resilience, and security to manage those risks.



2021 State of Reliability

NERC's [2021 State of Reliability](#), which looked at performance during the previous year, found that the grid continued to perform well in 2020—a year in which it faced numerous challenges, including extreme weather, cyber and physical threats, and a rapidly changing generation resource mix, all within the context of a global pandemic. The report, which identified seven key findings and four high-level recommendations, highlighted the strength of the interconnected system and the effectiveness of the ERO Enterprise's reliability risk mitigation activities. Key indicators showed that mitigation efforts put in place for critical risks are effectively being addressed. Outages due to human error and equipment failure continued to decline, demonstrating the success of mitigation activities focused on human performance and system maintenance.

The *2021 State of Reliability* recommended that the ERO Enterprise and industry should continue improving their ability to model, plan, and operate a system with a significantly different resource mix. Additionally, the report recommended that system planners should evaluate the need for flexibility as conventional generation retirements are considered by industry and policymakers. Retirement planning studies should consider Interconnection-level impacts and sensitivity assessments associated with the loss of critical transmission paths and the loss of local generation in larger load pockets. The report also recommended that the ERO and industry develop comparative measurements and metrics to understand the different dimensions of resilience during the most extreme events and how system performance varies with changing conditions. Finally, the report recommended that the ERO Enterprise, industry, and government significantly increase the speed and detail of the cyber and physical security threat information that is shared; this will allow the Enterprise to counter the increasingly complex and targeted attacks by capable nation-state adversaries and criminals that could be a threat to critical infrastructure. This should be complemented by a review of cyber security standards, supply chain procurement, risk assessments, and a review of the CIP standards' bright-line criteria between high-, medium-, or low-impact assets.

With appropriate insight, careful planning, and continued support, industry will continue to navigate the challenges facing the grid in a manner that maintains reliability.

State of Reliability 2021
The *State of Reliability* provides analysis of past bulk power system performance to identify system trends and emerging reliability risk. It also highlights the health of the interconnected bulk power system and the effectiveness of reliability risk mitigation activities.

- The bulk power system remained reliable even though operator-initiated load shedding increased in 2020. Pandemic impacts were avoided through advanced planning.
- Summer load shedding underscores energy adequacy risk and a growing vulnerability to extreme weather.
- Collectively, weather events and wildfires caused transmission outages with greater frequency than in prior years and were contributors to the most widespread transmission outages. Outages due to human error and equipment failure show continued improvement.
- Supply chain disruptions increase the threat landscape and the urgency of cyber security risk response.
- Increasing variable resource levels require more flexible resources to balance supply and demand.

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

FERC and ERO Enterprise Joint Report on Real-Time Assessments

Real-time assessments evaluate system conditions by using real-time data to measure existing and potential operating conditions in order to ensure continued reliable operation of the BES. In 2021, staff from FERC, NERC, and the Regional Entities reviewed the focus on strategies and techniques that were used by Reliability Coordinators and Transmission Operators to perform these assessments following a loss or degradation of data or tools used to maintain situational awareness. The review included on-site discussions with representatives of nine participating Reliability Coordinators and Transmission Operators.

The resulting joint report—[FERC and ERO Enterprise Joint Report on Real-time Assessments](#)—concluded that system operators were prepared to manage limited impairments of their primary assessment tools or data through system redundancy and redundant data sources. However, infrequent events involving significant real-time data loss or the failure of primary analysis tools that lasted more than two hours required the development of alternative data sources, tools, and analyses to mitigate the potential loss of visibility and control that resulted from the impairment of their primary tools. The joint report addressed seven technical areas related to real-time assessments and included observations, conclusions, and recommendations for each topic.

Recommendations

Within the seven technical areas, the joint staff review team's recommendations focused on the following issues and objectives:

- Maintaining situational awareness when tools are impacted
- Ensuring actions are known and consistent in timing and scope
- Having feasible, accurate backup plans with related training programs
- Establishing verification procedures to ensure that models are accurate and consistent
- Maintaining awareness of changes/upgrades to the energy management system





Seasonal Assessments

As the grid transforms and weather-dependent resources become increasingly important to maintaining the real-time supply for electricity, the BPS becomes more vulnerable to abnormal weather as highlighted in NERC's annual seasonal assessments—the Summer Reliability Assessment and the Winter Reliability Assessment.

Summer Reliability Assessment

In the [2021 Summer Reliability Assessment](#), NERC warned that parts of North America were at elevated or high risk of energy shortfalls for Summer 2021 during above-normal peak temperatures. While NERC's risk scenario analysis showed adequate resources and energy for most of North America, Texas, New England, MISO, and parts of the Western United States were at an "elevated risk" of energy emergencies. California was also in the "high risk" category as the state relies on large energy imports during peak demand scenarios and when solar resource output slows in the evening hours. Above-average seasonal temperatures, such as those NERC predicted for the summer, can contribute to high peak demand and impact the availability of generation resources and imports from neighboring areas.

Recommendations

- Load-serving entities and regulators should work with their Balancing Authorities and Reliability Coordinators to ensure that clear lines of communication are open for coordination during periods of system stress. Reliability Coordinators, Balancing Authorities, and Transmission Operators should review outage schedules well in advance and coordinate across the Reliability Coordinator area.
- Balancing Authorities and Reliability Coordinators should conduct drills on their alert programs to ensure that they are prepared to signal need for conservative operations, restrictive maintenance periods, etc. Balancing Authorities and Generator Operators should verify protocols and operator training for communication and dispatch.
- Load-serving entities should prepare for demand-side conservation measures and potentially condition customers to their need and efficacy.
- Balancing Authorities and Reliability Coordinators should maintain the highest vigilance during peak risk hours and forecasted high temperature periods.
- Load-serving entities should review non-firm customer inventories and rolling blackout procedures to ensure that no critical infrastructure loads (e.g., natural gas, telecommunications) will be affected.

Winter Reliability Assessment

In its [2021–2022 Winter Reliability Assessment](#), NERC found that reliability risk was elevated in parts of North America that are especially vulnerable to extreme weather, natural gas supply disruptions, and low hydro conditions. NERC advised industry to ensure the readiness of operating plans to manage potential supply shortfalls and take proactive steps for generator readiness, fuel availability, and sustained operations in extreme conditions. The assessment identified the Central United States, New England, California, and the Western United States and Canada as areas of particular risk.

While industry has taken major steps to prepare for extreme weather conditions this winter, the report warned that the existing generation fleet and fuel infrastructure remained exposed in many areas. To reduce the risks of energy shortfalls, NERC recommended that Grid Operators (Reliability Coordinators and Balancing Authorities), Generator Owners, and Generator Operators review the [NERC Level 2 alert](#) and NERC's [Generating Unit Winter Weather Readiness Guideline](#) and take recommended steps prior to winter. The report also recommended that Balancing Authorities poll their generating units periodically and in advance of approaching severe weather to understand their readiness level for normal and extreme conditions, giving consideration for unit weatherization as well as fuel supply risk. Additionally, Balancing Authorities and Reliability Coordinators should conduct drills on alert protocols to ensure that they are prepared to signal the need for conservative operations, restrictive maintenance periods, etc. Balancing Authorities and Generator Operators should verify protocols and operator training for communication and dispatch. Finally, the assessment recommended that distribution providers and load-serving entities review non-firm customer inventories and rolling blackout procedures to ensure that no critical infrastructure loads (e.g., natural gas, telecommunications) would be affected.

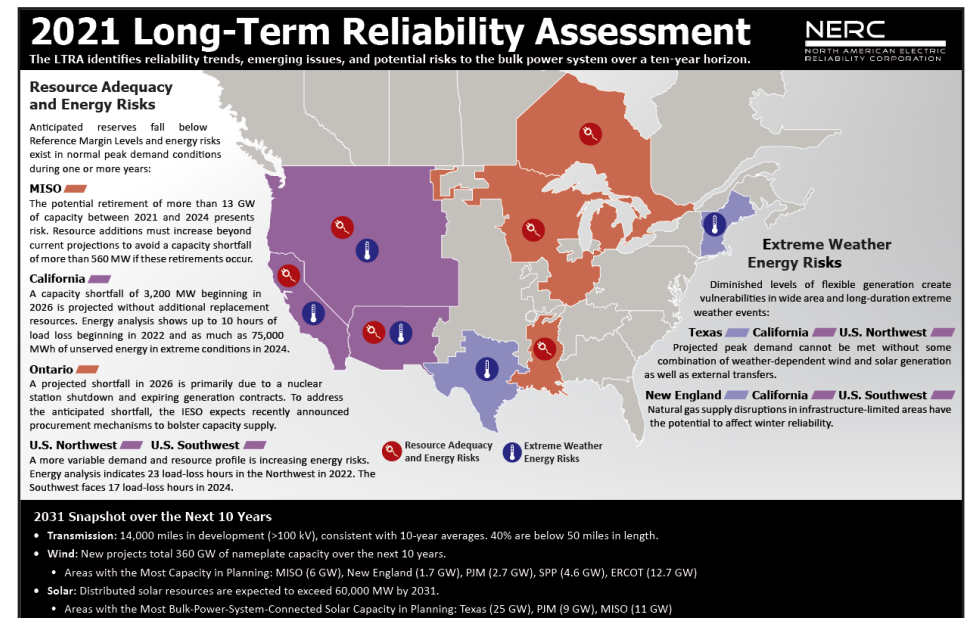


Long-Term Reliability Assessment

The [2021 Long-Term Reliability Assessment](#) (2021 LTRA)—the ERO Enterprise’s independent assessment and comprehensive report on the adequacy of planned BPS resources to meet electricity demand across North America over the next 10 years—concluded that managing the transformation of the grid and the associated rapid change to the resource mix is the greatest challenge to reliability.

While the 2021 LTRA found that all Interconnections will face increasing reliability issues over the next 10 years, California, parts of the Northwestern and Southwestern United States, and the Midcontinent Independent System Operator (MISO) areas in particular projected capacity shortfalls and periods of insufficient energy due to declining reserve margins and generator retirements. Texas, California, and the Northwest United States projected that peak demand cannot be met without some combination of variable generation and imports. In addition, the natural gas infrastructure that supports electricity generation in New England, California, and the Southwestern United States is susceptible to disruptions that can affect winter reliability. The report also provided areas of focus for the ERO Enterprise, stakeholders, and policymakers.

The 2021 LTRA called attention to the need for industry’s collective focus on energy assurance and greater coordination between the natural gas and electricity industries as stakeholders and policymakers work together to ensure reliability during this time of grid transition. Prioritizing reliability as climate change policies are developed will support a transition that assures electric reliability in an efficient, effective, and environmentally sensitive manner.



Odessa Disturbance Report

On May 9, 2021, the Texas Interconnection experienced a widespread reduction of over 1,100 MW of solar photovoltaic (PV) resources due to a normally cleared fault on the BPS. This event is known as the “Odessa Disturbance.” While the ERO Enterprise has analyzed multiple similar events in California, this is the first disturbance that involved a widespread reduction of solar PV resources in the Texas Interconnection. The event involved facilities across a large geographic area of up to 200 miles from the location of the initiating fault. The report also documents a smaller event involving solar PV resources that subsequently occurred on June 26.

NERC and Texas RE analyzed the Odessa Disturbance in coordination with ERCOT, and the resulting [Odessa Disturbance Report](#) documented several key findings and high-level recommendations. The report provided details regarding the initiating event, performance of the BPS-connected solar PV fleet during the event, and additional details around the event. The report also described modeling and studies improvements needed to address the root causes of these issues that are applicable to all Interconnections.

Findings and Recommendations

- **Industry Not Sufficiently Implementing Recommendations from NERC Reliability Guidelines—Further Action Is Needed:** Conversations with Generator Owners and Generator Operators of affected solar PV facilities and ERCOT highlighted that industry is aware of the guidance materials published by NERC, yet are not comprehensively adopting the recommendation contained in those materials, leaving gaps in their implementation and in performance from BPS-connected inverter-based resources across multiple footprints and Interconnections.
- **Significant Updates and Improvements Needed to the FERC Generator Interconnection Agreements:** All of the performance issues identified in the NERC disturbance reports stem from a lack of performance requirements. The recommended approach is for FERC to update the pro forma Interconnection Agreements with all the necessary performance specifications covered in the NERC reliability guidelines to ensure that all resources are consistently and effectively being interconnected to the BPS.
- **Improvements to NERC Reliability Standards Needed to Address Systemic Issues with Inverter-Based Resources:** Ongoing analysis of abnormal performance of BPS-connected solar PV facilities continues to highlight gaps in the NERC Reliability Standards that need to be addressed by industry.



Building a Strong E-ISAC-Based Security Capability

The cyber and physical security landscape evolved rapidly in 2021. Against the backdrop of the pandemic, many entities implemented their response and recovery plans in the face of actual cyber, physical, or ransomware attacks. The sheer volume, complexity, and velocity of threats demonstrates our adversaries' potential capability to disrupt critical infrastructure in North America.

Executing the E-ISAC Strategic Plan

Although the E-ISAC is not aware of any impacts to the BPS at the time of this report, events—such as SolarWinds, the Microsoft Exchange compromise, the Pulse Connect Secure vulnerability, and ongoing ransomware attacks—highlight the potential risk to reliability. Now more than ever, the three pillars of the [E-ISAC Long-Term Strategic Plan](#)—information sharing, analysis, and engagement—are essential to reducing and mitigating security risks to the BPS:

Information Sharing

Gathering and sharing timely, actionable information across industry and with government partners is fundamental to achieving our reliability mission. This year, in collaboration with the National Rural Electric Cooperative Association and the American Public Power Association, the E-ISAC created a member-driven community that provides information tailored for small and medium power utilities. This included the introduction of a weekly cyber and physical security summary that identifies specific threats. Also, the E-ISAC further strengthened its partnerships with Canadian authorities, such as the Canadian Security Establishment, which increased intelligence sharing and collaboration. In addition, the partnership among the E-ISAC, the Downstream Natural Gas ISAC, and the Oil and Natural Gas ISAC provides a robust information exchange on shared security risks with the recognition of interdependency of natural gas and electricity industries.

E-ISAC Outreach Activities

- Critical Broadcast Programs: 2
- All-Points Bulletins: 6
- Direct Alerts and Shares: 1,200



Analysis

In 2021, the E-ISAC focused on increasing visibility into utility OT environments while working in partnership with the CRISP community and the U.S. government as well as Canadian members and government partners to improve awareness of threats:

Lighthouse: During the year, the Canadian Independent Electric System Operator granted the E-ISAC access to their threat reporting program, Lighthouse, which provides a near real-time view into cyber threats and incidents that can impact the BPS. In collaboration with the Independent Electric System Operator, selected E-ISAC reports are posted on the Lighthouse portal for awareness.

CRISP Operational Technology Pilots: CRISP is a unique resource for utilities that provide threat and trend analysis to participants in partnership with the U.S. DOE and Pacific Northwest National Laboratory. In 2021, the E-ISAC expanded this resource into OT networks. The E-ISAC worked with a vendor and the National Rural Electric Cooperative Association on two pilot projects that gave E-ISAC analysts greater capability to analyze CRISP utility data and identify trends. These capabilities will continue into 2022 and underscore the importance of collective defense and threat intelligence sharing.

DOE 100-Day Cyber Security for Industrial Control System Plan: The White House's 100-Day Plan, which seeks to improve the cyber security of electric utilities' OT networks and secure the energy sector supply chain, included the E-ISAC. Consequently, E-ISAC analysts now have greater access into OT network data of participating utilities, enabling cross-correlation of data and enhancing the ability to spot trends when combined with other data sets in order to alert members to take appropriate mitigation actions.

Engagement

The E-ISAC's member profile reflects the diversity of the industry in the United States and Canada. Membership in the E-ISAC has grown to over 1,300 member organizations with more than 6,800 individual E-ISAC Portal users—a 22% increase since 2020. This year, the E-ISAC focused on growing membership among small and medium public power and cooperative utilities, resulting in a 32% increase in that member group.

The 2021 E-ISAC stakeholder feedback survey focused on the overall customer experience and the extent to which E-ISAC's products, programs, and services helped to reduce risk. In response, the E-ISAC launched several initiatives, including more targeted material, such as a weekly vulnerability summary, as well as a product focused specifically on industrial control system vulnerabilities. The E-ISAC resumed its Industry Engagement Program in a virtual format and conducted four sessions geared toward cooperatives, public power, Canadian utilities, and the Regional Entities.

E-ISAC Canadian Engagement

E-ISAC also increased its focused engagement with Canadian entities: coordinating regularly with the Canadian Electricity Association (CEA) and participating in CEA's quarterly Security and Infrastructure Protection Committee meetings as well as briefings on the Canadian Centre for Cybersecurity's monthly energy sector coordination calls. These engagements reflect efforts to strengthen existing and build new partnerships in Canada and to increase membership.

GridSecCon 2021

A record number of attendees participated in NERC's 10th annual security conference, GridSecCon 2021. Hosted by NERC, the E-ISAC, and Texas RE, the conference featured a [virtual conversation](#) between U.S. DOE Secretary Jennifer Granholm and NERC President and CEO Jim Robb.

GridEx

More than 250 organizations participated in GridEx VI, exercising their response and recovery plans in the face of simulated, coordinated cyber and physical attacks on the North American BPS and other critical infrastructure. The exercise—the largest grid security exercise in North America—concluded with an executive tabletop session that brought together 81 senior executives from industry and government to focus on strategic and policy-level issues raised during the exercise. Participation in the tabletop expanded to include more representation from public power, co-ops and municipal entities, and Canadian partners as well as other critical infrastructure sectors, such as natural gas, original equipment manufacturers, financial services, and telecommunications. These cross-border, cross-industry relationships provide the necessary strength in the depth needed to mitigate the current threat landscape.

The following are key themes that emerged from the tabletop: strengthening operational coordination between the electricity industry and telecommunications providers, enhancing emergency operations coordination between the electricity industry and natural gas providers, and building a common understanding of the consultation process and goal of a grid security emergency order. NERC will issue the GridEx VI lessons learned report in March 2022.



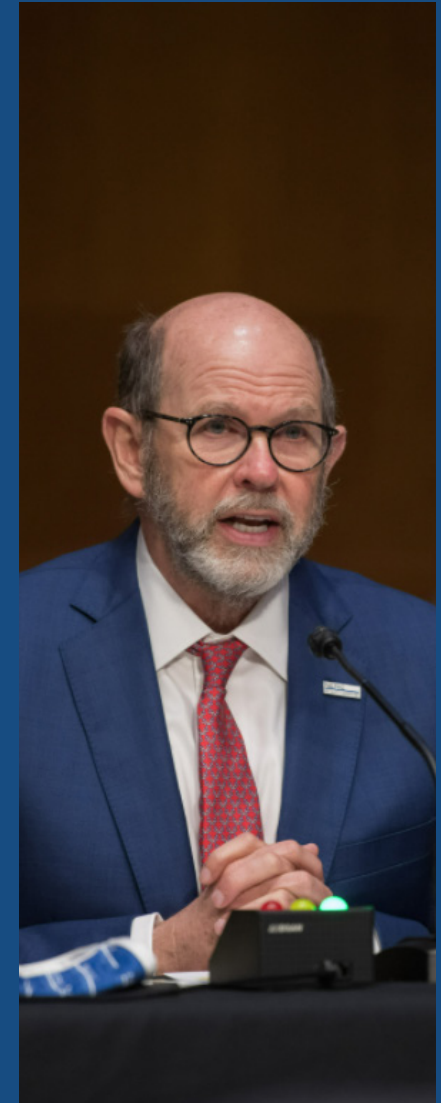
Strengthening Engagement across the Reliability and Security Ecosystem in North America

Maintaining electric reliability and security requires broad engagement among a diverse array of stakeholders. Electric utilities, regulators, and policymakers in North America bear the shared responsibility for a reliable and secure electric grid. Therefore, fostering and maintaining relationships with each other is vitally important, and the ERO Enterprise is dedicated to working hand-in-hand in support of its collective mission of reliability, resilience, and security.

North American Engagement

The reliability and security events of 2021 warranted continued significant engagement with policy stakeholders at the state and federal levels, often at the highest levels. Following the severe cold weather events that affected Texas and the Central United States, Jim Robb, NERC's president and CEO, was called to testify before Congress at separate hearings held by the U.S. Senate Committee on Energy and Natural Resources and the U.S. House Committee on Energy and Commerce. These hearings illuminated reliability risk associated with winterization efforts, fuel assurance, and critical sector interdependencies. NERC also briefed state and provincial regulators on topical cyber security events. This was in addition to regular engagement with these audiences on NERC reliability assessments and technical work in coordination with the Regional Entities' state outreach teams.

NERC and Regional Entity staff continued to work to strengthen relations between the United States and Canada. Conversations and information exchange around technical and regulatory matters included key partners, such as the Canadian Electricity Association, Natural Resources Canada, and the Canadian Associations of Members of Public Utility Tribunals (CAMPUT), among others. In August, more than 30 regulators from seven Canadian provinces and Canada's federal government joined NERC's Board of Trustees to discuss topics of interest to both countries around managing operating characteristics of an evolving grid, fuel assurance, and interdependencies with other critical sectors—such as the natural gas system and telecommunications. Cyber security threats across critical sectors and efforts to monitor, analyze, and mitigate cyber risks were also discussed. Session participants, including CEOs from Regional Entities with Canadian territory in their footprints, discussed the status of Reliability Standards and enforcement activities within the provinces and key coordinated efforts within the ERO Enterprise.



Jim Robb, NERC president and CEO, speaking before the U.S. Senate in March 2021.



European Union



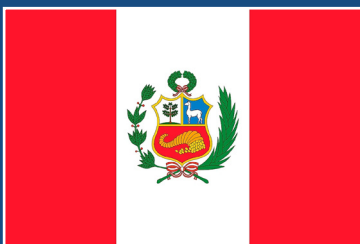
Chile



Republic of Korea



Colombia



Peru

Additionally, NERC executives participated in several Canadian events. Jim Robb was a keynote speaker during CAMPUT's Autumn conference, which focused on the importance of relationships, fostering collaboration, and creating space for innovation upon emerging from the pandemic. In November, Manny Cancel, NERC's senior vice president and CEO of the E-ISAC, delivered keynote remarks to senior industry leaders at the Ontario Independent Electricity System Operator annual cybersecurity executive briefing, discussing cyber threats and policies.

The value of the ERO model continues to attract attention internationally. In 2021, NERC held two information exchanges with partners from the European Union and conducted technical engagements with industry and policy stakeholders from Chile, the Republic of Korea, Central America, West Africa, Colombia, and Peru.

Additional Engagement Efforts

In addition to ongoing technical work with industry that is critical to stakeholder participation in the ERO process, two special engagements took place in 2021 that helped NERC identify risk and develop mitigation solutions. In January, NERC and the RISC hosted the first fully virtual Reliability Leadership Summit with leaders of the reliability community, including top industry executives, state and federal regulators, and NERC and Regional Entity senior leadership. The summit focused on four specific areas: grid transformation, extreme natural events, security risks, and critical infrastructure interdependencies. Open panel discussions were held at the end of each day to address these and any other risks that required deeper discussion. The leadership summit helped inform the [2021 ERO Reliability Risk Priorities Report](#), which presents the results of the RISC's continued work to strategically define and prioritize risks to the reliable operation of the BPS and thereby provide recommendations to the Board.

In July, NERC entered into an enhanced [memorandum of understanding](#) with the Electric Power Research Institute to collaboratively enable improved resilience and reliability of the North American electric grid. In this agreement, NERC and the Electric Power Research Institute pledged to more effectively and efficiently leverage their collective knowledge of the rapidly transforming power sector. The agreement calls for the two organizations to meet regularly and coordinate on several fronts, including supporting effective deployment of industry resources to address emerging issues, jointly sponsoring workshops or meetings, and identifying and collaborating on key projects and activities. This strengthened collaboration endeavors to better accelerate energy-system innovation and solve reliability challenges before they happen.

Capturing Effectiveness, Efficiency, and Continuous Improvement Opportunities

The ERO Enterprise embraces consistency, quality, efficiency, and timeliness of results and recognizes that improvements in efficiency are essential to mitigating the ongoing cost of maintaining and improving the quality and effectiveness of ERO Enterprise operations. In 2021, the ERO Enterprise focused on three main objectives: the rollout of the Align project and the ERO Enterprise Secure Evidence Locker (ERO SEL), the Standards Efficiency Review (SER), and the implementation of the Reliability and Security Technical Committee (RSTC).

Align Rollouts and ERO Enterprise Secure Evidence Locker

The ERO Enterprise shares a collective mission and vision to assure the reliability, resilience, and security of the North American BPS. The 2021 rollout of Align and the ERO SEL was the next step in the highly cooperative, mission-driven relationship that has been forged between NERC and the Regional Entities, eliminating unwieldy processes and improving efficiency and effectiveness.

Align

The Align Project, formerly known as the CMEP Technology Project, is a culmination of strategic efforts that began in 2014 with the goal of improving and standardizing processes across the ERO Enterprise in order to enhance the efficiency of ERO Enterprise operations and improve the effectiveness of executing statutory functions. Align moves all compliance monitoring and enforcement business processes to a common standardized platform, resulting in a consistent application of the ERO Enterprise CMEP and a more secure method of managing and storing CMEP evidence and data. The ERO SEL—a key component of the reimagined suite of CMEP work and data management tools—provides a secure, isolated environment to collect and protect compliance monitoring and enforcement evidence that significantly reduces the risk of loss or exposure of evidence and harmonizes the evidence collection processes.





The ERO Enterprise launched Release 1 of the Align tool and the ERO SEL for MRO, NERC, and Texas RE on March 31, 2021. Release 1 was subsequently launched in WECC, NPCC, ReliabilityFirst, and SERC in May. Release 1 included self-reporting/self-logging, enforcement processing and mitigation functionality in Align as well as the use of the ERO SEL to collect registered entity-provided evidence as part of the ERO Enterprise's CMEP activities. Release 2 launched across industry beginning July 19, 2021, with some Regional Entities going live for various functions in September and October. Release 2 included technical feasibility exceptions, periodic data submittals, attestation and self-certification functionalities in Align as well as the use of the ERO SEL to collect registered entity-provided evidence to support these activities. The Align project team completed the development, regression testing, and user acceptance testing of Release 3 in October and deployed it to the Align training environment in early November. Release 3 functionality will consist of core capabilities for audits, audit planning, and scheduling.

Release 4, scheduled for 2022, will encompass functionality originally scheduled for Release 3: inherent risk assessments, compliance oversight planning as well as enhancements to audits, audit planning, and scheduling. The main reason for the bifurcation is taken from the lessons learned with Release 1 and Release 2: take deliberate steps and break the effort into pieces to ensure each release is properly implemented as demonstrated by the phased rollout of Release 1 by Regional Entity and the phased rollout of Release 2 by function.





Standards Efficiency Review

The SER multiphase project began in 2017 as NERC began using both internal ERO Enterprise resources and industry resources to evaluate candidates for potential Reliability Standard retirements. To date, the SER project has resulted in FERC approval of the retirement of 18 Reliability Standard requirements with other retirement recommendations pending. The additional phases of the SER project include recommended Rules of Procedure changes and enhancements to various standards development resources that are pending implementation.

The SER team evaluated the set of CIP standards and identified a list of three recommended retirements and six modifications. The team determined that there was not sufficient justification for retiring requirements that outweighed the reliability and security benefits of the requirements, particularly in light of past FERC directives and the evolving nature of cyber security. Therefore, the working team decided to change their focus and be more strategic. In May 2021, NERC released its [*Standards Efficiency Review Report and Transition Plan*](#), which included the CIP SER working team's overall recommendation for industry to create an initiative to align the CIP standards with the results-based framework. The timing, scope, and participants of a CIP standards alignment initiative will be determined at a later date. The alignment initiative will consider observations made by the Standards Committee Process Subcommittee evaluation of standards template and/or drafting team process changes.

The SER Advisory Group recognized that Reliability Standards efficiency should be an ongoing priority. To accomplish this goal, the Standards Committee Process Subcommittee, in coordination with the Standards Committee and NERC staff, will perform a comprehensive assessment and propose identified enhancements in the standards development and review processes to engrain efficiency principles. NERC will continue to coordinate with the industry team to ensure all of the information developed through previous standards grading efforts (including consideration of content, quality, cost, and reliability impact analysis) align with the SER transition and future development projects.

Reliability and Security Technical Committee Implementation

In 2020, the RSTC replaced three legacy committees—the CIP Committee, the Operating Committee, and the Planning Committee—to create a forum for aggregating ideas and interests; draw from diverse industry stakeholder expertise; and leverage that expertise to identify solutions to study, mitigate, and/or eliminate emerging risks to the BPS for the benefit of industry stakeholders, the Board, and ERO Enterprise staff and leadership. The RSTC is organized into three categories with unique focuses under which subcommittees, working groups, and task forces perform their work: performance monitoring, risk mitigation, and reliability and security assessment.

In 2021, the RSTC subcommittees began developing reliability (operating and planning) and security guidelines as well as technical guidance documents, which include the collective experience, expertise, and judgment of the industry. The objective of the reliability guidelines is to distribute key practices and information on specific issues critical to promote and maintain a highly reliable and secure BPS.

Approved Guidelines and Documents

Approved Reliability Guidelines

Balancing

- [Reliability Guideline: Area Control Error Diversity Interchange Process](#)
- [Reliability Guideline: Operating Reserve Management](#)

Energy Assurance

- [Reliability Guideline: Gas and Electrical Operational Coordination Considerations](#)

Resource Performance

- [Reliability Guideline: Performance, Modeling, and Simulations of BPS-Connected Battery Energy Storage Systems and Hybrid Power Plants](#)

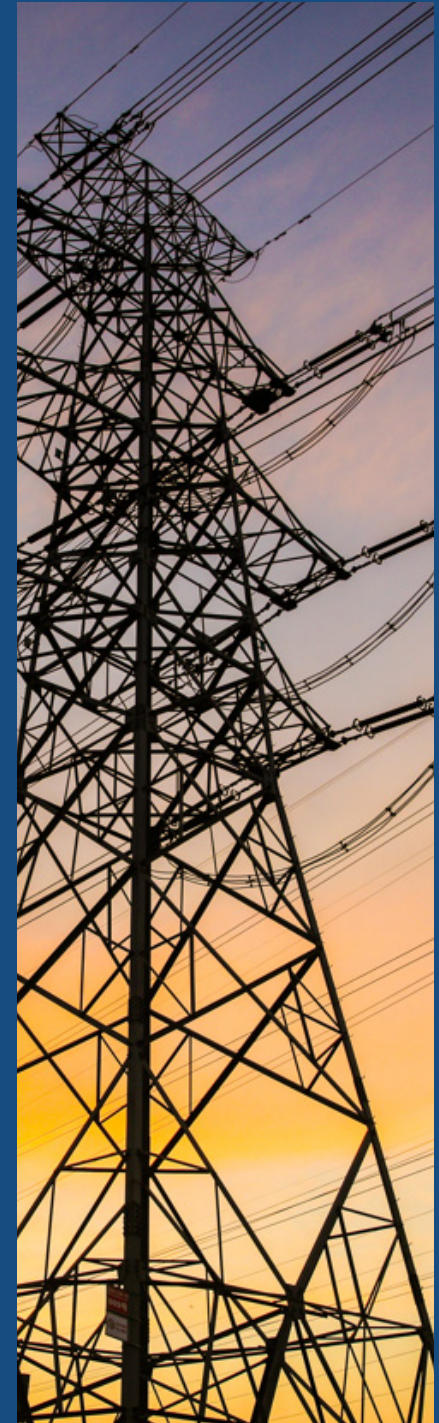
Transmission Planning

- [Reliability Guideline: Model Verification of Aggregate DER Models used in Planning Studies](#)

Approved Technical Reference Documents

Cyber

- [Technical Reference Document: Assessing and Reducing Risk](#)
- [Technical Reference Document: Assessing and Reducing Risk Tool](#)



Letter from the NERC Board Chair

This past year provided quite a journey for reliability, resilience, and security. When we started the ERO effort in 2006, the focus was to address the root causes of the 2003 cascading blackout. Appropriately, that caused us to focus on the traditional functions of operating the BES, such as planning, operations, situational awareness, operator training, vegetation management, facilities ratings, system maintenance, and relay misoperations. We have tracked improvement in all of these traditional functional areas and have a very reliable grid. The challenges we are facing in 2021 and beyond test these original perceptions and assumptions in ways we could not contemplate.

Coming off of the SolarWinds event in December 2020, we saw Winter Storm Uri impact a significant part of the country with particularly devastating effects in Texas. The loss of firm load was the third worst in the history of the grid. FERC Chairman Glick, Jim Robb, and the NERC Board all share a commitment to act upon the recommendations from the *FERC–NERC–Regional Entity Staff Report*.

The report, produced in November of 2021, did not disappoint. More than 28 recommendations were provided, including several for mandatory standards. It was clear that voluntary recommendations from similar events in prior years were not implemented sufficiently to prevent another major event. In addition to moving forward on cold weather Reliability Standards in August, a Level 2 alert was issued to registered entities to gauge actions being taken to prepare for the upcoming winter, specific mitigations from existing guidelines, and implementation of lessons learned.

The NERC Board identified three top priorities for 2021: weatherization, energy reliability assurance, and cyber security:

The subject of weatherization will remain a priority for some time. Throughout the grid transformation, we have seen increased dependence on resources that are impacted by weather, and planners and operators recognize that greater attention is required on how to prepare for these extreme and more likely events.

Another key area of focus is energy reliability assurance—ensuring that there is always sufficient energy to serve demand. Historically, we focused on reserve margins at the peak as a way to assure we had sufficient resources to meet load throughout the year. However, with the rapid growth of variable renewable generation and the retirement of traditional baseload generation, the risk of resource shortfalls is no longer restricted to the summer peak demand periods as they become energy limited due to constraints in fuel and must now be anticipated during other hours, shoulder months or even winter. We are enhancing our modeling and probabilistic analyses to better understand these structural changes that historically exhibit high capacity margins.

The third priority for the Board—cyber security—is by no means last on the list of importance.

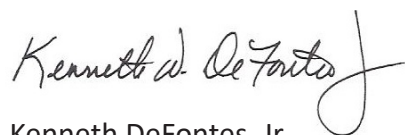


Kenneth DeFontes, Jr.
Board Chair

I have been extremely pleased with the development of NERC's E-ISAC. The E-ISAC has been deeply engaged in addressing cyber security compromises and their implications to industry through alerts and other communication efforts. The success of GridSecCon and GridEx VI further amplify the comprehensive approach to North American security that the E-ISAC undertakes. It is this combination of information sharing and analysis, along with CIP standards, that provide a vital defense of the BPS across North America. Robust designs and new study tools that incorporate the requisite cyber security are needed to support grid transformation and help ensure reliability and resilience. Furthermore, we must continue to work to enhance the structure of the CIP standards—including a review of the bright-line criteria and assessment of protections for low-impact devices—as well as protection against coordinated attacks. Ensuring that all of these efforts provide a strong foundation for security was a top priority in 2021 and will continue. This can only be done through the collaborative partnership between NERC, the Regional Entities, the E-ISAC, stakeholders, and government partners in Canada and the United States.

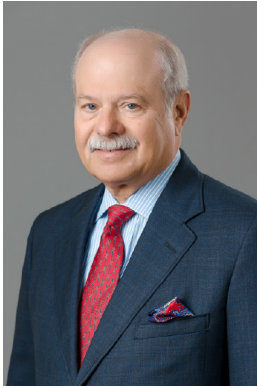
The Board recognizes there are significant policy and technical forces that are driving change in how electricity systems are designed, planned, operated, and secured. These changes are occurring at a rapid pace. While striving for efficient and effective programs, NERC's core processes were designed in an era of much more gradual change that focused on consultation, deliberation, and consensus building. The Board sought input from stakeholders in September to identify new ways of working and making processes more efficient and agile. The responses from stakeholders were very positive, agreeing that looking for more nimble and agile approaches while maintaining the technical expertise and stakeholder consensus building process, a hallmark of ERO programs, is a laudable goal.

The more complex the system becomes, the greater the risk to reliability, resilience, and security. At the same time, the future offers exciting new opportunities and transitions for an industry that is amazingly adaptive to change. As chair of the NERC Board of Trustees, I am very proud of the efforts undertaken in 2021, but much more remains to be done. I look forward to working with all of our stakeholders and policymakers as we rededicate and reorient ourselves to meeting these challenges.



Kenneth DeFontes, Jr.

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