

Generator Winterization Program

2021-2022 General Findings

April 2023



**MIDWEST
RELIABILITY
ORGANIZATION**

380 St. Peter St, Suite 800
Saint Paul, MN 55102

651-855-1760

MRO.net

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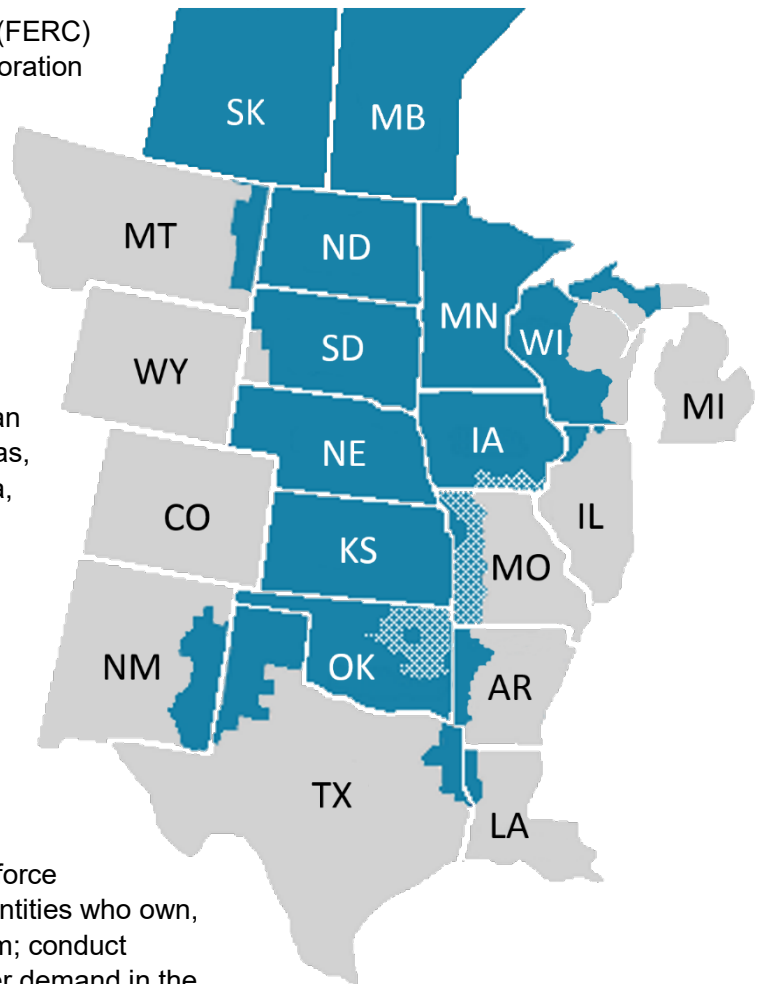
PREFACE

Midwest Reliability Organization (MRO) is dedicated to its vision of **a highly reliable and secure North American bulk power system**. To ensure reliability of the bulk power system in the United States, Congress passed the Energy Policy Act of 2005, creating a new regulatory organization called the Electric Reliability Organization (ERO) to establish mandatory Reliability Standards and monitor and enforce compliance with those standards on those who own, operate or use the interconnected power grid.

In 2006, the Federal Energy Regulatory Commission (FERC) approved the North American Electric Reliability Corporation (NERC) as the ERO under section 215(e) (4) of the Federal Power Act. NERC delegates its authority to monitor and enforce compliance to six Regional Entities established across North America, of which MRO is one. Recognizing the international nature of the grid, NERC as the ERO, along with MRO, established similar arrangements with provincial authorities in Canada.

The MRO region spans the provinces of Saskatchewan and Manitoba, and all or parts of the states of Arkansas, Illinois, Iowa, Kansas, Louisiana, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wisconsin. The region includes more than 225 organizations that are involved in the production and delivery of electric power, including municipal utilities, cooperatives, investor-owned utilities, transmission system operators, federal power marketing agencies, Canadian Crown Corporations, and independent power producers.

MRO's primary responsibilities are to: monitor and enforce compliance with mandatory Reliability Standards by entities who own, operate, or use the North American bulk power system; conduct assessments of the grid's ability to meet electric power demand in the region; and analyze regional system events. Additionally, MRO creates an open forum for stakeholder experts in the region to discuss important topics related to addressing risk and improving reliable operations of the bulk power system.



INTRODUCTION

Background

The MRO Generator Winterization Program (GWP) began in 2021 in response to the severe cold weather event of 2018 that resulted, in over 180 individual generating units experiencing an outage, derate or failure to start (14,000 MW). Subsequently, FERC and NERC issued a joint 2019 staff report ([*The South Central United States Cold Weather Bulk Electric System Event of January 17, 2018*](#)¹) identifying reliability concerns and actions to be taken to promote a highly reliable and secure North American bulk power system.

Two findings were identified:

1. Failure to properly prepare or “winterize” the generation facilities for cold temperatures.
2. Gas supply issues and natural gas-fired units representing a large percentage of the unplanned outages or derates.

The report’s actions/recommendations were focused on Generator Owners/Operators, Reliability Coordinators, and Balancing Authorities preparedness for cold weather conditions. The envisioned solution was presented as a three-pronged approach:

1. Development or enhancement of one or more NERC Reliability Standards.
2. Enhanced outreach to Generator Owners/Generator Operators.
3. Market (Independent System Operators/Regional Transmission Organizations) rules where appropriate.

The purpose of the GWP is to enhance outreach to Generator Owners/Generator Operators within MRO’s regional footprint. The program is outside of any compliance or enforcement activities and is meant to promote cold weather reliability by sharing information, identifying best practices, and offering recommendations to help reduce weather-related risks. The primary goal of the program and this report is to prevent reoccurrence of large-scale, unplanned outages due to cold weather. This report highlights key findings from GWP activities in 2021 and 2022, as well as activities underway at NERC to address operational challenges during cold weather.

Target Audience

- Generator Owners
- Generator Operators



MRO GWP IMPLEMENTATION

The GWP is by design a voluntary program. MRO’s Reliability Analysis Department is responsible for management of the program. Components of the GWP include: a survey, data/information request, site visits, site specific reports, a general findings report, and the promotion of outreach by NERC and/or the ERO Enterprise related to cold weather (i.e., practice guidance, lessons learned, upcoming standards, NERC Alerts, etc.). The GWP’s content and resources can be found on [MRO external website](#).

MRO reviews generator data related to geographic locations, plant configurations, and technology annually. These three factors are used by the registered entity to develop winter readiness plans, and therefore, the data is important in determining MRO’s approach to implementing the GWP cold weather preparedness survey and subsequent site visits. Regional generation inventory data (Generating Availability Data System data) provides quarterly generating unit performance data. Functional registrations of Generator Owner and Generator Operators demonstrate growth trends while asset/facility verifications provide deeper detail into configurations and technologies. Figure 1 demonstrates the 2021 vs 2022 numbers of functional registrations for Generator Owner and Generator Operator and the numbers of generation assets.

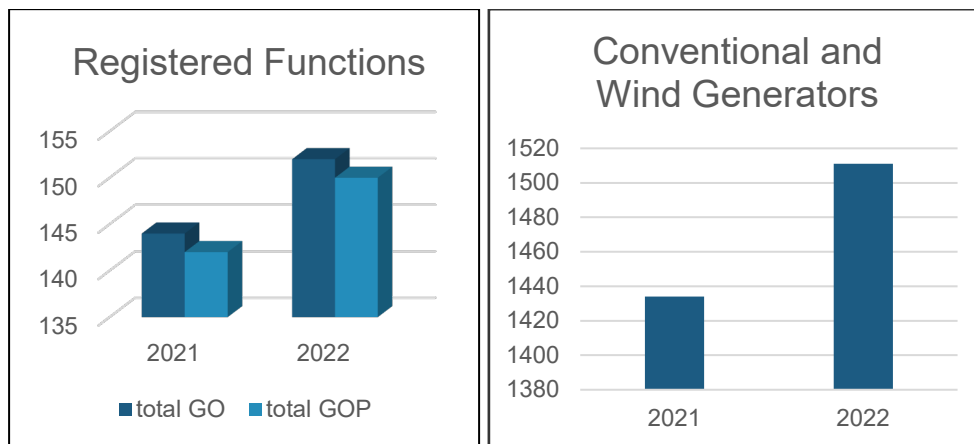


Figure 1: Number of Registered GO/ GOPs and Conventional and Wind Generators

The GWP cold weather preparedness survey is reviewed and updated annually by MRO staff. A version of the survey is available year round and is a good way for entities to self-assess generator winter readiness. MRO surveys a select number of entities each year through the GWP. Stakeholder participation in the survey is voluntary, but highly encouraged. The survey data is utilized to develop a baseline understanding of a facility’s winterization efforts and compare trends. To date, eighteen entities from the MRO region have completed the cold weather preparedness survey.

Similar to the survey, the GWP requires a select number of entity site visits each year. Site visits are forward looking aimed to address potential reliability concerns. Stakeholder participation in site visits is voluntary, but highly encouraged. The site visit provides MRO an observation of efforts taken by generation facilities to minimize impact of cold weather to plant operations. The entity receives an on-site report which summarizes findings from the survey, site visit, and any reviewed documentation identifying best practices



and offering recommendations. Figure 2 illustrates ten completed site visits in six different states within the MRO region.

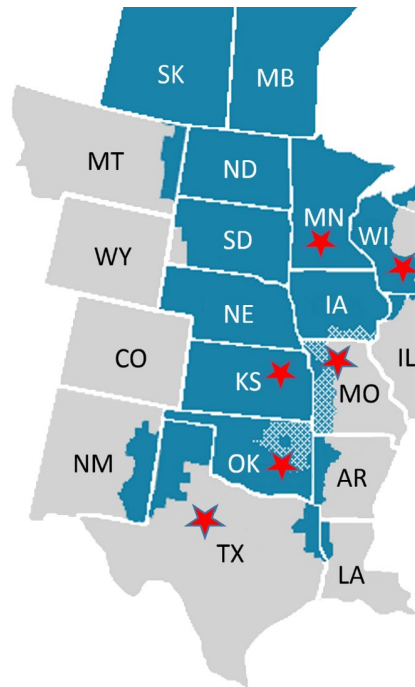


Figure 2: States within the MRO footprint where a GWP Site Visit was performed



WINTERIZATION TIMEFRAME

Routine cold weather readiness/preparedness work should be completed prior to the local expected seasonal first freeze date. Figure 3, the [NOAA First Frost Date⁴](#), suggests the month of September for the northern portion (north of Kansas) of the MRO region, while the southern half experiences first frost in October. The GWP work found that all entities had established preparedness activities within this timeframe, with an average start date for both northern and southern entities in the month of September. Preparation activities/work orders averaged a month's duration for completion. The September start in the southern portion of the MRO region ensured winter preparations were in place by early October, which follows the historical first frost dates. The northern portion of the MRO region starting preparation in September is not aligned to have winter preparations completed by the first historical frost dates.

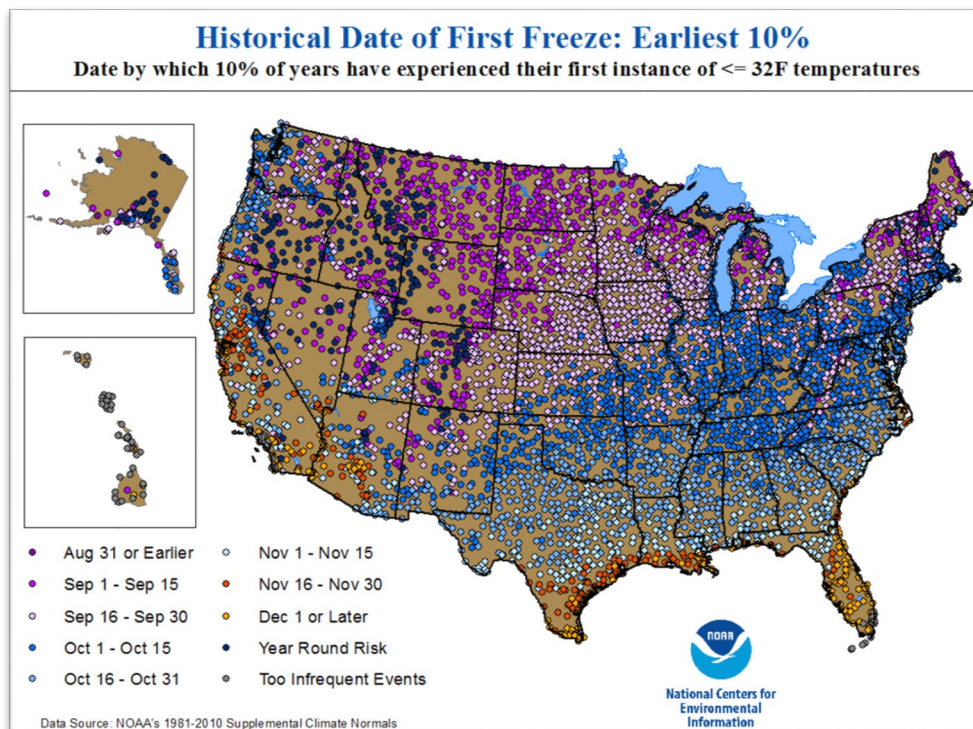


Figure 3: Earliest 10% of Historical First Freezes in the U.S.

The removal of winterization measures should wait until after the local expected seasonal last freeze date. Figure 4, the [NOAA Last Spring Freeze Date⁵](#), suggests a varying range of spring thaw across the MRO region (late February through May). The GWP work uncovered the end of the winter/cold weather season is not as defined by the entity as the start of the season. Not enough data has been collected through the GWP to conclusively determine the average end date of entities' winter preparedness periods, and therefore this will be a focus in 2023. The down time of the cold weather season is the best time to reflect upon lessons learned, develop new internal controls, and implement improvements/upgrades prior to the start of the next winter season.

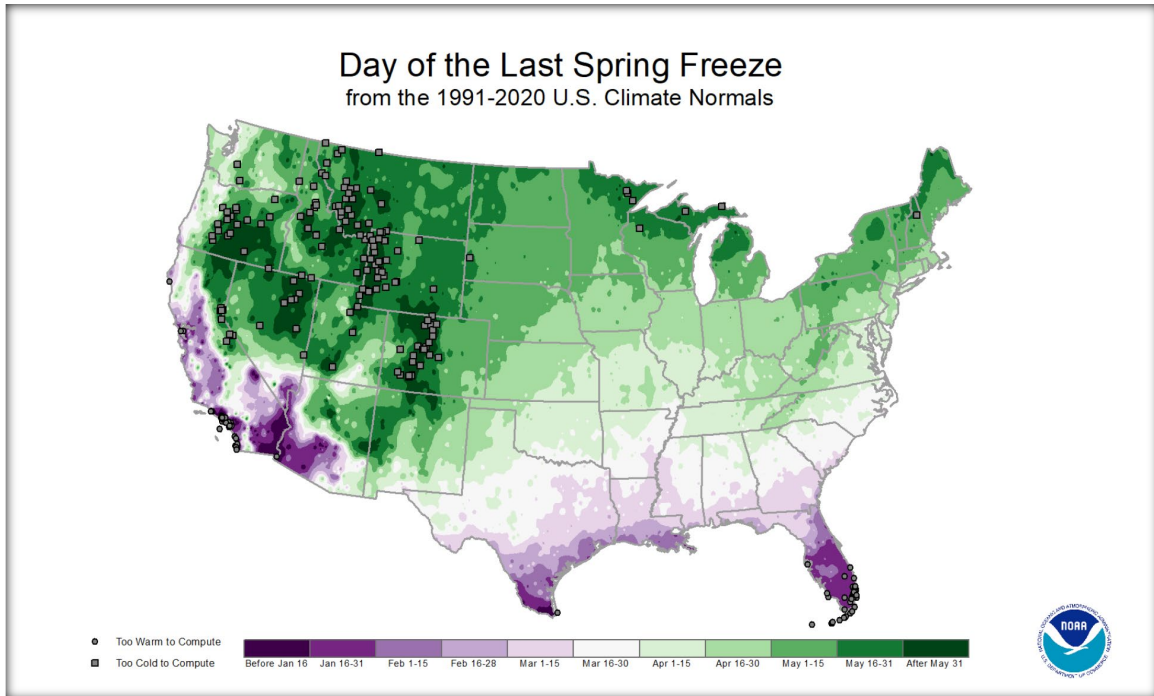


Figure 4: Historical Day of Last Spring Freeze in the Continental U.S.



WINTER WEATHER READINESS PROGRAM EFFECTIVENESS

The seven key components in [NERC's Reliability Guideline: Generating Unit Winter Weather Readiness – Current Industry Practices – Version 3⁶](#) are described as the general framework for developing an effective winter weather readiness program. The GWP found the level of effectiveness across MRO registered entities' winter readiness programs varied when focusing on these seven components.

1. Safety
2. Management Roles and Expectations
3. Processes and Procedures
4. Evaluation of Potential Problem Areas with Critical Components
5. Testing
6. Training
7. Communications

Figures 5a-c, show the results between 2021 and 2022 of MRO's review of entity programs. These results are reflective of information provided by twelve entities in 2021 and six entities in 2022. A yes indicates inclusion while a no indicates non-inclusion. Less than half of the twelve entities had a winterization plan in 2021, however; ten of the twelve entities had preparedness processes and procedures in place. In 2022, all six entities had a weatherization plan and supporting processes and procedures.

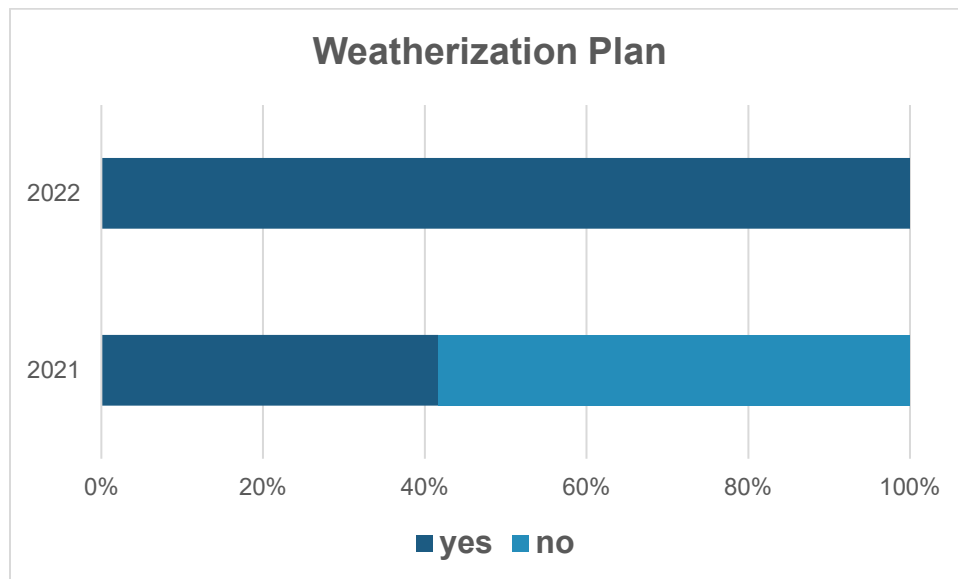


Figure 5a-2021 vs 2022 comparison of Winterization Plan



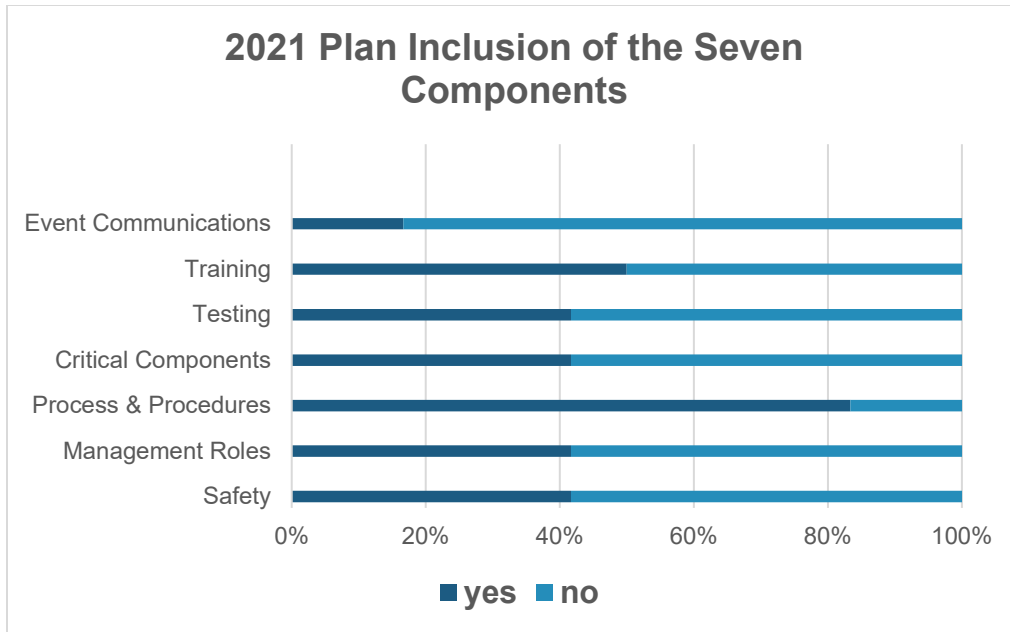


Figure 5b: 2021 Plan Inclusion of the Seven Components

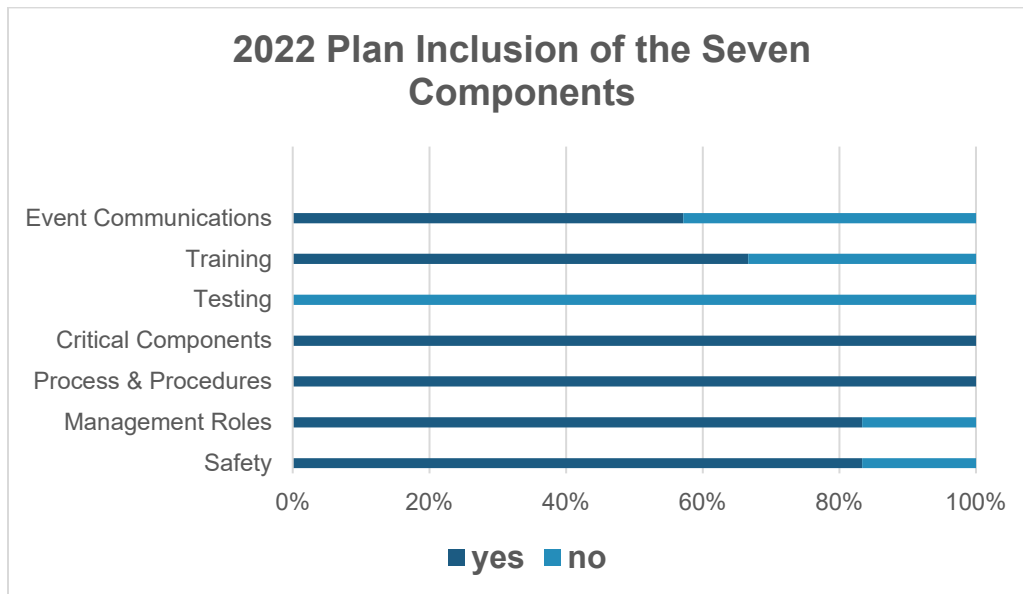


Figure 5c: 2022 Plan Inclusion of the Seven Components

Safety

Employee safety is priority and must be addressed in any winterization program/plan. Steps to reduce risk should be incorporated in winter weather programs and plans. Emergency response plans should be developed, known, and communicated in the event severe weather occurs. The MRO GWP observed positive improvements between 2021 and 2022 with regards to the inclusion of the safety component.



Management Roles and Expectations

Effective programs require maintenance and management plays a key role. Safety, operational performance, and reliability expectations should be clearly defined by senior management. Plant management should make sure the site plan is effective and executed as designed, addressing issues as they occur. This component's inclusion was lacking in at least half of entity programs assessed in 2021. In 2022, it appeared lacking from only one entity program. The GWP assessment reflects that the management roles and expectations component is an area where programs could be strengthened.

Processes and Procedures

There are no boundaries when it comes to processes and procedures as these internal controls are the key to conveying how elements of cold winter weather are addressed. Entities should review plant design, configuration, and historical trends to identify known and potential issues. The development and implementation of processes and procedures requires review and maintenance. The GWP assessment reflects that this component is the strongest amongst entity programs.

Evaluation of Potential Problems with Critical Components

Generator cold weather critical components are not currently defined by NERC, but have been referred to as any generating unit component or associated fixed fuel supply component that is under the Generator Owner's control and is susceptible to freezing issues, the occurrence of which would likely lead to a Generator Cold Weather Reliability Event. These vulnerabilities or problem areas need to be identified, known, and addressed to prevent cold weather operational issues from occurring. Previous cold weather events and lessons learned have developed lists of typical problem areas. Figure 5 demonstrates the component inclusion to entity programs, and additionally confirms that ERO outreach over the two-year period with regards to generator critical components was effective.

Testing

Low frequency tasks can be problem areas in response to cold weather events. Entities should identify these tasks and incorporate them into the winter readiness preparations, training and/or weather event response actions. The GWP assessment reflects that testing was the most overlooked/not included component in entity programs.

Training

Winter/cold weather specifics and plant/site specific awareness and maintenance training should be conducted annually. The results in Figure 5 show approximately 50 percent inclusion each year. The GWP found many entities incorporating daily safety meetings, weekly look-ahead, and post event lesson learned training into their programs.

Winter Event Communications

A cold weather generator reliability event can be described as any de-rate, outage, or failure to start caused by cold weather. Event communications must be clear and timely as they can be crucial to event response actions and prevention of future reoccurrence. The findings of this component were not strong, and it remains a close second behind testing as being overlooked for program inclusion.



GENERAL FINDINGS

MRO's GWP aims to obtain an understanding of registered entities' Winter Readiness Programs and corresponding internal controls related to the scope of work performed during winterization activities. This information informs future outreach, GWP program activities, and leverages best practices that can be shared across the region. Following review of the GWP findings, MRO will determine the program's overall effectiveness and implement any changes as a result.

Positive observations relate favorably to the quality of entities' processes, controls, or corporate culture of compliance. Entities are generally dedicated to winterizing critical components and investments/enhancements made to heat trace systems were impressive. MRO staff observed functional heat trace circuits, with heat trace applied on the entire length and not just 60 percent of lines, with overhaul heat trace projects underway to allow for lower baseline start up temperatures.

Winter weather readiness program recommendations are suggested opportunities for improvement in the control-related processes, procedures, or tools to enhance the reliability, security, or resiliency of the bulk power system. MRO's GWP recommendations mostly emphasize the continued development and formalization of entity programs to include all seven-framework components. Outside of the framework components, MRO suggested enhancements to internal controls, such as consider the creation of a troubleshooting plan/process diagram for operators and/or management with regards to fuel supply or supply chain issues.

Best practices identify ways of working to achieve the goal reliably and safely. Safety was evident as a top priority amongst all site visits. Not only have enclosures been built for vulnerable equipment, but also to give personnel shelter and areas to stay warm. Due to snow and ice conditions, cooling tower structures have been enhanced with extra structural support and innovative non-slip surfaces. Daily job briefs and the tracking of lessons learned continue to provide effective change solutions, such as implementing post event response teams to include trades, scaffolding, welding, and boiler crews.



FINDINGS RELATED TO NERC ALERTS

Cold Weather NERC Alerts provide specific actions that registered entities should consider when preparing for winter weather. Since 2021, NERC has issued three cold weather alerts. NERC issued an alert in September of 2022, [Industry Recommendation: Cold Weather Preparations for Extreme Weather Events II](#)⁷, which had three specific recommendations for the functions of Generator Owner (GO) and Generator Operator (GOP).

Recommendation #2

GO and GOP(s) should review Reliability Coordinators, Balancing Authorities, and Transmission Operators seasonal operating plans to ensure unit assumptions are accurate and that there is a defined readiness time for GO/GOPS to make necessary arrangements to maximize the availability of resources.

Related GPW Finding

GWP activities found that replenishment of natural gas fuel supply and communications with fuel suppliers was a common concern. Preparation and contracts only go so far and fuel constraints continue to be a common cause for winter seasonal outages. A solution to fuel supply issues remains at large. Wind and solar configurations/units have yet to be part of a GWP site visit, thus a better understanding of these unit's cold weather capabilities, cold weather packages, associated timeframes of readiness, and assumption communications, such as deicing capabilities, are a focus for 2023.

Recommendation #3

GO/GOP unit de-rate communications to RCs, BAs, and TOPs need improvement. Due to factors of unavailability related to weather, fuel constraints (gas restrictions and refueling limitations), derates for alternate fuels, potential concerns with increased outages or delayed starts based on unit ambient ratings (including the effect of precipitation and accelerated cooling of wind, etc.), and historical performance derates during cold weather may be forecasted or actual.

Related GWP Finding

The GWP concludes that the determination of original equipment manufacturer (OEM) design parameters and unit ambient ratings was/is a major frustration. Some resolution was offered through comments on Standards Project 2019-06 Cold Weather, where a revision to the upcoming effective EOP-011 Standard now allows for the use of historical data as an alternative to OEM ratings when determining the unit's minimum operating temperature. However, issues of unit turbine tuning by OEMs/vendors remains a contributor to unit derate or unavailability as entities are waitlisted due to vendor resourcing. Derate communications should be part of the seasonal, outage coordination, day-ahead, and real-time energy assessments.

Recommendation #5

This recommendation was specific to GO/GOPs with dual fuel units.

Related GWP Finding

To date, the MRO GWP has included two site visits that had dual fuel configurations. The GWP found that neither site had weatherization procedures that included testing to ensure resources can switch to the alternate fuel. However, one site had preparations and monitoring actions to know how much alternate fuel



was on site. An additional take away was that under normal conditions the offload of fuel rate was only slightly faster than a unit's burn rate.

On February 13, 2023, NERC issued an alert [Industry Advisory Cold Weather Standards⁸](#). This advisory suggests that later in 2023 NERC will likely issue a Level 3 NERC Alert regarding "Essential Actions" pertaining to cold weather operations. The alert will be sent to registered entities upon gathering additional information related to extreme winter weather events during the 2022-2023 winter season. The basis of the proposed Level 3 Alert will be the requirements outlined in enhanced versions of EOP-011-3 and EOP-012-1, which have been filed with FERC.



FINDINGS RELATED TO COLD WEATHER STANDARDS

This report and the GWP are outside of Compliance Monitoring and Enforcement Program (CMEP) activities, however; one or more NERC Reliability Standards will be enhanced to reduce cold weather risk.

[Project 2019-06 Cold Weather](#)² impacts several Reliability Standards that become enforceable on April 1, 2023.

- EOP-011-2 Emergency Preparedness and Operations
- IRO-010-4 Reliability Coordinator Data Specification and Collection
- TOP-003-5 Operational Reliability Data

[Project 2021-07 Extreme Cold Weather Grid Operations, Preparedness, and Coordination](#)³ is underway and addresses reliability-related findings from the [Federal Energy Regulatory Commission \(FERC\), NERC, and Regional Entity Joint Staff Inquiry into the February 2021 Cold Weather Grid Operations](#)¹⁰. On February 16, 2023, FERC issued an Order Approving Extreme Cold Weather Reliability Standards EOP-011-3 and EOP-012-1 and Directing Modification of Reliability Standard EOP-012-1.

- EOP-011-4 Emergency Operations
- EOP-012-1 Extreme Cold Weather Preparedness and Operations
- TOP-002-5 Operations Planning

Project 2019-06 standards were of common concern and a frequent topic of discussion brought forward by entities participating in GWP site visits.

EOP-011-2

The EOP-011-2 standard requires applicable functions to have processes to prepare for and mitigate emergencies. Requirement 1.2.6. states that provisions to determine reliability impacts shall include 1.2.6.1. cold weather conditions, and 1.2.6.2. extreme weather conditions.

Findings

The GWP identified that of the eighteen GO/GOP entities assessed, only three defined extreme conditions in cold weather programs. The determination of expected normal versus extreme/severe winter weather varied. Those entities that identified extreme weather conditions were located in the southern portion of MRO's region, and generalized extreme as below 32 degrees Fahrenheit for an expected duration of 36 hours or more.

Declarations of extreme winter weather had notable associated actions observed by the GWP. These "extreme" actions/mitigations help to ensure reliable generator performance and help prevent unplanned outages due to cold weather. Extreme actions are summarized as:

- Increase in frequency of walk downs
- Equipment added to the routine freeze protection checks
- Heaters/enclosures/wind breaks or insulating blankets are utilized for not only critical, but also support equipment
- Additional procedures, such as those for de-icing or preheating, are called to action
- Standby equipment is prepared
- Increases to resourcing and staffing (including confirming on-call lists)



NERC authored a technical reference document, [Calculating Extreme Cold Weather Temperature](#)⁹, which demonstrates a method to acquire data and determine the extreme cold weather temperature for a given/specific location.

IRO-014 and TOP-003-5

Both standards IRO-010-4 Reliability Coordinator Data Specification and Collection and TOP-003-5 Operational Reliability Data identify GO/GOP operation data as a deliverable, a response to the receipt of requested data specifications from either an RC or TOP.

Finding

The 2022 GWP site visits and discussions found most entities were focused on how to prepare for, and meet, EOP-011-2 requirements and that not much attention was yet given to the IRO-010-4 and TOP-003-5 standards that become effective April 1, 2023.



CONCLUSION

A GO/GOP's generating unit weatherization program and plan should address factors that could impact availability. Specifically with regard to geographical locations, plant configurations, and technology, all of which play a role in an entity's winter weather readiness program development. The MRO GWP recommends that GO/GOPs inspect and maintain weatherization measures ahead of the upcoming winter season, before the onset of and during extreme cold weather conditions. Adopting and implementing the seven framework components into an entity's winter weather readiness program/plan aligns with, and expands upon, the minimum requirements defined through the upcoming effective cold weather standards.

Cold weather continues to have an impact on the reliability of generation. Enhanced outreach to Generator Owners/Generator Operators will continue to be a focus of MRO and the ERO Enterprise. Encouraging actions that foster generator performance/reliability and help prevent cold weather unplanned outages is the primary goal of MRO's GWP, the program will continue to respond and adapt to provide cold weather outreach and share lessons learned.



RELATED INFORMATION

[2021 Preparation for Severe Cold Weather Webinar.pdf](#)

[2022 Winter Preparation for Severe Cold Weather Webinar.pdf](#)

[2022 MRO Regional Winter Assessment](#)

[2022 MRO Cold Weather Preparedness Workshop packet.pdf](#)

[NERC 2022-2023 Winter Reliability Assessment](#)

[2022 NERC Lesson Learned-Air Blast Circuit Breaker Cold Weather Operation](#)



REFERENCES

1. [2019 staff report, The South Central United States Cold Weather Bulk Electric System Event of January 17, 2018](#)
2. [Project 2019-06 Cold Weather](#)
3. [Project 2021-07 Extreme Cold Weather Grid Operations, Preparedness, and Coordination](#)
4. [NOAA First Frost Date](#)
5. [NOAA Last Spring Freeze Date](#)
6. [Reliability Guideline Generating Unit Winter Weather Readiness – Current Industry Practices – Version 3](#)
7. [September of 2022, Industry Recommendation: Cold Weather Preparations for Extreme Weather Events II](#)
8. [February 13, 2023 NERC issued an alert Industry Advisory Cold Weather Standards](#)
9. [Calculating Extreme Cold Weather Temperature](#)
10. [Federal Energy Regulatory Commission \(FERC\), NERC, and Regional Entity Joint Staff Inquiry into the February 2021 Cold Weather Grid Operations](#)

