NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Extreme Cold Weather Preparedness

Technical Rationale and Justification for EOP-012-2

~~January~~February 2024

RELIABILITY | RESILIENCE | SECURITY




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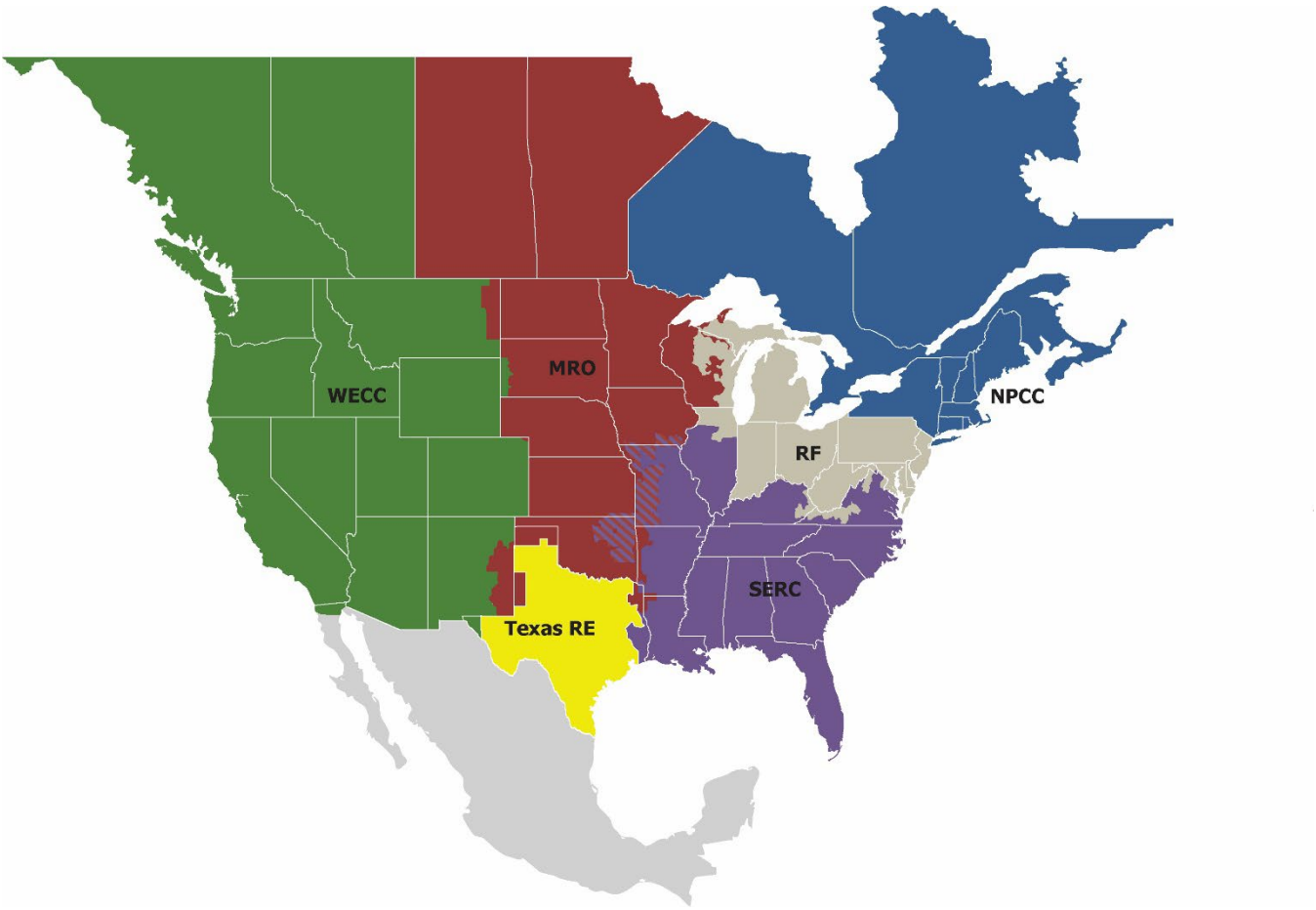
Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown on the map and in the corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

Introduction

This document explains the technical rationale and justification for the proposed Reliability Standard EOP-012-2. It provides stakeholders and the ERO Enterprise with an understanding of the technology and technical requirements in the Reliability Standard. This Technical Rationale and Justification for EOP-012-2 is not a Reliability Standard and should not be considered mandatory and enforceable.

Background

From February 8 through February 20, 2021, extreme cold weather and precipitation caused large numbers of generating units to experience outages, derates or failures to start, resulting in energy and transmission emergencies (referred to as the "Event"). The total Event firm load shed was the largest controlled firm load shed event in U.S. history and was the third largest in quantity of outaged megawatts (MW) of load after the August 2003 Northeast blackout and the August 1996 West Coast blackout. The Event was most severe from February 15 through February 18, 2021, and it contributed to power outages affecting millions of electricity customers throughout the regions of ERCOT, SPP, and MISO South. Additionally, the February 2021 event is the fourth cold weather event in the past 10 years, which jeopardized BPS reliability. A joint inquiry was conducted to discover reliability-related findings and develop recommendations from Federal Energy Regulatory Commission (FERC), NERC, and Regional Entity staff. The FERC, NERC, and Regional Entity Staff Report into the February 2021 Cold Weather Outages[1] ("Joint Inquiry Report") was published on November 16, 2021.

Project 2021-07 is a two-phase project to address the 10 sub-recommendations in Key Recommendation 1 of the Joint Inquiry Report for new or enhanced NERC Reliability Standards. Reliability Standard EOP-012-1 was originally developed to address Recommendations 1d, 1e, and 1f of the Joint Inquiry Report through new and enhanced requirements for generator preparedness for extreme cold weather conditions. Reliability Standard EOP-012-2 was revised to address Key Recommendations 1a, 1b, and 1c as well as the Federal Energy Regulatory Commission ("FERC") directives in the February 2023 order approving the Phase 1 standards EOP-011-3 and EOP-012-2.[2]

[1] The February 2021 Cold Weather Outages in Texas and the South Central United States | FERC, NERC and Regional Entity Staff Report | Federal Energy Regulatory Commission

[2] *N. Am. Elec. Reliability Corp.*, 182 FERC ¶ 61,094 (2023) (FERC Order), *notice denying reh'g and providing for further consideration*, 183 FERC ¶ 62,034 (2023).

Defined Terms

The SDT developed five defined terms to be added to the NERC Glossary of Terms to make the requirements easier to read and understand. These five terms are:

Extreme Cold Weather Temperature

The temperature equal to the lowest 0.2 percentile of the hourly temperatures measured in December, January, and February from 1/1/2000 through the date the temperature is calculated.

The definition of Extreme Cold Weather Temperature (ECWT) was developed by the Standard Drafting Team (SDT) to provide clarity to the Generator Owner (GO) on determining what temperature triggers the requirement obligations. Each GO should select a reliable source of data from a recording location near the plant to determine their ECWT. Sources could include, for example, the National Weather Service (NWS) or National Oceanographic and Atmospheric Administration (NOAA) weather stations, Federal Aviation Administration (FAA) weather stations, or Environment and Climate Change Canada location for Canadian entities[3], etc. NOAA's National Centers for Environmental Information provides Climate Data Online (CDO) as a free resource that includes quality-controlled weather data and 30-year Climate Normals[4]. In general, GOs should use the location nearest the plant, but may select a further location if geographic or local climatic patterns make a further location more representative of the weather at the generating unit. GOs may use on-site weather stations if data, which reasonably matches reliable nearby off-site sources since January 1, 2000, is available. The starting period chosen by the SDT to gather data to determine the lowest temperatures that occur near a facility is based on the completion of the modernization of the National Weather Service project known as MAR (Modernization and Associated Restructuring). This project was completed in the year 2000. In general, the National Weather Service modernization provides weather data to be available at most large airports. This will make it fairly accessible for companies to gather data and perform the required analysis. The December through February timeframe was selected to correspond to the meteorological winter, as defined by NOAA.[5]

The SDT discussed methods for determining an ECWT with engineering design professionals, and it was determined that it is typical engineering practice to use a statistical approach to determine the design temperature when implementing generation facility freeze protection measures. The SDT determined that only winter temperature values (i.e. between December and February) shall be used for the statistical approach and based on analysis of multiple weather data sites, it was determined that by using the lowest 0.2 percentile, there will be sufficient data points to ensure that a single hour at a temperature that may not be accurate, or may be a statistical anomaly, doesn't result in an overly conservative design or preclude the ability of the GO to use historical operating data to prove compliance to the requirements. The SDT selected the 0.2 percentile of winter month temperatures since 1/1/2000 to identify a temperature which has been rarely surpassed, but which allows some margin for a GO to have previously demonstrated successful operation. The SDT considered using the lowest recorded hourly ambient temperature, but upon further review of the historical weather data and generally accepted design principles, determined that the statistical approach to setting the ECWT for a site's location was more reasonable.

If reliable data is not available at a single weather station back to January 1, 2000, the GO should document the methodology they use to determine their ECWT, such as appending data from multiple weather stations or selecting a complete data set from a weather station further away from the facility. Please reference the Calculating Extreme Cold Weather Temperature document drafted by the SDT for more information on how to calculate the ECWT.[6]

[3] Environment and Climate Change Canada - Canada.ca
[4] https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals
[5] https://www.ncei.noaa.gov/news/meteorological-versus-astronomical-seasons
[6] Report (nerc.com)

Generator Cold Weather Critical Component

Any generating unit component ~~and/~~or system, 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. This definition excludes any component ~~and/~~or system or associated Fixed Fuel Supply Component located inside a permanent building with a heating source that regularly maintains the space at a temperature above 32 degrees Fahrenheit (0 degrees Celsius).

The SDT felt the best method to address where freeze protection measures should be implemented was to define a term which specifies a subset of components that may be susceptible to freezing and are critical to the operation of generating units. GOs should consider previous freeze-related issues experienced by the generating unit(s), as well as actions taken to mitigate those freeze-related issues, when establishing its list of Cold Weather Critical Components. The SDT also felt it is appropriate to specifically exclude components that are not susceptible to freezing due to being inside heated buildings that maintain the interior temperature above freezing.

The SDT's intent with regard to the language "that is under the Generator's Owner's control" was to clearly delineate that cold weather events external to the generation site such as loss of fuel supply or loss of auxiliary power to the site that resulted in a Generator Cold Weather Reliability Event (see definition below) would not be subject to this standard. Furthermore, ice buildup on transmission lines and/or high voltage lines between the generating station and point of interconnection with the Transmission Owner would not constitute a freezing condition in the context of this Standard, and therefore, these lines would not be considered a Generator Cold Weather Critical Component.

The SDT's intent with the use of the phrase "permanent building" is to refer to a structure that is in place year round, shall accommodate personnel entry, and has a heating source that regularly maintains the space at a temperature above 32 degrees Fahrenheit for the purpose of protecting components from freezing (e.g. heated container that protects inverter-based resources or battery energy systems).

Fixed Fuel Supply Component

Non-mobile equipment that supports the reliable delivery of fuel to the generating unit and under the control of the Generator Owner at a plant site. Gaseous, liquid, or solid fuel handling components that are installed on site as fixed parts of the fuel delivery system that are under the Generator Owner's control are included. Mobile equipment such as trains, bulldozers, or other equipment that are not fixed in one location are excluded.

The SDT wanted to clarify the boundaries of responsibility for the GO as it relates to sites having fuel handling equipment within their control and responsibility to provide freeze protection. The intent of this definition is to clarify that mobile equipment is not part of this requirement, but permanent fixed equipment impacting fuel delivery needed for generation is included.

Generator Cold Weather Reliability Event

One of the following events for which the apparent cause(s) is due to freezing of equipment or impacts of freezing precipitation (e.g., sleet, snow, ice, and freezing rain) on equipment within the Generator Owner's control, and the dry bulb temperature at the time of the event was at or above the Extreme Cold Weather Temperature:

(1) a forced derate of more than 10% of the total capacity of the unit but not less than 20 MWs for longer than four hours in duration;

(2) a start-up failure where the unit fails to synchronize within a specified start-up time; or

(3) a Forced Outage.

Key Recommendation 1d: To require Generator Owners that experience outages, failures to start, or derates due to freezing to review the generating unit's outage, failure to start, or derate and develop and implement a corrective

action plan (CAP) for the identified equipment, and evaluate whether the CAP applies to similar equipment for its other generating units. Based on the evaluation, the Generator Owner will either revise its cold weather preparedness plan to apply the CAP to the similar equipment, or explain in a declaration (a) why no revisions to the cold weather preparedness plan are appropriate, and (b) that no further corrective actions will be taken. The standard drafting team should specify the specific timing for the CAP to be developed and implemented after the outage, derate, or failure to start, but the CAP should be developed as quickly as possible, and be completed by no later than the beginning of the next winter season.

The Key Recommendation from the Joint Inquiry Report recommends a Reliability Standard that requires GOs to develop a Corrective Action Plan (CAP) for generating units that experience outages, failures to starts, or derates due to freezing. The Joint Inquiry Report identifies that most of the outages and derates in the February 2021 event were due to freezing of instrumentation, transmitters, sensing lines, or wind turbine blades (p 166 in the Joint Inquiry Report). As such, the SDT followed the Joint Inquiry Report recommendation to require a CAP when the apparent cause of the event is freezing of equipment or impacts of freezing precipitation (e.g., sleet, snow, ice, or freezing rain) on equipment. The SDT felt that it was important to clearly call out freezing precipitation as these events were included in the outages and derates that identified as freezing in the Joint Inquiry Report. Furthermore, Key Recommendation 1c of the report requires GOs to account for the effect of precipitation. The SDT has developed parameters around these events to clarify a reasonable baseline of what level of derate qualifies as an event, and provide additional language to identify what constitutes a start-up failure. With the additional clarifications, the SDT determined that the standard would benefit from a defined term, to clearly and efficiently state what constitutes an event. The result is a new defined term, Generator Cold Weather Reliability Event, that defines the circumstances for which a CAP is required (i.e., when a freezing event affects the equipment within the control of the GO). The defined term will make the standard easier to understand and implement by providing clear and reasonable factors to determine whether the impact of an event requires mitigation. The SDT is using the definition of apparent as defined in the Webster's dictionary as "clear or manifest to the understanding".

The CAP requirement applies to any forced outage due to freezing, regardless of duration. Derates, which are short-lived (specified as four hours by the SDT) or of small capacity impact (specified as less than 20 MW by the SDT, which corresponds with the threshold for Bulk Electric System (BES) impacting Generation units), are excluded from the CAP requirement to limit the administrative burden to GOs for events that are minimally impacting to the BES. Also excluded are proactive operational actions to limit the potential of forced outages or derates. It should be noted that nothing in this standard prevents a GO from taking its own corrective actions resulting from such events. Startup failures for conventional generation are defined using the GADS definition with the removal of "following an outage or reserve shutdown", since the definition of reserve shutdown is different in GADS than it is in some of the Regional Transmission Organizations (RTO's) and Independent System Operators (ISOs). From the GADS data reporting instructions, the startup period for each unit is determined by the operating company. It is unique for each unit and depends on the condition of the unit at the time of startup (cold, warm, or hot). A typical unit startup occurs in three phases: warm up, synchronization, and ramp up. NERC defines a startup period to begin with the command to start and end when the unit is synchronized. A Startup Failure begins when a problem preventing the unit from synchronizing occurs. The Startup failure ends when the unit is synchronized, another Startup Failure occurs, or the unit enters another permissible state.

The SDT determined that CAPs will be required for any freezing event that occurs at temperatures above the generator site's ECWT. By using the site's ECWT, as opposed to the generator unit minimum temperature as defined by the GO in Requirement R1 Part 1.2.2 as the threshold, this achieves the following:

- Provides a consistent basis for the temperature at which CAPS are required for all GOs
- Provides a consistent basis for when CAPS are required for all generation types

- Provides a consistent basis for when CAPS are required regardless of the level of effort that GOs may have applied to-date winterizing their generators such that they can operate to the ECWT that their sites will reasonably experience
- Removes any incentive (perceived or real) to not further winterize GOs generating sites to meet the ECWT at the GO site by not providing a window where one site might not be subject to the CAP requirement while sites in the same vicinity experiencing the same temperatures are subject to this requirement
- Removes any disincentive for GOs to design the units to operate well below the ECWT for a site by not requiring them to perform CAPs while sites in the same vicinity experiencing the same temperatures are subject to this requirement

Generator Cold Weather Constraint

Any condition that would preclude a Generator Owner from implementing freeze protection measures on one or more Generator Cold Weather Critical Components using the criteria below. Freeze protection measures are not intended to ~~refer~~be limited to optimum practices, methods, or technologies, but ~~rather~~are also intended to ~~be~~include acceptable practices, methods, or technologies generally implemented by the electric industry in areas that experience similar winter climate conditions.

Criteria used to determine a constraint include practices, methods, or technologies which, given the exercise of reasonable judgment in light of the facts known at the time the decision to declare the constraint was made:

- *Were not broadly implemented at generating units for comparable unit types in regions that experience similar winter climate conditions to provide reasonable assurance of efficacy;*
- *Could not have been expected to accomplish the desired result; or*
- *Could not have been implemented at a reasonable cost consistent with good business practices, reliability, or safety. A cost may be deemed "unreasonable" when implementation of selected freeze protection measure(s) are uneconomical to the extent that they would require prohibitively expensive modifications or significant expenditures on equipment with minimal remaining life.*

The SDT reviewed the material from the FERC Order when determining how best to draft the Generator Cold Weather Constraints section. The SDT relied upon the industry's long practice of using "good utility practice" as a basis for implementing new practices, methods, or technologies and as such developed a definition that largely built upon this language and approach. The SDT also ensured that constraint language would be fully captured within the standard itself and was customized to the freeze protection measures that will be implemented as part of this standard.

The following non-comprehensive list contains examples that may, depending on the circumstances, constitute a Generator Cold Weather Constraint(s):

- Warranties that would be voided by application of a freeze protection measure
- Accelerated retirement of an existing generating unit
- Cancellation of new generating unit(s)
- Reduction in summer capability
- Introduces an increased personnel or safety risk
- Introduces a risk of noncompliance with environmental regulations
- Compromised ability to provide ancillary services
- Technology not utilized by a significant portion of the electric utility industry

Ultimately, it will be the GO's responsibility to document in the declaration the circumstances and reasons why the modification needed to address the freezing issue was not implemented. A declaration that no further corrective actions will be taken is expected to be used sparingly.

The SDT is intentionally leaving room for interpretation as it would be impossible to foresee every potential circumstance that could possibly necessitate a review of potential freeze protection technologies across the breadth of the US and Canada and the breadth of generating unit types and ages that fall under this Standard. Furthermore, the SDT wants to ensure that the standard language supports the adoption of new freeze protection practices, methods, or technologies while not immediately requiring a new freeze protection practice, method, or technology to be implemented industry-wide when a leading utility pilots a novel approach, as this would be a disincentive to utilities piloting new technologies. The SDT encourages additional studying of freeze protection measures to remove constraints as appropriate over time.

Facilities

4.1. *Facilities:*

4.1.1. *Bulk Electric System (BES) generating units. For purposes of this standard, the term "generating unit" subject to these requirements refers to the following BES resources:*

4.1.1.1. *A BES generating resource identified in the BES definition, Inclusion I2 and I4; or*

4.1.1.2. *A Blackstart Resource, identified in the BES definition, Inclusion I3.*

After reviewing this reference material, the SDT determined that EOP-012-2 should mirror the existing EOP-011-2 and apply to all BES generating units in order to ensure consistency in extreme cold weather preparedness. The Applicability section first defines "generating unit" as a BES resource. The NERC Glossary of Terms provides the foundation for what BES resources are included in the definition (see Inclusions I2 through I4). Additionally, Blackstart Resources are also specifically declared subject to the winterization requirements. Such Blackstart Resources, consistent with the NERC Glossary of Terms, are those units designated in the Transmission Operator's restoration plans. Proposed EOP-012-2 clarifies which Facilities are subject to implementing freeze protection measures through specific language in Requirements R2 and R3.

Requirement R1

R1. *At least once every five calendar years, each Generator Owner shall, for each of its applicable generating unit(s): [Violation Risk Factor: Lower] [Time Horizon: Long-term Planning]*

1.1. *Calculate the Extreme Cold Weather Temperature for each of its applicable unit(s) and identify the calculation date and source of temperature data; and*

1.1.1. *If the re-calculated Extreme Cold Weather Temperature is lower than the previous Extreme Cold Weather Temperature, the entity shall review and update its cold weather preparedness plan under Requirement R4 within six (6) months of the recalculation. If new corrective actions are needed to provide the required operational capability under Requirement R2 or R3, the entity shall develop a Corrective Action Plan within 6 months of the recalculation.*

1.2. *Identify generating unit(s) cold weather data, to include:*

1.2.1. *Generating unit(s) operating limitations in cold weather to include:*

1.2.1.1. *Capability and availability;*

1.2.1.2. *Fuel supply and inventory concerns;*

1.2.1.3. *Start-up issues;*

1.2.1.4. *Fuel switching capabilities; and*

1.2.1.5. *Environmental constraints.*

1.2.2. *Generating unit(s) minimum:*

- *Design temperature and if available, the concurrent wind speed and precipitation;*
- *Historical operating temperature at least one hour in duration, and if available, the concurrent wind speed and precipitation; or*
- *Current cold weather performance temperature determined by an engineering analysis, which includes the concurrent wind speed and precipitation.*

Much of the criteria of R1 is carried over from the previously approved EOP-011-2 Standard and requires the GO to document several cold weather performance parameters for the unit. This information is valuable, and in some cases, must be shared with other entities. For Requirement R 1.1, the GO is required to determine the ECWT for each unit using a reliable source of data. The SDT believes that the GO is in the best position to select the most representative weather information relative to its generating unit. The ECWT will be updated if a new lower ECWT is determined under the periodic review requirement of R1. Defining the operating limitations in R1.2.1 will make affected personnel more aware of unit capabilities and constraints as well as systems and practices that may be necessary to ensure reliability in cold weather, particularly when alternative fuels are involved. In addition, the unit minimum temperature identified in R1.2.2 is used to demonstrate compliance with R3 for existing units. The SDT chose one-hour of historical operating data recognizing that there is extremely limited historical operating data available for a unit below their ECWT. This was not to infer that the drafting team expects that existing generation will only reliably operate for one hour during an extreme cold weather event. The information contained within R1.2 is required to be requested by the Balancing Authorities in TOP-003-5 to make sure they have the most accurate unit performance information possible for their reliability analysis during the winter season.

It is recognized that the determination of a single unit minimum temperature is of limited value if applied without consideration of the other ambient conditions under which it was determined, that is, wind and

precipitation. Consideration of wind and precipitation, along with the minimum temperature, provides a greater understanding of the potential generating unit capability for cold weather resource planning. The standard requires that the GO include wind and precipitation data with their generating unit minimum temperature data when the data is available. The impact of deviations from this known temperature/wind/precipitation stated point are expected to be evaluated qualitatively. For example, if the historical minimum temperature occurred at low wind and dry conditions, and actual future cold weather event expected conditions are high winds with precipitation, planning personnel will recognize that a specific unit may not achieve the minimum temperature and can arrange for additional resources. The opposite also applies, i.e., if a calculated design minimum temperature assumes some level of wind and precipitation and actual cold weather expectations are for low wind and dry conditions, planning personnel will recognize that there is increased likelihood that a generation resource may continue to be available below its minimum temperature. If no information about wind or precipitation is known, wind and precipitation are assumed to be zero at the minimum temperature until further information is obtained.

Requirement R2

R2. *Applicable to generating units with a commercial operation date on or after October 1, 2027: Each Generator Owner, for each generating unit that has a calculated Extreme Cold Weather Temperature at or below 32 degrees Fahrenheit (zero degrees Celsius) as determined in Requirement R1, and that self-commits or is required to operate at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius),[7] shall: [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning, Operations Planning]*

- *Implement freeze protection measures to protect Generator Cold Weather Critical Components that provide the capability to operate at the unit(s)' Extreme Cold Weather Temperature with sustained concurrent twenty (20) mph wind speed for (i) a period of not less than twelve (12) continuous hours, or (ii) the maximum operational duration for intermittent energy resources if less than twelve (12) continuous hours; or*
- *Develop a Corrective Action Plan(s) to add new or modify existing or previously planned freeze protection measures to provide the capability to operate at the unit(s)' Extreme Cold Weather Temperature with a sustained concurrent twenty (20) mph wind speed for (i) a period of not less than twelve (12) continuous hours, or (ii) the maximum operational duration for intermittent energy resources if less than twelve (12) continuous hours.*

The Joint Inquiry Report Key Recommendation 1f references recommendation 12 of the 2011 report[8] suggesting that consideration should be given to designing all new generation plants and designing modifications to existing plants (unless committed solely for summer peaking purposes) to be able to perform at the lowest recorded ambient temperature for the nearest location for which historical weather data is available.

The SDT recommends this requirement apply to generation going into service three (3) years after the effective date of EOP-012-1 (October 1, 2027). The team believes that there needs to be allowances made for units that are in the development process, and for which the design phase may have already commenced. Generation that comes online before that time would be subject to Requirement R3.

The key recommendation identifies wind and freezing precipitation as examples of weather conditions to consider during the design of new generating units and modifications to existing plants. Realizing the many differences in weather that generator sites face across the ERO, the Project 2021-07 SDT developed language to provide additional context and detail around these weather conditions, while allowing flexibility for site-specific circumstances. The requirement language considers wind at a specific rate when designing new facilities. New units with commercial operation dates after the effective date of EOP-012-2 shall implement freeze protection measures such that their facilities are capable of continuous operation for not less than 12 hours at the ECWT assuming a concurrent twenty (20) mph wind speed on any exposed Generator Cold Weather Critical Component.

GOs with generating units that enter commercial operation on or after October 1, 2027 and cannot operate for twelve (12) continuous hours at the ECWT taking into account a concurrent twenty (20) mph wind speed shall develop a CAP. The GO then must implement the CAP according to R7. In addition, it is recognized that Generator Cold Weather Constraints may exist that prevent a new generating unit(s) from being capable of twelve (12) continuous hours of operation at their identified ECWT. Thus, the SDT included in R7.4, the option for the GO to make a declaration supporting why Generator Cold Weather Constraints preclude the ability to implement appropriate freeze protection measures. The SDT chose 12 hours of continuous operation because it is a typical length of the nighttime in winter in

[7] Generating unit(s) that do not self-commit or are not required to operate at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius), but may be called upon to operate in order to assist in the mitigation of BES Emergencies, Capacity Emergencies, or Energy Emergencies during periods at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius), are exempt from this requirement.

[8] sw-task-force-cover-new2.psd (nerc.com)

most regions of the US and Canada~~.~~ and typically include the hours with the coldest experienced temperatures. The SDT is of the opinion that tying the requirement to the 12-hour period would provide a reasonable level of reliability during a cold weather event. The SDT chose a concurrent sustained 20 mph wind speed after an evaluation using the wind chill formula developed by the NWS in the United States. Though wind chill temperature is not an exact science, it is widely understood to reflect the non-linear increased rate of convective heat loss due to air moving at different velocities. Commonly available charts show wind chill temperatures as a function of actual air temperature at various wind speeds. Approximately 2/3 of the wind chill temperature drop between 0 – 60 mph is achieved at 20 mph. Using the NWS chart, this holds true for still air temperatures starting at 40 F and dropping in 20-degree increments to -40 F. Further, 20 mph is a wind speed commonly experienced across the ERO and yet appropriately higher than the approximate average wind speeds in the United States and Canada, 6-12 mph and 8-11 mph respectively. Each of these three probabilistically infrequent conditions (the ECWT, a steady 20 mph wind, and a duration of 12 continuous hours at these conditions) is in and of itself conservative. When they have their effects combined, it results in a requirement that will significantly contribute to BES reliability during extreme cold weather conditions.

Requirement R3

R3. *Applicable to generating unit(s) in commercial operation prior to October 1, 2027: Each Generator Owner, for each generating unit that has a calculated Extreme Cold Weather Temperature at or below 32 degrees Fahrenheit (zero degrees Celsius) as determined in Requirement R1, and that self-commits or is required to operate at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius),[9] shall: [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning, Operations Planning]*

- *Implement freeze protection measures to protect Generator Cold Weather Critical Components that provide the capability to operate at the unit(s)' Extreme Cold Weather Temperature; or*
- *Develop a Corrective Action Plan to add new or modify existing freeze protection measures to provide the capability to operate at the unit(s)' Extreme Cold Weather Temperature.*

The SDT created a requirement for existing generating units, as defined in Requirement R3, to be able to operate at their ECWT. One expectation of the SDT is that generating units will be able to operate at this temperature as soon as possible, but not later than the timetable requirements laid out in Requirement R7. Furthermore, the SDT has the expectation that those generating units should be able to operate during extreme cold weather events at the ECWT; therefore, to address the FERC order on EOP-012-1 that rejected a one-hour timing requirement, the SDT chose not to put a specific time in R3. If a generating unit cannot adhere to the requirements of R3, it is required to develop a CAP that requires either new freeze protection measures, or modification of existing freeze protection measures, to be capable of operations at the ECWT (as calculated in Requirement 1).

As discussed in Requirement R7, unless a Generator Cold Weather Constraint declaration is made, the SDT designated timetables are to be included in the implementation of CAPs to ensure they are not unresolved for a significant period of time.

[9] Generating unit(s) that do not self-commit or are not required to operate at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius), but may be called upon to operate in order to assist in the mitigation of BES Emergencies, Capacity Emergencies, or Energy Emergencies during periods at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius), are exempt from this requirement.

Requirement R4

R4. *Each Generator Owner shall implement and maintain one or more cold weather preparedness plan(s) for its generating units. The cold weather preparedness plan(s) shall include the following, at a minimum: [Violation Risk Factor: High] [Time Horizon: Operations Planning and Real-time Operations]*

- ***4.1*** *The lowest calculated Extreme Cold Weather Temperature for each unit, as determined in Requirement R1;*
- ***4.2*** *The generating unit cold weather data, as determined in Part 1.2;*
- ***4.3*** *Documentation identifying Generator Cold Weather Critical Components;*
- ***4.4*** *Documentation of freeze protection measures implemented on Generator Cold Weather Critical Components which may include measures used to reduce the cooling effects of wind determined necessary by the Generator Owner to protect against heat loss, and where applicable, the effects of freezing precipitation (e.g., sleet, snow, ice, and freezing rain); and*
- ***4.5*** *Annual inspection and maintenance of generating unit(s) freeze protection measures.*

General Considerations

Requirement R4 requires GOs to develop and maintain cold weather preparedness plans for their unit(s) and describes the information and documentation required in such plans. It is an expansion of the cold weather preparedness plan required under Requirement R7 of EOP-011-2~~,~~ and is intended to be used and reviewed regularly by the GO. R4.5 requires the GO to annually inspect and perform necessary maintenance of freeze protection measures. Working in concert with other parts of EOP-012-2, including R1, R5, and R6, the substantive elements of the plan will be subject to review requirements, updated as necessary, and the GO is required to annually train personnel on its requirements.

Requirement R4 Part 4.1

In R4.1, the GO is required to include in the cold weather preparedness plan the lowest ECWT, as calculated pursuant to R1, for each unit using reliable source(s) of data. The SDT believes that the GO is in the best position to select the most representative weather information relative to its generating unit. The cold weather preparedness plan will be updated if a new lowest ECWT is calculated under the periodic review requirement of R1.

Requirement R4 Part 4.2

R4.2 is intended to capture within the cold weather preparedness plan the information being developed pursuant to R1.2, which is carried over from the previously approved EOP-011-2 standard, and requires the GO to document several cold weather performance parameters for the unit. This information is valuable, and in some cases, must be shared with other entities consistent with the data specification requirements contained in TOP-003-5 and IRO-010-4. A requirement for the GO to document this information within the cold weather preparedness plan ensures the information is readily available and documented when the GO responds to a data specification. See the Technical Rationale for Requirement R1 for substantive rationale regarding the operating limitations and generating unit minimum temperatures documented in the cold weather preparedness plan.

Requirement R4 Part 4.3

In R4.3, the GO identifies the Generator Cold Weather Critical Components to help inform their decision on where to implement appropriate freeze protection measures. The NERC *Reliability Guideline, Generating Unit Winter Weather Readiness – Current Industry Practices*[10], presents a suggested list of components that GOs may choose to utilize when developing their own Generator Cold Weather Critical Component inventory.

[10] Reliability Guideline Generating Unit Winter Weather Readiness – Current Industry Practices

Requirement R4 Part 4.4

R4.3 requires GOs to document the freeze protection measures implemented on Generator Cold Weather Critical Components. These freeze protection measures may include those to reduce the cooling effects of wind. Requirement R4 does not require GOs to install new freeze protection measures to reduce the cooling effects of wind, but rather to determine if freeze protection measures will protect against heat loss and the effect of freezing precipitation, where applicable, and document those measures (e.g., water-resistant insulation, protective shielding, insulated boxes, etc.). These measures could include temporary measures as well, such as wind breaks, but there is no expectation for entities to list all climate-controlled areas as freeze protection measures.

Requirement R4 Part 4.5

R4.5 is carried over from the previously approved EOP-011-2 standard and requires annual inspection and maintenance of the freeze protection measures identified in the cold weather preparedness plan. This requirement ensures these freeze protection measures will be ready and serviceable when needed.

Requirement R5

R5. *Each Generator Owner in conjunction with its Generator Operator shall identify the entity responsible for providing the generating unit-specific training, and that identified entity shall provide annual training to its maintenance or operations personnel responsible for implementing the cold weather preparedness plan(s) developed pursuant to Requirement R4. [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning, Operations Planning]*

Key Recommendation 1e: To revise EOP-011-2, R8, to require Generator Owners and Generator Operators to conduct annual unit-specific cold weather preparedness plan training.

Project 2019-06 Cold Weather established the requirement that the GO, in conjunction with its Generator Operator, would provide generating unit-specific training for its personnel responsible for implementing cold weather preparedness plan(s) for its generating units. The Joint Inquiry Report recommended that EOP-011-2 R8 be revised to require the generating unit-specific training be provided on an "annual" basis. The Joint Inquiry Report explains "Responses from the GOs/GOPs involved in the Event show that annual training is not yet universal in the Event Area."[11] To address this recommendation, the SDT has utilized the existing language in EOP-011-2 and added the word "annual" to require the training on an annual basis. The requirement is deleted from EOP-011-3, and will be placed as a requirement in a new EOP-012-2 Reliability Standard dedicated solely to extreme cold weather preparedness.

The intent of the SDT is that training ~~shall~~ be provided to operational personnel who are responsible for inspection, maintenance, and/or ensuring operability of freeze protection measures. The operational personnel ~~includes~~may include employees of the Registered Entity as well as any dedicated on-site full-time contractors or equipment OEM personnel responsible for inspection, maintenance, and/or ensuring operability of freeze protection measures. Vendors who perform inspection, maintenance, or installation of freeze protection measures prior to the winter season do not need to receive the training on the cold weather preparedness plan.

The SDT anticipates that training for personnel ~~shall~~may include instructions on actions taken to prepare the generating unit(s) for cold weather operations prior to the cold weather season as well as on actions taken when cold weather events (severe low temperatures, significant accumulation of ice/snow, etc.) are forecasted and occurring in real time. This training may include response to freeze protection panel alarms, troubleshooting and repair of freeze protection circuitry, identification of plant areas most affected by winter conditions, application of portable heaters, review of special inspections or rounds implemented during severe weather, fuel switching procedures, and maintenance of freeze protection measures, etc.

[11] The February 2021 Cold Weather Outages in Texas and the South Central United States | FERC, NERC and Regional Entity Staff Report | Federal Energy Regulatory Commission, p190

Requirement R6

R6. *Each Generator Owner shall, for each generating unit that has a calculated Extreme Cold Weather Temperature at or below 32 degrees Fahrenheit (zero degrees Celsius) as determined in Requirement R1 and that self-commits or is required to operate at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius),[12] develop a Corrective Action Plan when the generating unit experiences a Generator Cold Weather Reliability Event. The Corrective Action Plan shall be developed within 150 days or by July 1, whichever is earlier, and contain at a minimum: [Violation Risk Factor: High] [Time Horizon: Long-term Planning]*

6.1. *A summary of the identified cause(s) for the Generator Cold Weather Reliability Event, where applicable, and any relevant associated data;*

6.2. *A review of applicability to similar equipment at generating units owned by the Generator Owner; and*

6.3. *An identification of operating limitations or impacts to the cold weather preparedness plan that would apply until execution of the corrective action(s) identified in the Corrective Action Plan.*

Key Recommendation 1d: To require Generator Owners that experience outages, failures to start, or derates due to freezing to review the generating unit's outage, failure to start, or derate and develop and implement a corrective action plan (CAP) for the identified equipment, and evaluate whether the CAP applies to similar equipment for its other generating units. Based on the evaluation, the Generator Owner will either revise its cold weather preparedness plan to apply the CAP to the similar equipment, or explain in a declaration (a) why no revisions to the cold weather preparedness plan are appropriate, and (b) that no further corrective actions will be taken. The standard drafting team should specify the specific timing for the CAP to be developed and implemented after the outage, derate, or failure to start, but the CAP should be developed as quickly as possible, and be completed by no later than the beginning of the next winter season.

The Key Recommendation from the Joint Inquiry Report recommends a standard that requires GOs to develop a CAP for generating units that experience outages, failures to starts, or derates due to freezing. The Joint Inquiry Report identifies that most of the outages and derates in the February 2021 event were due to freezing of instrumentation, transmitters, sensing lines, or wind turbine blades (p 166 in the Joint Inquiry Report). As such, the SDT followed the Joint Inquiry Report recommendation to require a CAP when the apparent cause of the event is freezing. The SDT has developed parameters around these events to clarify a reasonable baseline of what level of derate qualifies as an event, and provide additional language to identify what constitutes a start-up failure. With the additional clarifications, the SDT determined that the standard would benefit from a defined term, to clearly and efficiently state what constitutes an event. The result is to a new defined term, Generator Cold Weather Reliability Event, that defines the circumstances for which a CAP is required (i.e., when a freezing event affects the equipment within the control of the GO). The defined term will make the standard easier to understand and implement by providing clear and reasonable factors to determine whether the impact of an event requires mitigation.

General Considerations for All CAPs

To simplify the proposed requirements related to creating a CAP, the SDT used the NERC Definition of a CAP. The CAP definition reads "A list of actions and an associated timetable for implementation to remedy a specific problem." As written, the definition requires two parts for a document to qualify as a CAP, i.e., a list of items to be addressed and a timeline for completion. A CAP without both a list of actions and the timeline to implement is not complete.

[12] Generating unit(s) that do not self-commit or are not required to operate at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius), but may be called upon to operate in order to assist in the mitigation of BES Emergencies, Capacity Emergencies, or Energy Emergencies during periods at or below a temperature of 32 degrees Fahrenheit (zero degrees Celsius), are exempt from this requirement.

Requirement R6

The CAP requirement applies to any forced outage due to freezing, regardless of duration. Derates, which are short-lived (specified as four hours by the SDT) or of small capacity (specified as 10% of the total capacity of the unit, but not less than 20 MW impacts), are excluded from the CAP requirement to limit the administrative burden to GOs for events that are minimally impacting to the BES. It should be noted that nothing in this standard prevents a GO from taking its own corrective actions resulting from such events. Startup failures are defined using the GADS definition with the removal of "following an outage or reserve shutdown", since the definition of reserve shutdown is different in GADS than it is in some of the RTO's.

R6 requires the GO to act within 150 days or by July 1 to develop the CAP. These timeframe options were chosen by the SDT to allow GOs to review multiple events holistically following a winter season if that scenario occurs, and create one CAP for components with common failure causes.

The SDT determined that CAPs will be required for any freezing event that occurs at temperatures above the site's ECWT. By using the site's ECWT, as opposed to the Generator Unit Minimum Temperature as defined by the GO as the threshold, this achieves the following:

- Provides a consistent basis for the temperature at which CAPS are required for all GOs
- Provides a consistent basis for when CAPS are required for all generation types
- Provides a consistent basis for when CAPS are required regardless of the level of effort that GOs may have applied to-date winterizing their generators such that they can operate to the ECWT that their sites will reasonably experience
- Removes any incentive (perceived or real) to not further winterize GOs sites to meet the ECWT at the GO site by not providing a window where one site might not be subject to the CAP requirement while sites in the same vicinity experiencing the same temperatures are subject to this requirement
- Removes any disincentive for GOs to design the units to operate well below the ECWT for a site by not requiring them to perform CAPs while sites in the same vicinity experiencing the same temperatures are subject to this requirement

Requirement R7

R7. *Each Generator Owner, for each Corrective Action Plan developed pursuant to Requirements R1, R2, R3, or R6, shall: [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

7.1. *Include a timetable for implementing the selected corrective action(s) that shall:*

7.1.1. *List the action(s) which address(es) existing equipment or freeze protection measures, if any, to be completed within 24 calendar months of completing development of the Corrective Action Plan;*

7.1.2. *List the action(s) which require(s) new equipment or freeze protection measures, if any, to be completed within 48 calendar months of completing development of the Corrective Action Plan;*

7.1.3. *List the updates to the cold weather preparedness plan required under Requirement R4 to identify the updates or additions to the Generator Cold Weather Critical Components and their freeze protection measures;*

7.2. *Implement the Corrective Action Plan in accordance with the specified timetables in Requirement R7 Part 7.1;*

7.3. *Update the Corrective Action Plan~~,~~ action(s) and timetable(s), with justification, if corrective action(s) change or timetable(s) exceed the timelines in Requirement R7 Part 7.1; and*

7.4. *Document in a declaration, with justification, any Generator Cold Weather Constraint that precludes the Generator Owner from implementing selected action(s) contained within the Corrective Action Plan.*

In EOP-012-2, R7 is expanded from EOP-012-1 to provide additional definition on the requirements to implement a CAP, and to meet the direction for this requirement set forward by FERC. One such direction was to define expectations on implementation timelines for CAPs. Under EOP-012-2 R7, CAPs are divided into two categories: 1) those which address existing freeze protection measure(s), and 2) those which require new equipment or freeze protection measure(s). The former category requires completion of the CAP to remedy the cause(s) within 24 months, and the latter requires completion of the CAP within 48 months. The SDT modeled this timeline structure after similar CAP implementation requirements in TPL-007. These are maximum durations and entities are expected to work diligently to correct issues and take prompt actions to mitigate future issues as soon as practical. At the same time, the SDT recognizes that the following limitations make the 24 and 48 calendar months maximum timelines reasonable: scoping applicability to similar units, freeze protection engineering and design, project development, annual budgeting process, material supply lead times, outage scheduling, skilled labor availability, and startup/commissioning.

Considering this expectation, the SDT believes that the 24-month/48-month timeframe for execution of CAPs under R7 will allow NERC and the industry to observe the success of this measure through completion of corrective actions in the near future. The SDT added part 7.1.3. for completeness to ensure updates would be made to document needed changes to the cold weather preparedness plan(s) to eliminate future issues. In establishing these timeframes, the SDT considered the FERC directives, and that NERC include a timeframe for completion for CAPs, shorten the implementation plans, and that NERC stagger Implementation Plans to have more generation compliant faster. The SDT considered a staggered timeframe both in the standard and ~~IP~~Implementation Plan but determined that more aggressive completion time frames, combined with a shorter implementation plan, would serve the reliability goal to have generating units operating at the ECWT with less administrative burden that could be associated with proving compliance with a staggered implementation plan fleet wide. There is ~~not~~no specific staggering requirement within the 24- or 48-month completing time frames because of industry concern about

additional complications of completing work efficiently. There will be some natural staggering due to unit outages and personnel availability as an example.

Within the revised R7, the GO is required to implement the CAP within a timetable defined by the GO in the CAP, but limited by maximum durations in section 7.1. If the GO is unable to complete the CAP within the time limits in section 7.1, or the corrective action(s) change, the GO is required to update the CAP with justification. GOs that are unable to complete the CAP due to a Generator Cold Weather Constraint are required under Section 7.4 to create a declaration of such constraint which is required to be provided to the Balancing Authority in R8. Further requirements of the Generator Cold Weather Constraint are provided under R8.

In the case of a CAP triggered by a forced derate, forced outage, or startup failure and for which the apparent cause is the failure of relatively simple existing piece of freeze protection equipment, the scope of the Corrective Action Plan may be documented after the fact. Such prompt repairs may be completed before creation of the CAP, and the GO may complete the implementation of the CAP simply by evaluating the requirements of R6 and documenting how and when the repair work was completed. An example of this circumstance would be a freezing event caused by a single heat trace circuit which would have been sufficient to prevent the event had it not failed.

If one or more actions within a CAP fall under a constraint declaration, it is the intent of the SDT that only those ~~selected~~affected actions would not be implemented as part of the CAP. The remaining actions should be implemented.

Requirement R8

R8. *Each Generator Owner that creates a Generator Cold Weather Constraint declaration shall: [Violation Risk Factor: Medium] [Time Horizon: Long-term Planning]*

8.1 *Review the Generator Cold Weather Constraint declaration at least every five years or as needed when a change of status to the Generator Cold Weather Constraint occurs; and*

8.2 *Update the operating limitations associated with capability and availability under Requirement R1 Part 1.2 if applicable.*

In the FERC order, the Commission expressed concern that a GO may make a constraint declaration without informing planning and operational entities (e.g., the Balancing Authority) that are expecting the reliable operation of the generating unit to its ECWT.[1] An additional concern was that the constraint declarations may be used by a functional entity as an opt-out of compliance with requirements set forth in the standards or in a corrective action plan.[2] To mitigate the concern, the Commission directed NERC to work with Commission staff and submit a data collection and assessment plan that contains information related to GO constraint declarations and explanations thereof.[3] The SDT expects that ERO compliance staff will be the entity responsible for reviewing declared constraints and assessing compliance with the constraint definition criteria in accordance with established processes.

The SDT developed R8 to require the GO to perform a review and update any constraint declarations as needed. The SDT believes that constraints will be the exception. When GO's experience a ~~constraint~~condition such that they need to ~~take~~make a constraint declaration, the SDT believes the limiting factor causing the constraints will not change quickly, and as such a 5-year review is the appropriate time. While the SDT implemented a 5-year maximum time frame to review, it is the ~~SDTs~~SDT's intent that the GO's will be cognizant of their Cold Weather Constraints and will proactively remove these constraints when and where warranted. For instance, if a unit is slated for retirement and this status changes, it is the expectation of the SDT that the GO will review constraints based upon this ~~impending retirement~~change in condition and will no longer take this constraint for future CAPs that may require the implementation of freeze protection measures on this unit given that it is no longer slated for retirement.

Updated constraint declarations would also require an update to the operating limitations provided via data specification to the entities overseeing reliability (e.g., Balancing Authority, Transmission Operator, or Reliability Coordinator). In this manner, information relevant to taken constraint declarations are made available to the planning and operational entities pursuant to its data collection authority contained in TOP-003-5 and IRO-010-4.

[1] FERC Order, 182 FERC ¶ 61,094 at P 64.
[2] Id. At P 66.
[3] See id at PP 11, 68, 94-95.