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*RRS WHITE PAPER*

# DEVELOPMENT OF NYSRC RULES FOR MITIGATING EXTREME SYSTEM CONDITIONS

## 1.0 INTRODUCTION

This paper responds to a NYSRC 2022 goal for the NYSRC Reliability Rules Subcommittee (RRS) to: "identify actions to preserve NYCA reliability for extreme weather events and other extreme system conditions" and its corresponding action plan to: "evaluate the potential need for new resource adequacy and transmission planning design rules for planning the system to meet extreme weather and other extreme system conditions." Accordingly, this paper presents 10 *Extreme Weather Resilience Plan* recommendations which are designed to ensure that the NYS electric system continues to deliver reliable performance in the face of a changing climate.

RRS has identified the following Extreme System Conditions that are considered in this paper:

- Extreme Weather Events[1]
- Loss of Natural Gas Supply
- Cyber and Physical Attacks

Sections 2.0 and 3.0 of this paper cover Extreme Weather and Loss of Natural Gas Supply events, respectively. RRS has concluded that the existing NERC Standards adequately cover Cyber and Physical Security requirements and, therefore it agrees that no additional NYSRC rules for these types of extreme system conditions are needed at this time. Section 4.0 provides RRS' recommendations based on Sections 2 and 3 discussions.

The recommendations in this paper will be implemented in three phases as outlined in Section 4. Appendix A proposes Requirements for a PRR based on Phase 1 recommendations.

## 2.0 EXTREME WEATHER EVENTS

Climate change has~~Extreme weather events have~~ led to an increase in the frequency and intensity of extreme weather events, raising concerns about the resilience[2] of the electric grid and its ability to successfully address such~~to present and future climate and weather~~ hazards.[3]

[1] "Extreme weather events," as covered in this paper, are considered low-probability widespread weather events or climate conditions occurring within a limited period, with the potential of having a very severe impact on the reliability of the Bulk Power System.

[2] "Resilience" is defined as "the ability to prepare for and adapt to changing conditions and to withstand and recover rapidly from disruptions."

[3] "*Extreme Weather and Climate Vulnerabilities of the Electric Grid: A Summary of Environmental Sensitivity Quantification Methods*," Oak Ridge National Laboratory, August 16, 2016.

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All components of electricity supply and demand are potentially vulnerable to such events, including electric power generation and transmission. Further, the changing resource mix with higher penetrations of~~Future~~ solar and wind generation adds to the ~~resources will be particularly~~ vulnerability of the system t~~t~~o extreme weather. Extreme weather events, such as prolonged cold and hot weather spells, wind lulls, hurricanes and storms, are considered one of the main causes of wide-area electrical disturbances worldwide. In the United States, 96% percent of power outages in 2020 were caused by severe weather or natural disasters. Also in the United States, the annual financial impact of weather-related blackouts ranges from $20 to $55 billion and the trend of such events shows that their frequency has increased over the last 30 years, with a dramatic increase in the 2000s.[4]

Recent major loss of load disturbances in California[5] and Texas[6] caused by extreme weather events have demonstrated that in the future, extreme weather events will be a significant driver~~the most important driver~~ of resource adequacy, and highlights the need for the NYSRC to consider developing new reliability rules requiring the planning the system for maintaining ~~and~~reliability and timely recovery~~recovering~~ from such events.

Table 1 below illustrates the many types of extreme weather events that have impacted the NYS Power System in the past and which can be expected to impact the system~~it sometime~~ in the future.[7] Also shown are the types of resources or transmission that can be affected by each type of extreme weather events.

It should be noted that extreme weather events~~are~~, by their nature, infrequent but have a large impact on system reliability such as wide-spread blackouts. This is in contrast to normal or design events such as generator or transmission outage events. Normal events are predictable in a probabilistic sense in terms of, for example, expected forced outage rates for generators, and generally do not result in wide-spread blackouts. In terms of a statistical frequency distribution, normal events occur around the mean of the distribution while extreme weather events occur at the tails of the distribution. This means that a different form of analysis, reliability criteria,~~criterion~~ and system loading condition may be appropriate for extreme weather events when compared to normal events.

[4] From the paper, *"Influence of Extreme Weather and Climate Change on the Resilience of Power Systems: Impact and Possible Mitigation Strategies*," Mathaios Pantelia and Pierluigi Mancarella, 2015 ~~(not dated)~~

[5] CAISO, CPUC, CEC Issue Final Report on Causes of August 2020 Rotating Outages.

[6] 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.

[7] Based on data from the NYISO presentation, "*Climate Change Impact and Resilience Study - Phase II*", October 8, 2020.

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**Table 1**
**Types of Extreme Weather Events Impacting NYCA**
**and the System Elements That Are Affected**

| Event | NYCA Areas Affected | System Elements Affected |
|---|---|---|
| Heat Wave | All | Off-Shore and On-Shore Wind, Solar, Load, Transmission |
| Cold Wave | All | Solar, Load |
| Wind Lull | All | Off-Shore and On-Shore Wind |
| Coastal Storm, Hurricane | G-K | Load, Transmission, Off-Shore Wind, Solar |
| Severe Wind ~~s~~Storm - Upstate NY | A-F | Load, Transmission, On-Shore Wind, Solar |
| Icing | A-K~~C~~ | Load, Transmission, Off-Shore and On-Shore Wind |
| Drought | All | Hydro |
| Geomagnetic disturbance | All | Transmission |

Other North American power system entities are examining the extreme weather impacts. Appendix A provides a summary of NERC and WECC filings and reports covering this issue.

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### 2.1 EXTREME WEATHER IMPACTS ON RESOURCE ADEQUACY

The risk profiles in Table 2 below depict the reliability impacts of recent extreme weather events in California and Texas[8]. As a way of comparison, unserved energy or EUE resulting from the California event exceeded the average annual expected unserved energy in the NYSRC 2021 and 2022 IRM Study base cases by a factor of 12, while the unserved energy from the Texas event exceeded these IRM study base case EUEs by a factor of 4400! This example clearly illustrates the need for the NYSRC to consider new planning rules that would help~~take action in its rules to~~ avoid similar loss of load events.

[8] From a paper submitted to the 2021 NERC Probabilistic Analysis Forum, *Beyond 1-day-in-10, by* Derek Stenclik of Telos Energy.

**Table 2**
**Risk Profile of California and Texas Loss of Load Events Caused by Extreme Weather**

| LOL Event Characteristic | Metric | California Aug 2020 | Texas Feb 2021 |
|---|---|---|---|
| | | | |
| Number of Events | LOLE | 2 events | 1 event |
| Number of Days | LOLE | 2 days | 3 days |
| Number of Hours | LOLH | 6 hours | 71 hours |
| Unserved Energy | EUE | 2,700 MWh | 990,000 MWh |
| Max Shortfall | - | 1,072 MW | 20,000+ MW |

As part of its 2021 Reliability Planning Process the NYISO conducted a "wind lull" study[9]. In this study, the NYISO conducted several scenarios for which there is no wind generation output for an extended period of time, i.e., one week. Table 3 below shows the results of one of these scenarios.[10] In this scenario each base case LOL event resulted in a loss of energy of 857 MWhr compared to 1,276 MWhr for the wind lull scenario.

The NYISO study also calculated the compensatory MW (perfect capacity MW available every hour of the study year) required to bring NYCA back to the LOLE criterion for each of 18 scenarios examined. For these scenarios compensatory MW requirements ranged from 0 to 400 MW in Zones J or K

**Table 3**
**Risk Profile of Extreme Weather Loss of Load Event Scenario**
**Loss of 100% of Offshore Wind Capacity Due to an Extended Wind Lull**

| Loss of Load Event Characteristic | Metric | Base Case (Non- Wind Lull Event) | Wind Lull Event |
|---|---|---|---|
| Event Frequency | LOLE | 1 event /10 yr. | 1.6 events/10 yr. |
| Number of hours per event | LOLH | 2.9 hours | 3.5 hours |
| Unserved energy per event | EUE | 857 MWhr | 1,276 MWhr |
| Average shortfall per event | | 296 MW | 365 MW |
| ~~Customer cost from wind lull event~~ | | ~~--~~ | ~~$ 64 million~~ |

One important NYISO lull study conclusion was that using compensatory MW to bring the NYCA LOLE back to criterion level increases the Expected Unserved Energy (EUE) metric over the base case level. This is because non-extreme weather events are mitigated by the compensatory MW,

[9] See NYISO *2021-30 Comprehensive Reliability Report*, Appendix E, *70X30 Scenario - Extended Wind Lull Study.*
[10] This table was included in the report, "*Resource Adequacy Metrics and their Applications*," prepared by the NYSRC Resource Adequacy Working Group, February 3, 2022.

but the wind lull events themselves create a larger energy deficit than in the base case during the week of the extreme weather.

The above analyses highlight the need for the NYSRC to consider the development of~~develop~~ new reliability rules requiring the planning the system for maintaining reliability during, and timely recovery~~for and recovering~~ from extreme weather events. The RRS has concluded that in the absence of such rules, climate change -- exacerbated by the vulnerability of wind and solar generation to extreme weather -- is likely to make the future NYCA infrastructure increasingly vulnerable to extreme weather events.

**Accordingly, RRS recommends that the NYSRC should adopt an "extreme weather resource adequacy criterion" -- such as the 1-in-10-year LOLE criterion or a new criterion[11] -- for determining additional resource requirements (over and above existing IRM requirements) for mitigating loss of load impacts of extreme weather events.**

RRS recognizes that the NYISO and ICS will need adequate time to develop more detailed probabilistic models for extreme weather analyses and that the~~for~~ RRS will need sufficient time to develop and adopt an appropriate extreme weather resource adequacy criterion. Included in these~~the NYISO's~~ modeling efforts the NYISO and ICS should identify the types of extreme weather events to be considered and modeled, including an estimate of the relative likelihood of occurrence. The NYISO staff and ICS should also discuss and coordinate the development of procedures for using appropriate extreme natural event assumptions and data for NYCA resource adequacy and IRM assessments.

Prior to adopting an extreme weather resource adequacy criterion, RRS recommends that initial rules should be adopted requiring the NYISO to periodically conduct probabilistic resource adequacy assessments of the reliability impacts (LOLE, LOLH, and EUE metrics) of a range of types of extreme weather events~~, including options for mitigating reliability impacts,~~ similar to the "Wind Lull" analysis reported in Appendix E of the NYISO 2021-30 CRP report. In addition, it is recommended that the NYISO develop extreme weather scenarios based on appropriate system conditions as well as analytical methods with which to test system performance under extreme weather events. These initial assessments should utilize existing NYISO extreme weather probabilistic models which should improve over the near term.

[11] One example of a new criterion could be use of a dual LOLE/EUE criterion.

### 2.2 EXTREME WEATHER IMPACTS ON THE NYCA TRANSMISSION SYSTEM

The impact of weather on the power grid has grown with the number and magnitude of extreme weather events. NERC reports routinely find that the top causes of extreme transmission outages are weather related. Present NYSRC planning criteria require the NYISO to assess extreme system conditions on the NYCA transmission system assuming a 90th percentile load forecast to simulate extreme system conditions and report transmission reinforcements that would be required to meet NYSRC transmission design criteria. This requirement is now part of the NYISO's annual transmission assessment. The most recent NYISO transmission extreme weather assessment concluded that compensatory MVA would be required in 90th percentile load case for meeting NYSRC transmission criteria.[12]

Recognizing the potential threat of an increasing number of extreme weather events impacting the NYCA transmission system -- consistent with the above resource adequacy extreme weather conclusions -- **RRS recommends that "extreme weather transmission planning criteria" be adopted to plan the NYPA transmission system to mitigate extreme weather reliability impacts~~on the NYCA transmission system~~.** Such a criterion does not presuppose what events should be included in the criterion. RRS will consider alternate transmission extreme weather criteria, including planning the transmission system to maintain reliability at a 90th percentile load forecast criterion, before making a final recommendation. Before such a~~this~~ rule is adopted RRS will meet with NYISO staff to discuss the above criterion and how a proposed rule would be implemented~~referenced study and other study issues~~.

### 2.3 NYISO EXTREME WEATHER RESILIENCE OPERATING PLAN

RRS recommends a new Requirement for the NYISO to develop an *Extreme Weather Resilience Operating Plan* for withstanding and recovering rapidly from disruptions. This operating plan should include measures or solutions for mitigating reliability impacts. Additionally, the plan should have a current and forward-looking strategy to mitigate and minimize recovery time for such types of events. The plan should consider the following issues:

- The NYISO shall enhance its procedures for collecting historic NYS weather data as well as the capability of predicting future extreme weather trends.

[12] From the NYISO Transmission Assessment report, the 2025 90th percentile case steady state analysis indicated no thermal or voltage issues on the BPTF system for N-0 and N-1 analysis. With compensatory MVA considered in the 2025 90th percentile load case, all contingencies evaluated indicated a stable response. No voltage recovery issues on the BPTF system were identified, and no generator unit indicated an out-of-step condition other than by the fault clearing action.

- Possible emergency operating procedure and operating reserve changes.
- Ramping requirements to withstand extreme events.
- Improved operating practices for reducing recovery times.
- Examining whether system restoration procedures should be modified to address extreme weather events.
- Examining whether NYISO's Market Participant procedures should include new extreme weather mitigation requirements.
- Enhancing training requirements.

## 3.0 LOSS OF NATURAL GAS SUPPLY

The impact of natural gas supply interruptions on electric system reliability depends on a variety of factors. The majority of events of reduced or interrupted natural gas deliveries to generating facilitates are due to operational or scheduling or market deficiency issues. Natural gas pipeline failures account for a relatively minor fraction of loss of gas supply events. In NYCA~~NYPA~~ natural gas-fired generation is supplied by various networks of major gas pipelines.

As with extreme weather transmission assessment requirements, NYSRC rules also require the NYISO to perform loss of natural gas supply assessments as part of the NYISO transmission assessment process. These assessments provide system performance results and system requirements in terms of compensatory MW for meeting NYSRC criteria.

Before recommending whether a NYSRC loss of gas supply criterion should be established for mitigating loss of gas supply events, RRS will require additional review, including meeting with the NYISO staff.

## 4.0 RECOMMENDATIONS

Table 4 lists RRS recommendations for Executive Committee approval based on discussion and conclusions in Sections 2 and 3. As shown, these recommendations, if approved, will be implemented in three phases.

Appendix A shows proposed Reliability Requirements for inclusion in a new PRR in accordance with Phase 1 Recommendations 1 - 3.

**Table 4**
**RRS Extreme System Condition Recommendations**

| Recommendation No. | Recommendation | Phase | Target Date[13] |
|---|---|---|---|
| 1 | Establish a new Reliability Rule section in the RR&C Manual: "Extreme Weather Reliability & Resilience Rules" (RRS) | 1 | October 2022 |
| 2 | Prepare a new rule requiring the NYISO to periodically conduct probabilistic resource adequacy assessments of the reliability impacts for a range of types of extreme weather events. See Appendix BA. (RRS) | I | October 2022 (PRR #1) |
| 3 | Prepare a new rule requiring the NYISO to develop an "*Extreme Weather Resilience Operating Plan"* for withstanding and recovering rapidly from disruptions. See Appendix BA. (RRS) | 1 | October 2022 (PRR #1) |
| 4 | Develop an "Extreme Weather Transmission Reliability Criterion." (RRS) | 2 | June 2023 (PRR #2) |
| 5 | Prepare a new rule requiring the NYISO to conduct extreme weather transmission assessments for determining required transmission additions for meeting new Extreme Weather Transmission Criteria. (RRS) | 2 | June 2023 (PRR #2) |
| 6 | Consider the development of an "Extreme Weather Loss of Natural Gas Criterion." (RRS) | 2 | June 2023 |
| 7 | Prepare a new rule requiring the NYISO to conduct loss of natural gas assessments for determining required system additions if a new Extreme Weather Loss of Natural Gas Criteria is established. (RRS) | 2 | June 2023 (PRR #3) |
| 8 | NYISO to complete extreme weather modeling. | 3 | December 2025 |
| 9 | Develop an "Extreme Weather Resource Adequacy Reliability Criterion." (RRS) | 3 | December 2025 |
| 10 | Prepare a new rule requiring the NYISO to conduct extreme weather resource adequacy assessments for determining required resource additions for meeting new Extreme Weather Resource Adequacy Criteria. (RRS) | 3 | December 2025 (PRR #4) |

[13] These target dates are tentative and will be reexamined in the future.

## APPENDIX A

## NERC AND WECC RESPONSES TO THE EXTREME WEATHER EVENT ISSUE

In a filing to FERC made by NERC in response to question from a FERC Technical Conference on Extreme Weather, NERC stated following:

> *"The North American bulk-power system is undergoing major transformation that must be understood and planned for to preserve reliability. A rapidly changing generation resource mix is driving this transformation. Traditional baseload generation plants are retiring, while significant amounts of new natural gas and variable energy generating resources are being developed. During this transition, natural gas-fired generation is becoming more critical to provide both "bulk energy" and "balancing energy" to support the integration of variable energy resources. Extreme weather exacerbates the challenges of the transforming grid while also stressing the system in unique ways. Further, stresses on other critical infrastructures, such as the natural gas system that the electric system depends upon, can impact the reliable operation of the bulk-power system. This transition requires the electric industry to reconsider how the system is planned and operated."*

The NERC filing outlines the risks in a number of operating areas in North America. While New York is not among the concern areas noted at that time, NERC then goes on to outline its reliability assessment and regulation development plan and its roles as the Electric Reliability Organization for North America. The comments reference the NERC findings from various Reliability assessments over time noting that the power systems in some areas should embark of more detailed reviews of the generating positioning of resources in anticipation for extreme weather events[14] that New York must be prepared to do the same.

More recently WECC issued its report on the impacts of Extreme Weather.[15] This report provides analysis process details regarding how WECC is currently evaluating and identifying its extreme weather risk Exposure. In the WECC region an extreme natural event is considered as a confluence of multiple, low-probability, widespread weather events occurring simultaneously within a limited period with the potential of having a very large impact on the reliability of the power system. The purpose of the WECC assessment is to identify some of the key reliability risks associated with multiple extreme events happening simultaneously, under the future circumstances of the projected and planned changes in the resource mix. For its assessment, the reliability metrics explored by WECC were system voltage and frequency response, unserved energy, ancillary service deficiencies.

[14] NERC - Response to the FERC Extreme Weather Events Technical Conference on Climate change, Extreme Weather and Electric System Reliability. – April 15, 2021
[15] WECC – The Year 2030 Extreme Natural Event Study Report – April 27, 2022

## APPENDIX BA

## PROPOSED NYSRC RELIABILITY RULE REQUIREMENTS FOR MITIGATING EXTREME WEATHER CONDITIONS[16]

**R1.** NYISO Extreme Weather Resilience Operating Plan

The NYISO shall develop and implement an *Extreme Weather Resilience Operating Plan* for preparing, withstanding, and recovering rapidly from disruptions caused by Extreme Weather Events in order to preserve the security and reliability of the NYS Bulk Power System. This plan shall include, but not limited to, the following measures and procedures:

- Procedures for collecting historic weather data as well as the capability of predicting future extreme weather trends.
- Possible emergency operating procedure and operating reserve changes.
- Operating practices for preparing for impeding severe weather and reducing recovery times.
- System restoration procedures for specifically addressing extreme weather events.
- Training requirements.
- Provisions for notifying market participants to prepare for forecasted extreme weather conditions.

**R2.** Operation During Impending Severe Weather (Existing Rule **C.4**; R1)

During periods when severe weather (such as, but not limited to, tornadoes or hurricanes) exists or is forecast to occur, it may be necessary to take steps in addition to those procedures normally followed, to maintain system *security*. The *NYISO* shall enter this mode of operation for those portions of the *NYS Bulk Power System* affected by actual or impending severe weather when requested to do so by the affected *Transmission Owners*, or at any other times when it deems necessary to preserve the *security* and *reliability* of the *NYS Bulk Power System.*

**R1.1.** When a situation exists in which the effects of impending severe weather could severely jeopardize the *security* of the *NYS Bulk Power System*, corrective actions, which would be necessary to protect for one transmission *contingency* greater than the normal criteria within the affected area, shall be implemented.

**R1.2.** *Generation* may be ordered to full operating *capacity* and transmission facilities out of service for maintenance may be ordered restored to service

[16] The proposed Requirements in Appendix A may be modified during the PRR approval process.

**R3.**

The NYISO shall conduct annual NYCA Long-Term Extreme Weather Resource Adequacy Assessments covering the tenth year of a ten-year look-ahead period, as follows:

- The required assessments may be part of the NYISO's RNA Process, Comprehensive Planning Process, or a separate assessment.
- The extreme weather events scenarios in this assessment shall include heat waves, wind lulls, coastal storms (including hurricanes), severe Upstate NY wind storms, and any other type of extreme weather event that the NYISO may wish included.
- A report covering the assumptions and results of this assessment shall be provided to the NYSRC.