2020 SERC Reliability Risk Report

Reliability Risk Working Group (RRWG)

Document Information

Revision:	Rev. 5 - Final
Approval Date:	September 21, 2020
Approved by:	Operations, Planning, and Security Executive Committee
Document Title	2020 SERC Reliability Risk Report
Document ID Number:	
Information Security:	PUBLIC
Created:	9/2020
Department/Committee:	Reliability Risk Working Group (RRWG)
Author/Owner:	Reliability Risk Working Group (RRWG)
Last Edited:	
File Name:	
Template:	

TABLE OF CONTENTS

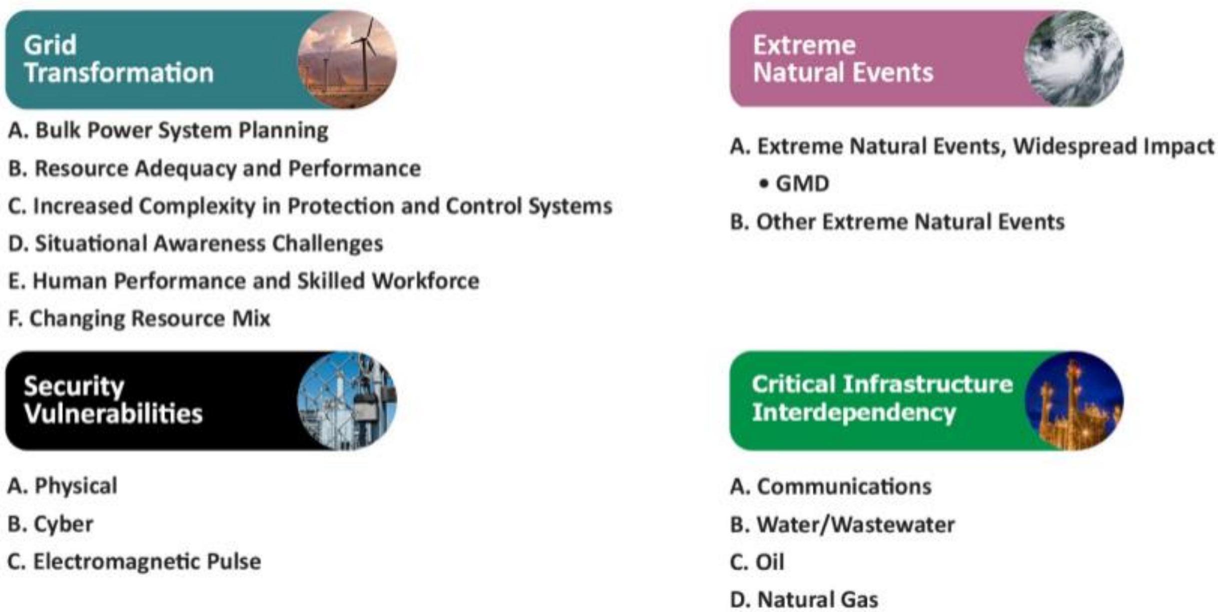
1.0 Executive Summary

The focus of the 2020 SERC Reliability Risk Report is to identify reliability risks within the SERC region of the North American Bulk Power System (BPS). These Risks were developed by leadership from the Engineering, Operations, and the Critical Infrastructure Protection Committees with support from SERC staff. Risks identified in this report are valuable inputs to the development of the SERC CMEP Implementation Plan.

For the 2020 SERC Reliability Risk Report the RRWG considered relevant 2019 risk elements, as well as the 2019 ERO Reliability Risk Priorities Report, and prioritized them based on the probability of occurrence and severity of impact to the SERC Region.

The 2019 ERO Reliability Risk Priorities Report introduced a consolidation of risks into four high level risks: 1) Grid Transformation, 2) Extreme Natural Events, 3) Security Vulnerabilities, and 4) Critical Infrastructure Interdependency

Figure 1: 2019 ERO Reliability Risk Priorities Report - Four High Level Risks[1]



In the review of SERC Reliability Risks the Engineering Committee (EC), Operations Committee (OC) and Critical Infrastructure Protection Committee (CIPC) identified the top Reliability Risks to the SERC Region. Each committee handles issues respective to planning, operations, and critical infrastructure.

Table 1 is a graphic representation of the top identified SERC Reliability Risks and their risk status for the SERC Region. The Manage (status) group includes emerging risks where mitigation plans need to be developed and implemented either through SERC or other Industry engagements or associated inflight mitigation plans need to be completed. The Monitor (status)

[1] 2019 ERO Reliability Risk Priorities Report https://www.nerc.com/comm/RISC/Related%20Files%20DL/RISC%20ERO%20Priorities%20Report_Board_Accpeted_November_5_2019.pdf

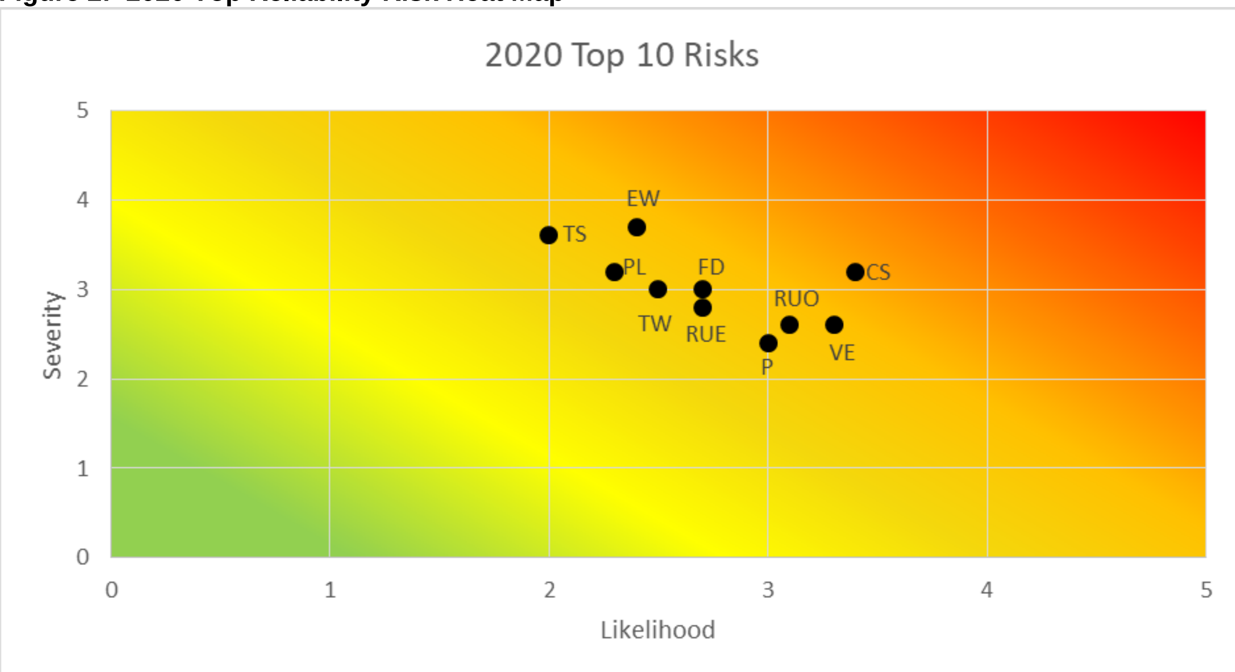
group includes risks that already have mitigation plans and guidance that are being implemented.

Table 1: Ranked Risk Elements and their risk status

Monitor	1. Cybersecurity threats result from exploitation	Manage	6. Fuel Diversity
Monitor	2. Extreme Weather	Monitor	7. Transitioning Workforce
Monitor	3. Variable Energy Resource Integration	Manage	8. Technologies and Services
Manage	4. Resource Uncertainty (EC)	Manage	9. (tie) Pandemic
Manage	5. Resource Uncertainty (OC)	Monitor	9. (tie) Parallel loop flow issues

Figure 2 is a heat map representation of the 2020 top ten identified SERC Reliability Risks.

Figure 2: 2020 Top Reliability Risk Heat Map



Reliability Risk Heat Map Legend

CS – Cybersecurity Threats	**FD – Fuel Diversity**
EW – Extreme Weather	**TW – Transitioning Workforce**
VE – Variable Energy Resources Integration	**TS – Technologies and Services**
RUE – Resource Uncertainty (EC)	**PL – Parallel/Loop Flows Issues**
RUO – Resource Uncertainty (OC)	**P – Pandemic**

SERC Reliability Risks Common Themes and Takeaways

- Interdependencies between industries and fuel types – Fuel Diversity, Resource Uncertainty, and Critical Infrastructure Interdependencies

- Increased security risks (both cyber and physical) – Cyber Security and Expanded Attacks on BPS
- The increase in natural gas and renewable generation coupled with the decline in nuclear and coal-fired generation - Resource Uncertainty and Variable Energy Resource Integration
- The importance of emerging technologies and how to best incorporate those into a reliable and secure BPS – Resource Uncertainty, Transitioning Workforce, and Variable Energy Resource Integration
- Significant changes to the grid require new models and tools for reliable integration - Transitioning Workforce and Variable Energy Resource Integration
- The SERC Region is susceptible to multiple types of Natural Events – Extreme Weather, and Pandemic

In the following sections, the Risk Profiles, Justification, and Mitigation practices will discuss the reliability risks as grouped by the Engineering, Operations, and Critical Infrastructure Protection function to the SERC Region.

2.0 Background

On July 20, 2006, the Federal Energy Regulatory Commission (FERC) certified the North American Electric Reliability Corporation (NERC) as the Electric Reliability Organization (ERO) in the United States, pursuant to Section 215 of the Federal Power Act. As the ERO, NERC may delegate authority to Regional Entities to monitor and enforce NERC Reliability Standards. NERC and the Regional Entities work to safeguard bulk power system (BPS) reliability throughout North America.

Figure 3: Six Regional Entities of North American BPS

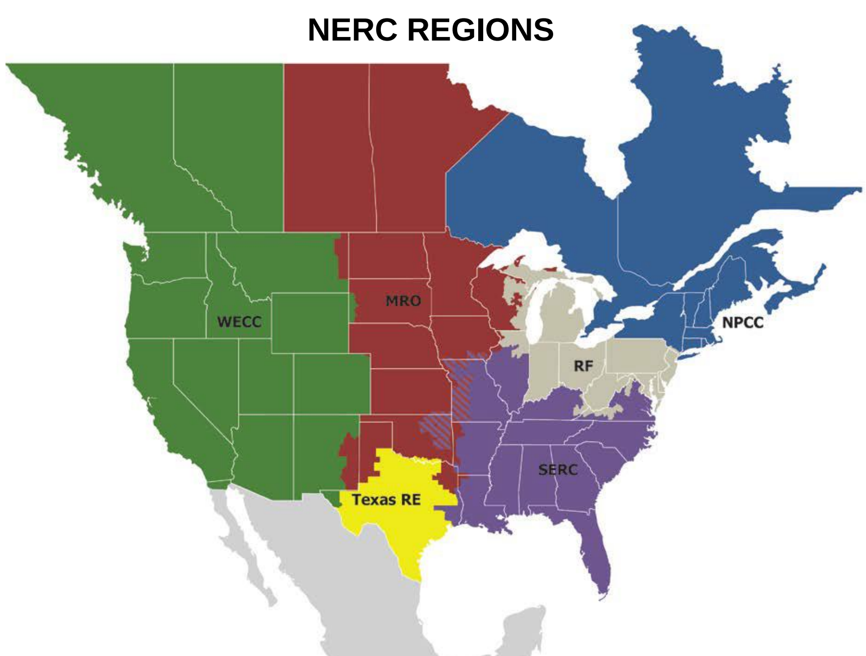
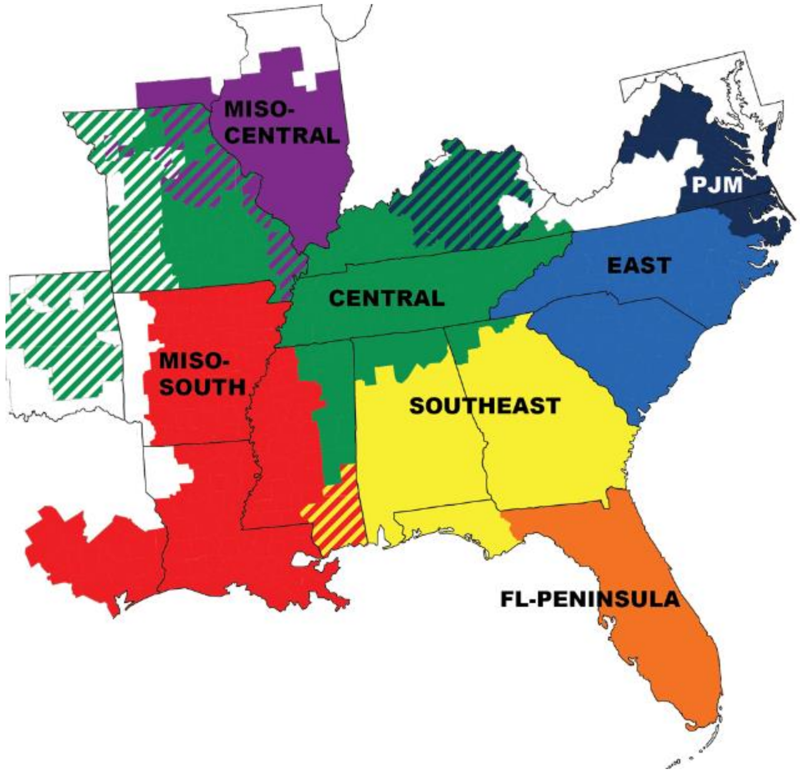


Figure 4: SERC Subregions



As one of six Regional Entities, SERC Reliability Corporation (SERC), located in Charlotte, North Carolina, performs certain functions delegated by NERC as the ERO, and is subject to FERC oversight. SERC promotes and monitors compliance with mandatory Reliability Standards, assesses seasonal and long-term reliability, monitors the BPS through system awareness, and educates and trains industry personnel.

The SERC Region includes all or portions of 16 states in the southeastern and central United States, including all of Alabama, Georgia, Mississippi, North Carolina and South Carolina, Florida and portions of Arkansas, Illinois, Iowa, Kentucky, Louisiana, Missouri, Oklahoma, Tennessee, Texas and Virginia. SERC covers an area of approximately 630,000 square miles. SERC comprises six diverse Reliability Coordinator (RC) Areas: Florida Peninsula (FL-Peninsula) Florida Reliability Coordinating Council, Inc. (RC); Midcontinent Independent System Operator (MISO) RC, subdivided as MISO-Central and MISO-South; Tennessee Valley Authority (TVA) RC - Central; Southeastern RC (SeRC) - Southeast; VACAR South (VACS) RC - East; PJM Interconnection, LLC (PJM) RC - PJM. SERC currently has 78 members, which include Investor-Owned Utilities; Municipal, Cooperative, State, and Federal Entities; Regional Transmission Organizations (RTOs); Independent System Operators (ISOs); Independent Power Producers (IPPs); and Power Marketers. In the SERC Region approximately 245 registered entities under the North American Electric Reliability Corporation (NERC) functional model.

SERC is a nonprofit regulatory authority that promotes effective and efficient administration of BPS reliability. SERC Technical committees and associated subcommittees share expertise among stakeholders and provide vital collaboration in maintaining the Region’s reliability.

3.0 Purpose

The Reliability Risk Working Group (RRWG) advises the SERC Operations, Planning, and Security Executive Committee (OPSEC) concerning risks to the reliability of the BPS for Engineering, Operating, and Critical Infrastructure Protection. They work to identify, analyze, and prioritize Regional risks and educate SERC members on these risks. The RRWG provides input to the SERC Compliance Monitoring and Enforcement Program (CMEP) Implementation Plan by providing reliability risks and justification for submission to the ERO CMEP Implementation Plan for the following year.

Each of the SERC technical committees nominate and evaluate potential risk elements in their technical area. While risks remain categorized in each of these three technical areas, some may align with more than one group. The RRWG uses the following risk ranking methodology:

- Identify the impact(s) of a risk element.
- Assess the probability of risk occurrence in each identified impact area(s).
- Assign a final risk score to the risk element.

For the 2020 SERC Reliability Risk Report the RRWG considered relevant 2019 risk elements, as well as the 2019 ERO Risk Report, and then prioritized them based on the probability of occurrence and severity of impact.

The 2019 ERO Reliability Risk Priorities Report introduced a consolidation of risks into four high level risks[2]: 1) Grid Transformation, 2) Extreme Natural Events, 3) Security Vulnerabilities, and 4) Critical Infrastructure Interdependency.

Higher Likelihood, Higher Impact
- Changing Resource Mix
- Variable Energy Resources Integration
- Cybersecurity threats result from exploitation of both external and internal vulnerabilities
- Resource Uncertainty/changing mix
- Fuel Diversity and Fuel Availability

Higher Likelihood, Lower Impact
- Transitioning Workforce
- Technologies and Services
- Parallel/Loop Flow Issues

Lower Likelihood, Higher Impact
- Extreme Natural Events
- Pandemic

Lower Likelihood, Lower Impact
- None identified at this time fall into this category

[2] 2019 ERO Reliability Risk Priorities Report https://www.nerc.com/comm/RISC/Related%20Files%20DL/RISC%20ERO%20Priorities%20Report_Board_Accpeted_November_5_2019.pdf

4.0 2020 ERO Enterprise Risk Elements[3]

Impact of Risk Elements

The Regional Entities (REs) evaluate the relevancy of the risk elements to the entity's facts and circumstances as they plan Compliance Monitoring and Enforcement Program Implementation Plan (CMEP IP) activities throughout the year. For a given registered entity, requirements other than those in the CMEP IP may be more relevant to assist mitigating the risk, or the risk may not apply to the entity at all. Thus, depending on regional distinctions or registered entity differences, focus will be tailored as needed.

The 2020 risk elements are included in

Table 2 and reflect a maturation of the risk-based approach to compliance monitoring. As the ERO Enterprise and industry continue to become more knowledgeable about the risks that require control emphasis or mitigation, risk elements will focus more on discrete risks. These discrete risks provide focus for measuring current state and validating registered entity progress. By tracking improvements, industry and the ERO Enterprise can justify focusing on different risks in the future.

[3] 2020 ERO Enterprise CMEP Implementation Plan – Version 2.0 https://www.nerc.com/pa/comp/CAOneStopShop/2020_ERO_CMEP_Implementation%20Plan.pdf#search=2020%20ERO%20Enterprise%20CMEP%20Implementation%20Plan

Table 2: Comparison of 2019 and 2020 Risk Elements

Comparison of 2019 Risk Elements and 2020 Risk Elements	
2019 Risk Elements	**2020 Risk Elements**
Improper Management of Employee and Insider Access	Management of Access and Access Controls
Insufficient Long-Term Planning Due to Inadequate Models	Insufficient Long-Term and Operations Planning Due to Inadequate Models
Insufficient Operational Planning Due to Inadequate Models	
Spare Equipment with Extended Lead Time	Loss of Major Transmission Equipment with Extended Lead Times
Inadequate Real-time Analysis During Tool and Data Outages	Inadequate Real-time Analysis During Tool and Data Outages
Improper Determination of Misoperations	Improper Determination of Misoperations
Inhibited Ability to Ride Through Events	Gaps in Program Execution
Gaps in Program Execution	Texas RE: Resource Adequacy

[4]

Table 3 contains the 2020 risk elements and associated areas of focus as listed in the 2020 ERO Enterprise CMEP Implementation Plan.

Table 3: ERO 2020 Risk Elements[5]

Management of Access and Access Controls	Standards	Requirements	Asset Types	Functional Areas
	CIP-003-7, CIP-003-8	R2	Back up Control Centers, Control Centers, Data Centers, Generation Facilities, Substations	BA, DP, GOP, GO, RC, TOP, TO
	CIP-004-6	R4, R5		
	CIP-005-5, CIP-005-6	R1, R2		
	CIP-006-6	R1		
	CIP-007-6	R1, R2, R3		
	CIP-010-2, CIP-010-3	R1, R4		

[4] 2020 ERO Enterprise CMEP Implementation Plan – Version 2.0 Table 1: https://www.nerc.com/pa/comp/CAOneStopShop/2020_ERO_CMEP_Implementation%20Plan.pdf#search=2020%20ERO%20Enterprise%20CMEP%20Implementation%20Plan

[5] 2020 ERO Enterprise CMEP Implementation Plan – Version 2.0: https://www.nerc.com/pa/comp/CAOneStopShop/2020_ERO_CMEP_Implementation%20Plan.pdf#search=2020%20ERO%20Enterprise%20CMEP%20Implementation%20Plan

	CIP-011-2	R1		
	CIP-013-1	R2		
Insufficient Long-Term and Operations Planning Due to Inadequate Models	**Standards**	**Requirements**	**Rationale**	**Functional Areas**
	MOD-033-1	R1, R2	Validating planning power flow models	PC, RC, TOP
	PRC-023-4	R1, R2, R6	Ensure protective relay settings do not limit transmission loadability	TO, GO, PC
	PRC-024-2	R1, R2	Ensure resources stay available during applicable voltage and frequency excursions, especially inverter-based resources	GO
	TPL-001-4	R1	Ensure accurate System Models	PC, TP
Loss of Major Transmission Equipment with Extended Lead Times	**Standards**	**Requirements**	**Rationale**	**Functional Areas**
	EOP-005-3	R7	Assess whether unavailability of Blackstart units and their associated systems, including Blackstart paths have been considered in the entity's spare equipment strategy	TOP
	TPL-001-4	R2.1.5	Ensure that unavailability of major Transmission equipment has been considered in the entity's spare equipment strategy	PC, TP
Inadequate Real-time Analysis during Tool and Data Outages	**Standards**	**Requirements**	**Rationale**	**Functional Areas**
	IRO-008-2	R4	Ensuring situational awareness is maintained regardless of Real-Time Contingency Analysis (RTCA)status	RC
	TPL-001-4	R13	Ensuring situational awareness is maintained regardless of RTCA status	TOP
Improper Determination of Misoperations	**Standards**	**Requirements**	**Rationale**	**Functional Areas**
	PRC-004-5(i)	R1, R3	Ensure proper analysis of protection system operations	GO, TO
	Standards	**Requirements**	**Rationale**	**Functional Areas**

Gaps in Program Execution	CIP-002-5.1a	R1, R2	Ensuring Entities maintain complex programs that handle large amounts or date, e.g., accurate inventories of equipment, following asset transfers, addition of new equipment, etc.	BA, GO, TOP, TO, RC
	CIP-010-2, CIP-010-3	R1		
	FAC-003-4	R1, R2, R3, R6, R7		GO, TO
	FAC-008-3	R6		
	PRC-005-6	R3		

The RRWG has attempted to identify potential families of NERC Standards to assist in the justification and identification of Major Reliability Risks to the SERC Region for 2020. This is not a complete list of possible and/or applicable standards to meet compliance and should not be used to meet compliance of the NERC Compliance Standards.

Table 4 lists the top 10 Reliability Risks for 2020 as identified by the SERC Technical Committees

Table 4: SERC 2020 Top 10 Reliability Risks

Cybersecurity threats result from exploitation of both external and internal vulnerabilities	**Family of Standards**	**Rationale/Impact Areas**
	CIPs	• Unauthorized entry into the ESP • Required patching and updates • Loss of communication – data/voice • Loss of coordination and situational awareness • Large block of power unexpectedly flowing through SERC
Extreme Weather	**Family of Standards**	**Rationale/Impact Areas**
	EOPs, TOPs, BALs, COMs, INTs, and/or TPLs	• Planning to deal with and emergency event • Required reporting of extreme events • Ensure that Network Modeling, State Estimation, and RTCA is resilient in extreme weather and backup measures are in place if primary tools fail (e.g. State Estimator fails to solve) • use of alternate tools -manual operation of system, Loss of situational awareness • Loss of communication data/voice Planning for extreme weather condition
Variable Energy Resources integration	**Family of Standards**	**Rationale/Impact Areas**
	BALs, MODs, TPLs, and/or FACs	• Ensure entity has operations planning tools and mitigations in place (operating procedure) for mitigating imbalances created by variable energy resources in a timely manner

		• Maintain sufficient reactive supply and voltage regulation • Additional reserves required, ramping requirements • Plan and build when VERs are not available • Additional scenario planning • Accurate Load forecasting • Harmonic impact to the system
Resource uncertainty/ changing mix along with generation retirements	**Family of Standards**	**Rationale/Impact Areas**
	EOPs, MODs, TPLs, FACs, and/or BALs	• Emergency Operations Plans are in place to mitigate and respond to Capacity and Energy Emergencies • Increased coordinated studies required with SERC neighbors. • Increase of DERS and potential lack of visibility • Policy or legislation changes could impact fuel prices due to environmental groups, activists and, public perception, PV manufacturing defect impacts a significant % of solar capacity, States remove PV economic incentives • Potential transmission system expansion and lead time concerns • Increase in VERs requiring additional reserves and need for plan/build of system to accommodate VERs unavailability • Additional scenario planning needed • Load forecasting, metered load • Lack of visibility of distributed energy resources (DERS) and its effect on load forecasting, metered load, and state estimation • Greater commitment/dispatch challenges for operators, (ramping requirements, plus others) • Additional reserves required to address VERS; increase in need to plan and build the system when VERs are not available
Fuel Diversity/Fuel Availability	**Family of Standards**	**Rationale/Impact Areas**

	NERC Fuel Assurance Reliability Guideline EOPs, and/or BALs	• Resource adequacy • Sudden changes in dispatch and operating conditions • Forced operating conditions • Need for fast acting capabilities of existing units • Significant event that would affect a certain fuel type • More reliance on natural gas
Transitioning Workforce	**Family of Standards**	**Rationale/Impact Areas**
	PERs	• Lack of experience leads to poor decision making/delayed actions to resolve emergency • Aging workforce (lack of knowledge transfer)
Technologies and services	**Family of Standards**	**Rationale/Impact Areas**
	CIPs	• Prevention of unauthorized access into the Electronic Security Perimeter (ESP), Software authentication • Supply chain protection of critical components • Loss of electric generation/transmission • Loss of situational awareness monitoring • Loss of communication data/voice • Loss of protection systems • Market disruption
Pandemic	**Family of Standards**	**Rationale/Impact Areas**
	EOPs, BALs, PER, and/or PRCs	• Entities need to have a tested, fully functional backup site for system operations should the primary site have active vectors for a virus threat. System Operators are periodically tested on operations from the backup site. • Load Uncertainty (reduction and/or profile changes) • Staffing • Training and Onboarding • Event response and recovery • Delay in execution of maintenance and capital project improvement plans

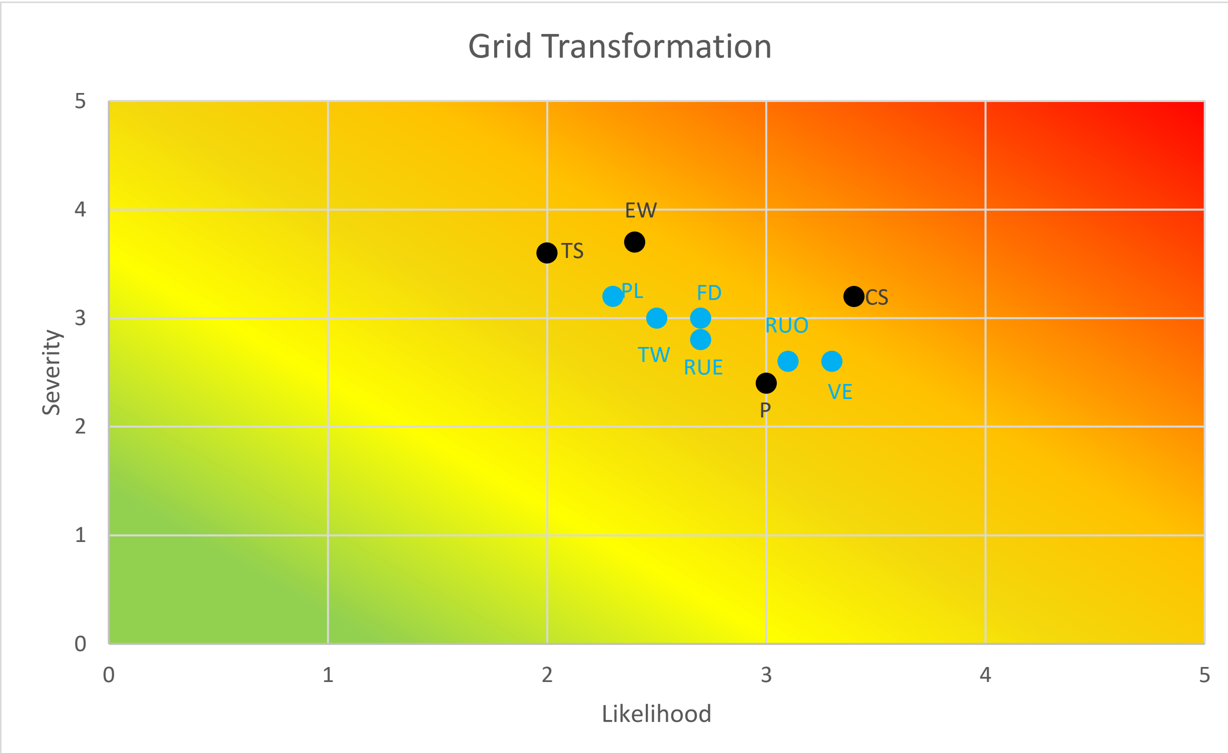
Parallel/Loop Flow Issues	Family of Standards	Rationale/Impact Areas
	IROs, TOPs, and/or FACs	• RCs know how to implement transmission loading relief procedures • System Operators develop Operating Plans for mitigating SOL exceedances • Lack of adequate outage coordination for generation and transmission facilities • Non-uniformity of market/traditional flow formulas • Lack of coordination to solve reliability issues • Inaccurate models for Operations Planning • Changing Resource Mix and Capacity Market resources creating unscheduled power flows • TLR as operational risk

5.0 2020 Reliability Risk Profiles

5.1 SERC EC, OC, and CIPC Committees 2020 Reliability Risk Profiles

5.1.1 Descriptors of the Reliability Risk Profile: Grid Transformation

Figure 5: Reliability Risk Profile - Grid Transformation



Reliability Risk Heat Map Legend

CS – Cybersecurity Threats	**FD – Fuel Diversity**
EW – Extreme Weather	**TW – Transitioning Workforce**
VE – Variable Energy Resources Integration	**TS – Technologies and Services**
RUE – Resource Uncertainty (EC)	**PL – Parallel/Loop Flows Issues**
RUO – Resource Uncertainty (OC)	**P – Pandemic**

Changing Resource Mix, Critical Infrastructure Interdependency, and Human Performance and Skilled Workforce

- **Variable Energy Resources Integration** – There has been a rise in the SERC renewable energy resource portfolio; wind energy in the west, and solar in the south and southeast. Integration of Variable Energy Resources (VERs) raises the risk of voltage regulation, dynamic response, and sudden change in dispatch patterns. The changing characteristic of the grid with the growth of VERs will affect how the grid is operated in future.

  Since VERs are weather dependent, planning for backup resources in the absence of generation becomes essential to maintain the reliability of the system.

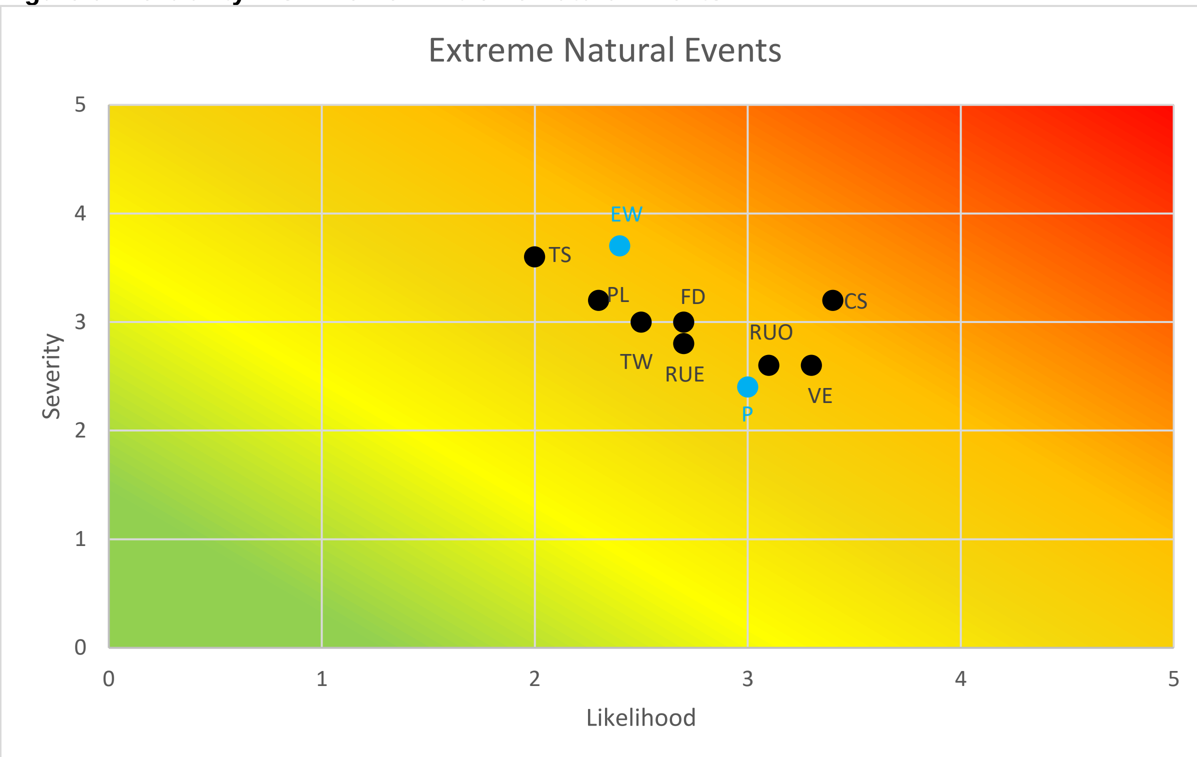
- **Resource Uncertainty and Changing Resource Mix with Generation Retirements** – A transition is taking place in the resource mix within SERC (and nationally) driven by both economics and public policy. While decreasing costs and lower emissions have propelled natural gas dominance as a fuel source (replacing coal), renewables (photovoltaic and to a lesser extent, wind) are making a surge due to dropping installation costs and state-based subsidies. Existing nuclear generation is struggling to be competitive in some areas.
- **Fuel Diversity and Fuel Availability** – Currently, natural gas accounts for more than 40 percent of generation in the SERC Region. There will be greater reliance on natural gas generation considering known and anticipated baseload coal plant retirement, fuel costs, and environmental policies. This will give rise to a less diverse portfolio, and an inability to respond to loss of a specific fuel type.

  Volatility in natural gas prices and aging natural gas infrastructure affect the dispatch of generation. Adequacy of natural gas pipeline infrastructure to serve extreme winter peak loads, along with traditional firm gas needs drive the need for fast acting capabilities of existing units. Policy or legislation changes could affect fuel prices due to environmental groups, activists, and public perception that a significant event could affect a certain fuel type as reliance on natural gas continues to grow.
- **Transitioning Workforce** – Lack of experience leads to poor decision making/delayed actions when resolving emergencies. An aging workforce, with a resulting lack of knowledge transfer, exacerbates this situation.
- **Parallel/Loop Flow Issues –** All SERC RCs confirm that parallel or loop flows represent a major operating risk to the BPS. Analysis of past SERC transmission loading relief (TLR) logs provides information on possible parallel or loop flow impacts. Influences for such flows include
  - The lack of adequate outage coordination for major generation and transmission facilities; and
  - The non-uniformity of market and non-market power flows, along with potential inadequate or inaccurate operation planning models.

  Parallel/loop flows put firm transactions at risk. These firm transactions usually serve as designated network resources (DNRs) for SERC entity load.

5.1.2 Descriptor of the Reliability Risk Profile: Extreme Natural Events

Figure 6: Reliability Risk Profile - Extreme Natural Events



Reliability Risk Heat Map Legend

CS – Cybersecurity Threats	**FD – Fuel Diversity**
EW – Extreme Weather	**TW – Transitioning Workforce**
VE – Variable Energy Resources Integration	**TS – Technologies and Services**
RUE – Resource Uncertainty (EC)	**PL – Parallel/Loop Flows Issues**
RUO – Resource Uncertainty (OC)	**P – Pandemic**

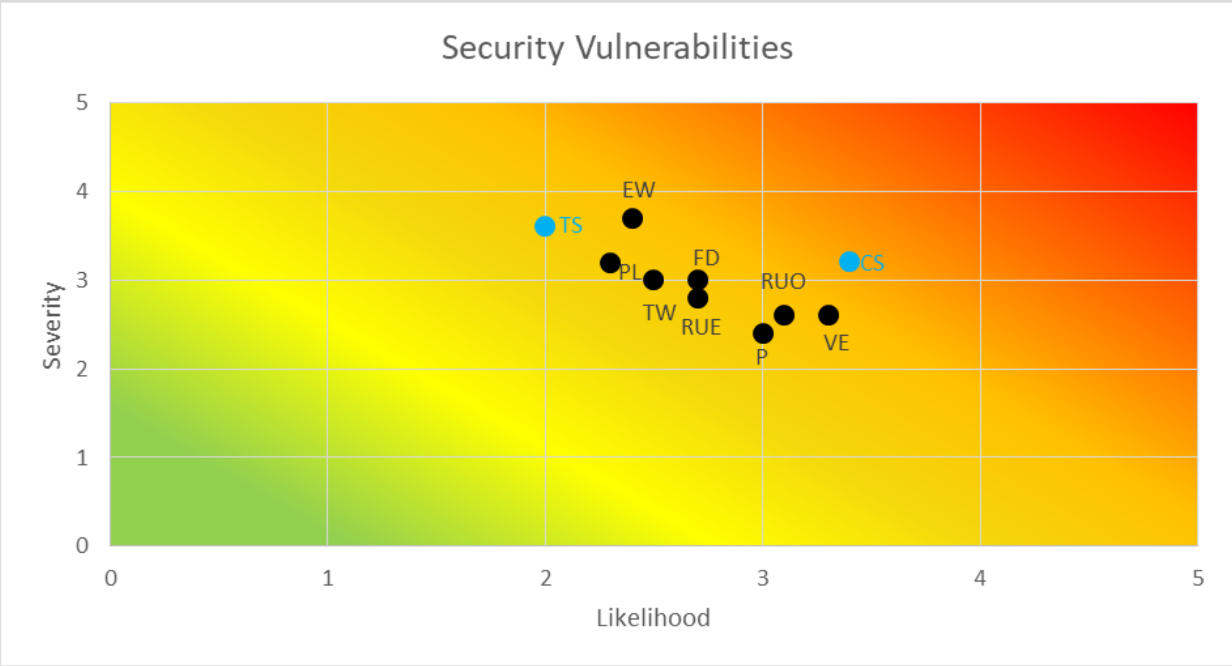
Other Extreme Natural Events

- **Extreme Weather** – Typically, the SERC Region experiences more than one tornado per year and prepares for at least three-to-four named tropical storms each year. Extreme weather poses a significant risk to BPS reliability due to disruptions in the fuel supply, vegetation impinging on transmission lines, loss of telecommunication, lack of BPS situational awareness, and associated forced outages of generation and transmission facilities. Severe cold weather gives rise to issues with the natural gas pipeline supply, freezing of piping or instrumentation at generator plants, freezing of coal piles, and other impacts. Extremely hot weather can adversely affect generation by restricting plant cooling, sources of cooling water, and hydroelectric generation due to drought or flooding, as well as reducing facility ratings.
- **Pandemic** – The recent COVID-19 pandemic brought a unique set of challenges that affected daily staffing levels; training and onboarding of personnel; load uncertainty causing load reductions and changes to the load profile; and availability of staff and

contractors. Along with personnel safety concerns, these culminated in delayed execution of maintenance and capital project plans.

5.1.3 Descriptor of the Reliability Risk Profile: Security Vulnerabilities

Figure 7: Reliability Risk Profile - Security Vulnerabilities



Reliability Risk Heat Map Legend

CS – Cybersecurity Threats	**FD – Fuel Diversity**
EW – Extreme Weather	**TW – Transitioning Workforce**
VE – Variable Energy Resources Integration	**TS – Technologies and Services**
RUE – Resource Uncertainty (EC)	**PL – Parallel/Loop Flows Issues**
RUO – Resource Uncertainty (OC)	**P – Pandemic**

Physical and Cyber

- **Cybersecurity threats result from exploitation of both external and internal vulnerabilities** – This includes exploitation of employee and insider access; weak security practices of host utilities, third-party service providers, vendors, and other organizations; unknown, undisclosed, or unaddressed vulnerabilities in cyber systems; growing sophistication of bad actors and nation states, and collaboration between these groups.
- **Technologies and Services** – There has been increased reliance on third party service providers and cloud-based services for BPS operations and support. Cybersecurity risks in the supply chain include software integrity and authenticity; vendor remote access; information system planning; and vendor risk management and procurement controls.

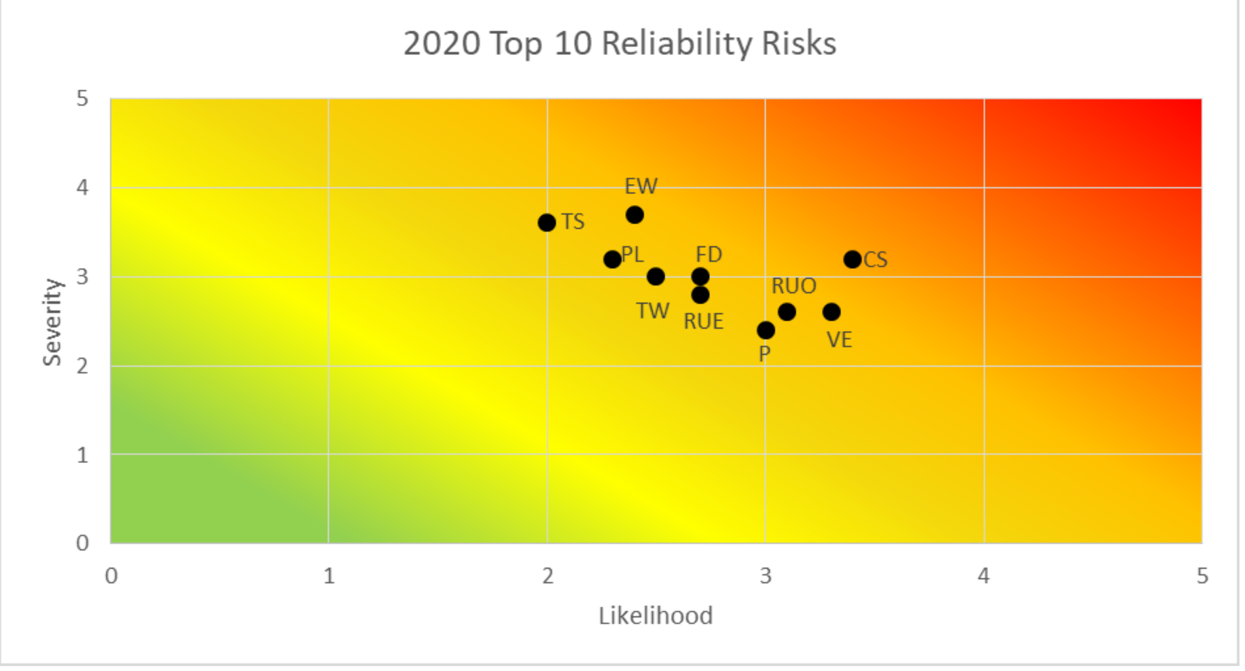
5.2 2020 SERC Risks and Mitigation Strategies

The following section represents the top 10 identified 2020 Reliability Risks based on their overall risk score, regardless of which Committee provided the risk. If a committee did not have 3 risks in the top 10, then the top 3 mitigation strategies are provided in this section. The overall risk score is determined by and prioritized based on the probability of occurrence and severity of impact to the SERC Region, as identified by the SERC RRWG. The section below discusses the mitigation strategies and provides an update as to their progress from 2019.

Appendices A, B, and C provide a complete list of evaluated risk elements.

Figure 8: Ranked Regional Risk Elements summarizes the top 10 risks for 2020 for the Engineering, Operations, and Critical Infrastructure Protection Committees combined.

Figure 8: Ranked Regional Risk Elements



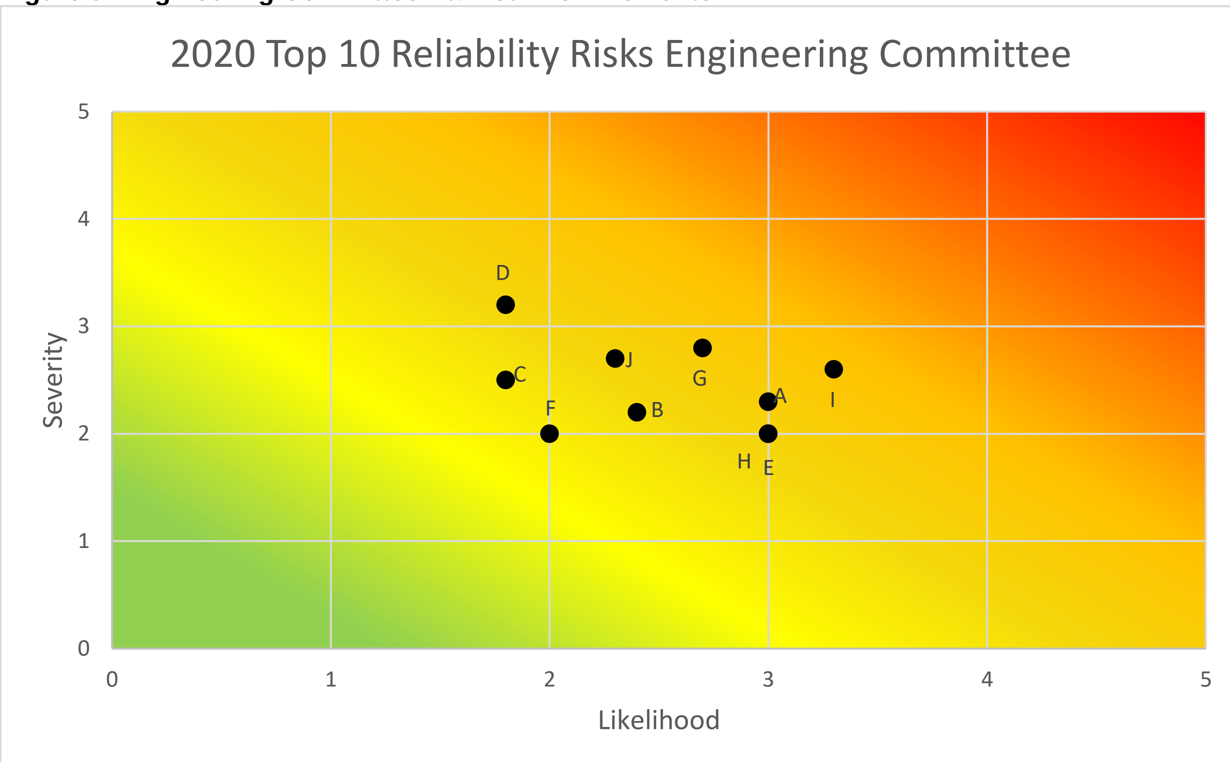
Reliability Risk Heat Map Legend

CS – Cybersecurity Threats	**FD – Fuel Diversity**
EW – Extreme Weather	**TW – Transitioning Workforce**
VE – Variable Energy Resources Integration	**TS – Technologies and Services**
RUE – Resource Uncertainty (EC)	**PL – Parallel/Loop Flows Issues**
RUO – Resource Uncertainty (OC)	**P – Pandemic**

5.2.1 Engineering Committee Risks and Mitigation Strategies

For 2020, 2 risks identified by the Engineering Committee made the RRWG top 10 Regional Risk Report. The top 3 engineering risks are identified below. For a complete set of the engineering risks, see Appendix A.

Figure 9: Engineering Committee Ranked Risk Elements



Reliability Risk Heat Map Legend – Engineering Committee

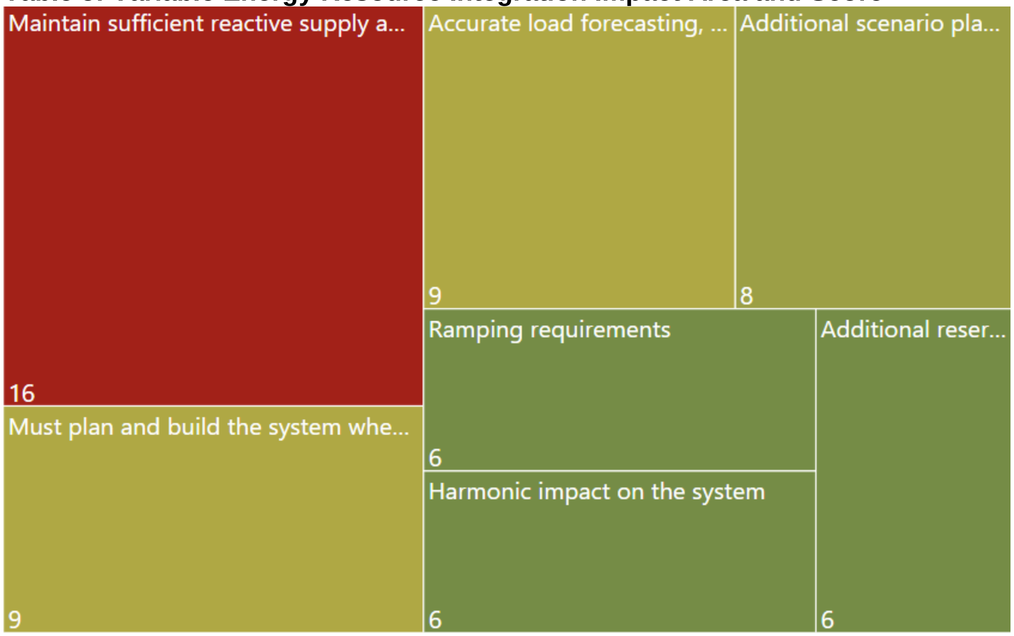
A – Generation and Transmission Monitoring	**F – Loss of large unit during shoulder months**
B – FAC-008	**G – Resource Uncertainty**
C – Flood or Drought for an extended period of time	**H – Supply Chain Management**
D – Generator Governor Frequency Response	**I – Variable Energy Resources Integration**
E – Modeling Firm Interchange in short and long term study models	**J – Fuel Diversity/ Fuel Availability**

5.2.1.1 Variable Energy Resources Integration

There has been rise in the SERC renewable energy resource portfolio: wind energy in the west and solar in south and southeast. Integration of VERs raises the risk of voltage regulation, dynamic response, and sudden change in dispatch patterns. The changing characteristic of the grid with the growth of VERs will affect how the grid is operated in future.

Since VERs are weather dependent, planning for backup resources in the absence of generation becomes essential to maintain the reliability of the system.

Table 5: Variable Energy Resource Integration Impact Area and Score*



***Please refer to Appendix A to see the detailed description of the impact area categories*

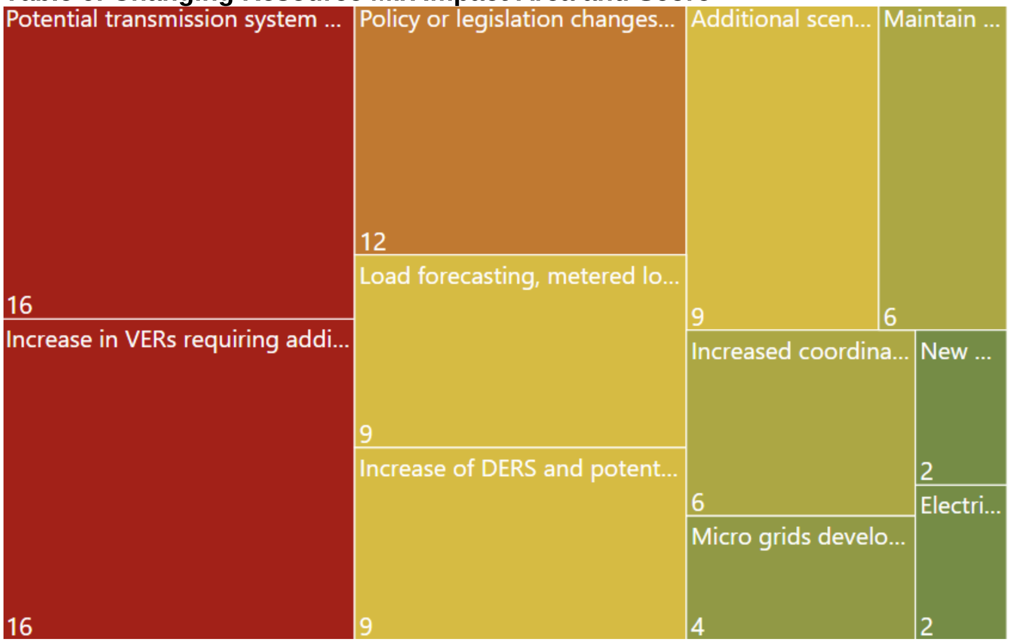
Risk Mitigation Status

The Variable Energy Resources Working Group (VERWG) continues to monitor these changes and aid with developing solutions to address Variable Energy Resource Integration. Specifically, the VERWG is developing an Inverter-Based Resource Interconnection Requirements Practices paper. The purpose of this paper is to document industry guidance and practices of SERC members regarding interconnection requirements for inverter-based resources. In addition to acting as a resource for SERC members, the paper will serve as a starting point for discussion between SERC entities on the best ways to incorporate future industry guidance and lessons learned. In addition, the paper will act as a training aid and starting point in helping entities develop inverter-based generation interconnection requirements and will provide insight on the practices of other SERC members as a resource until expertise is developed. We believe that providing this guidance to the SERC members will help each member accurately assess the impact of increasing integration of renewable energy in the SERC region.

5.2.1.2 Resource Uncertainty and Changing Resource Mix Along with Generation Retirement:

A transition is taking place in the resource mix within the SERC Region (and nationally), driven by both economics and public policy. While decreasing costs and lower emissions have propelled natural gas to prominence as a fuel source (replacing coal), renewables (primarily photovoltaic in the SERC Region and to a lesser extent, wind) are making a surge, due to dropping installation costs and state-based subsidies. Existing nuclear generation is struggling to be competitive in some areas.

Table 6: Changing Resource Mix Impact Area and Score*



Please refer to Appendix A to see the detailed description of the impact area categories

Risk Mitigation Status

The EC created the Renewable Impact Study Task Force (RISTF) to do the following:

- Consider the SERC Resource Adequacy Working Group's (RAWG) 2016 resources mix scenarios, analyze transmission impacts (voltage constraints, stability, etc.); and
- Initiate analysis across multiple technical groups (variable energy, dynamics, steady state, resource adequacy).

The EC recommended at the time that SERC could use the results from the analysis to identify potential reliability implications associated with resource mix changes, provide recommendations to entities in the Region, and provide a reliability perspective for ERO and policy considerations.

The RISTF completed its work and developed the final report. The recommendations from the task force were:

- Perform transmission analysis on various renewable penetration level sensitivities developed by the RAWG.
- Encourage the Dynamics Working Group to continue discussions on the Eastern Interconnection Planning Collaborative (EIPC) recommendations and pursue study efforts, as appropriate.

Additionally in 2017, the SERC EC formed a Variable Energy Resources Working Group (VERWG) to evaluate the effects of variable energy resource integration on the reliability of the bulk power system (BPS) in the SERC Region. This group is responsible for annually collecting data used for trending. In 2017, the VERWG collected limited distributed energy resource (DER) data through an informal survey of its members. In 2018, SERC modified and expanded the DER template to include associated DER characteristics. In order to reach a larger SERC audience and collect a more complete data set, the DER survey has been included in the annual, formal DCTF survey. However, the DER survey request does not yet contemplate hourly modeling data.

The RISTF recommended using the data available through the VERWG data collection for renewable impact analysis within other studies performed across other EC working groups.

The RISTF completed its report, and then the EC disbanded it in 2018.

5.2.1.3 Generation and Transmission Modeling

Accurate representation of transmission and generation modeling is the key to planning the transmission adequacy and to maintaining system reliability in the future. The rise of the renewable generation model and the use of inaccurate and black box models introduces errors and significantly affects planning studies.

Table 7: Generation and Transmission Modeling Impact Area and Score*

Please refer to Appendix A to see the detailed description of the impact area categories

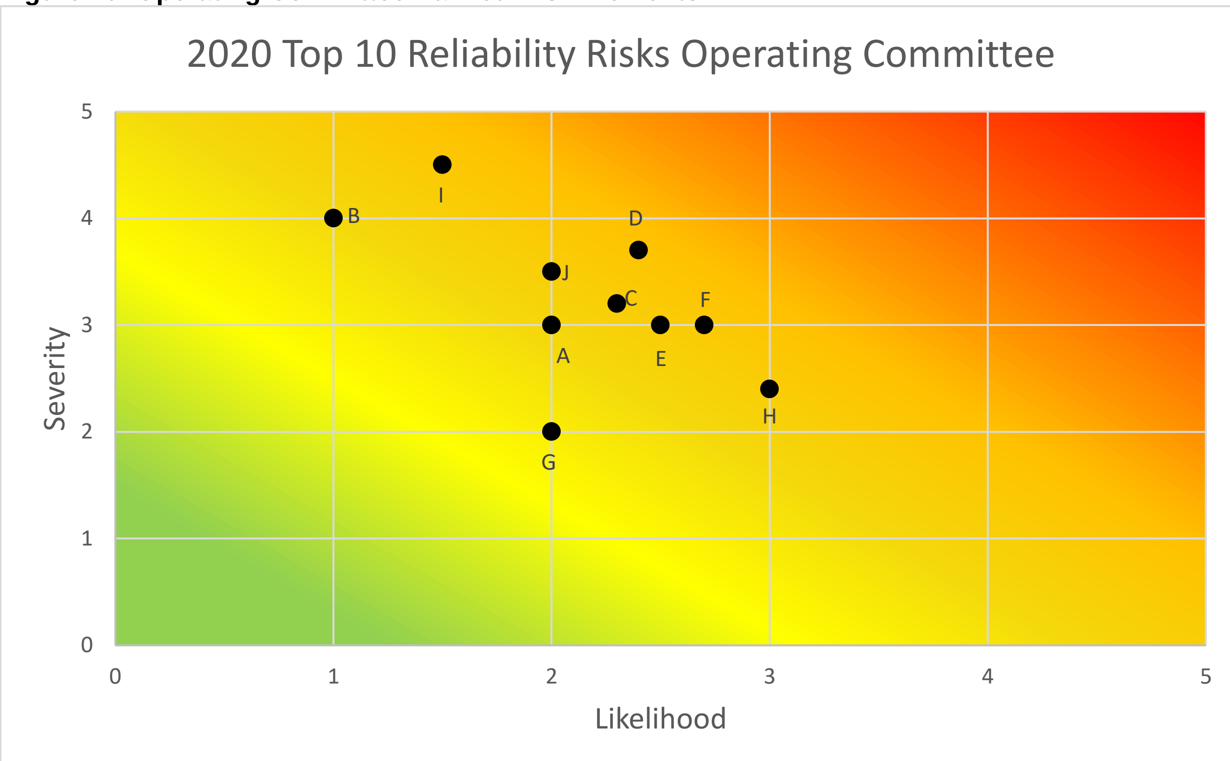
Risk Mitigation Status

Mitigation strategies need to be developed, the SERC Engineering Committee needs to evaluate the impact areas and create an action item to assign to the appropriate committee to develop mitigations.

5.2.2 Operating Committee Risks and Mitigation Strategies

For 2020, 6 risks identified by the Operating Committee made the RRWG top 10 Regional Risk Report. The top 6 operations risks are identified below. For a complete set of the operational risks, see Appendix B.

Figure 10: Operating Committee Ranked Risk Elements



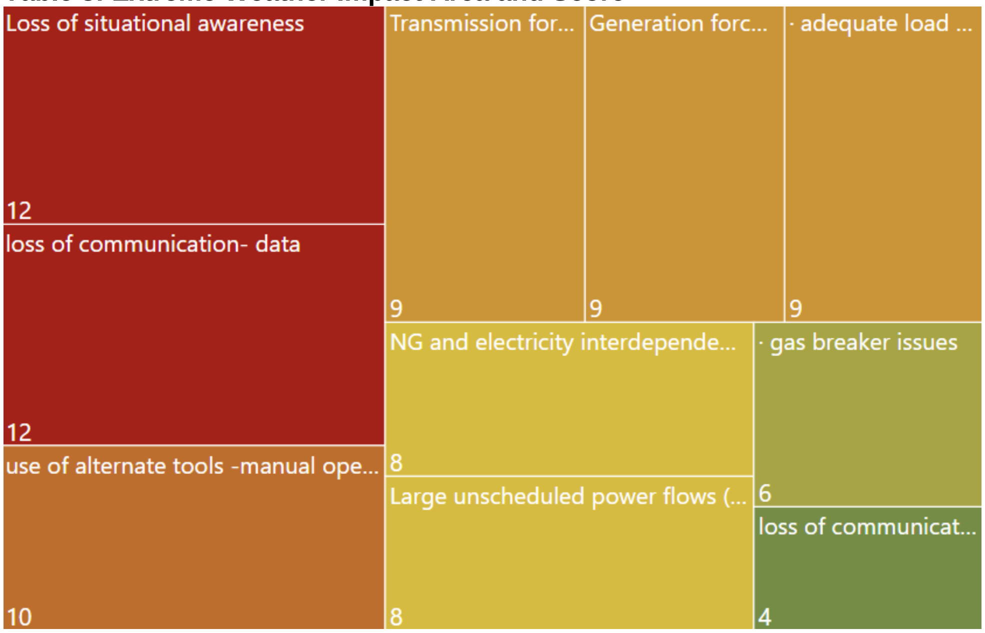
Reliability Risk Heat Map Legend – Operating Committee

A – Resource Uncertainty	**F – Fuel Diversity/ Fuel Availability**
B – Vegetation causing cascade event	**G – Loss of large unit during shoulder months**
C – Parallel/Loop Flow Issues	**H – Pandemic**
D – Extreme Weather	**I – AC Equipment Failure compounded by relay misoperations**
E – Transitioning Workforce	**J – Loss of Major Application (EMS/SCADA)**

5.2.2.1 Extreme Weather

Typically, the SERC Region experiences more than one tornado per year and prepares for at least three to four named tropical storms each year. Extreme weather poses a significant risk to BPS reliability due to disruptions in the fuel supply, vegetation impinging on transmission lines, loss of telecommunication, lack of BPS situational awareness, and associated forced outages of generation and transmission facilities. Severe cold weather gives rise to issues with the natural gas pipeline supply, freezing of piping or instrumentation at generator plants, freezing of coal piles, and other impacts. Extremely hot weather can adversely affect generation by restricting plant cooling, sources of cooling water, and hydroelectric generation due to drought or flooding, as well as reducing facility ratings.

Table 8: Extreme Weather Impact Area and Score*



****Please refer to Appendix B to see the detailed description of the impact area categories*

Risk Mitigation Status

The OC uses the *SERC OC Conservative Operations Guidelines (2017)* to guide SERC members in the development of a conservative operations procedure as one means of mitigating the risks associated with extreme weather experienced by the SERC Region.

NERC developed a Reliability Guideline[6], *Generating Unit Winter Weather Readiness*, which provides recommended industry practices for preparing for and operating through periods of extreme cold weather. SERC sent this document to SERC OC members for their company's consideration and use with winter preparedness activities.

The SERC OC developed a severe cold weather checklist (or guideline) document. A request to SERC OC members to provide copies of checklists they currently use resulted in the submission of three such lists. The final document was published in October 2018.

The SERC OC established a standing agenda item for their fall meeting to address preparations for cold weather operations.

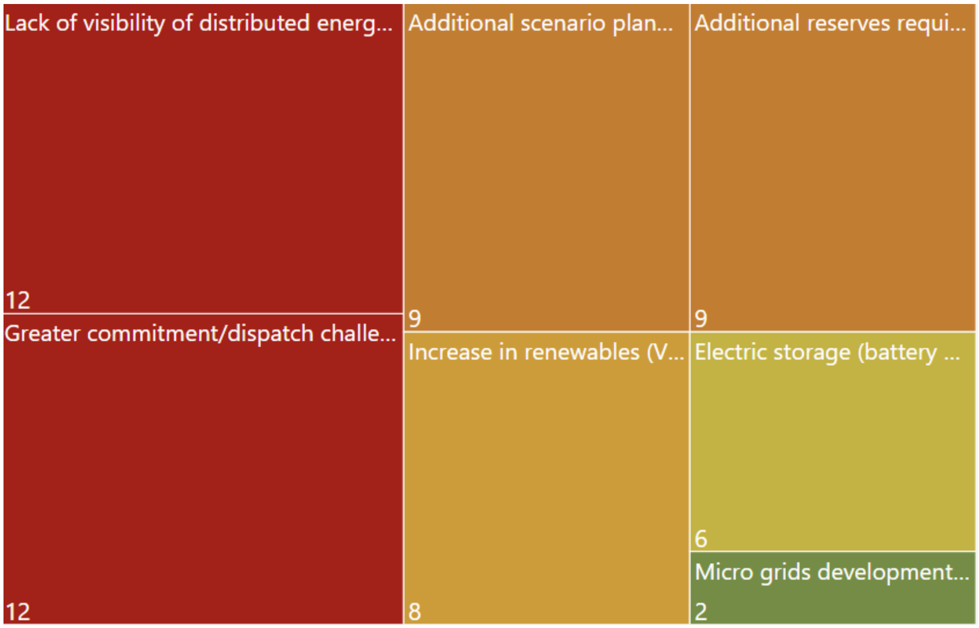
Members share best practices on events and issues they have experienced during extreme weather events.

5.2.2.2 Resource uncertainty/changing mix along with generation retirements

A transition is taking place in the resource mix within SERC (and nationally) driven by both economics and public policy. Renewables (photovoltaic and to a lesser extent, wind) are making a surge, due to dropping installation costs and state-based subsidies.

6 https://www.nerc.com/comm/OC/Reliability%20Guideline%20DL/Generating_Unit_Winter_Weather_Readiness_final.pdf

Table 9: Changing Resource Mix Impact Area and Score*



****Please refer to Appendix B to see the detailed description of the impact area categories*

Risk Mitigation Status

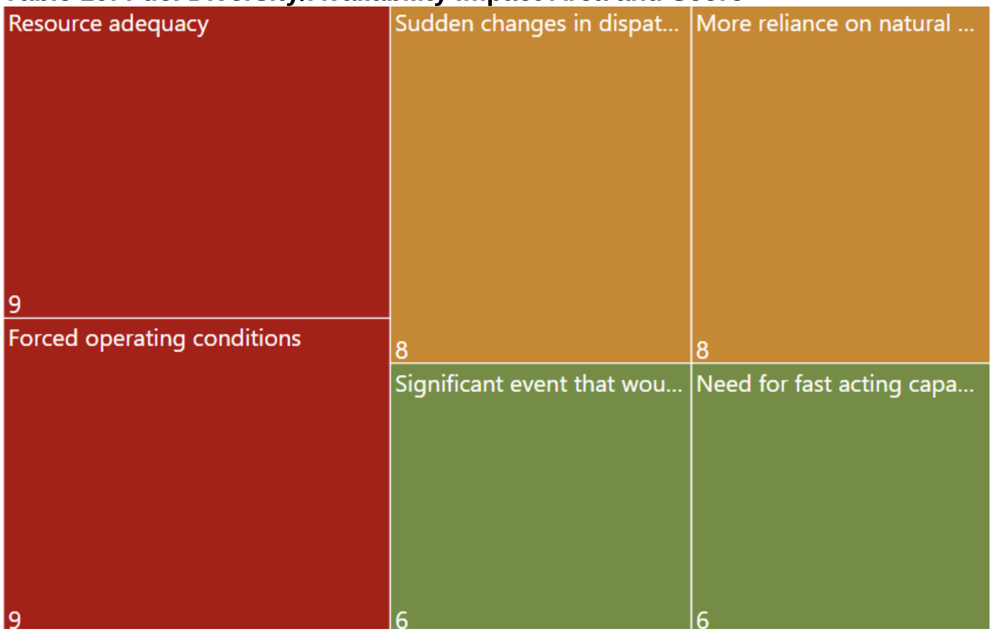
For this risk area, the RRWG recommends that the SERC OC should gain insight from the VERWG efforts and studies. The RRWG recommends the VERWG present updates on efforts and best practices to the SERC OC technical committee at its upcoming meetings to identify any actionable items on which the SERC OC should focus.

In addition, since the RRWG has identified a general gap with modeling Distributive Energy Resources (DERs) and having visibility of DERs on Energy Management Systems (EMS), the RRWG recommends best practice presentations from SERC OC members knowledgeable in this area.

5.2.2.3 Fuel Diversity/Fuel Availability

Fuel diversity and fuel availability are of equal risk to the reliable operation of the system. Currently, natural gas accounts more than 40 percent of generation in the SERC region. There will be greater reliance on natural gas generation because of baseload coal plant retirements, volatility in fuel costs, adequacy of natural gas pipeline infrastructure to serve extreme winter peak load along with traditional firm gas needs, and policy or legislation changes that could affect fuel prices due to environmental groups, activists and, public perception. This will give rise to a less diverse portfolio, and loss of the ability to respond to the loss of a single fuel type.

Table 10: Fuel Diversity/Availability Impact Area and Score*



****Please refer to Appendix B to see the detailed description of the impact area categories***

Risk Mitigation Status

In response to this risk, the OC has developed a multi-prong strategy consisting of ongoing monitoring and member best practice sharing efforts.

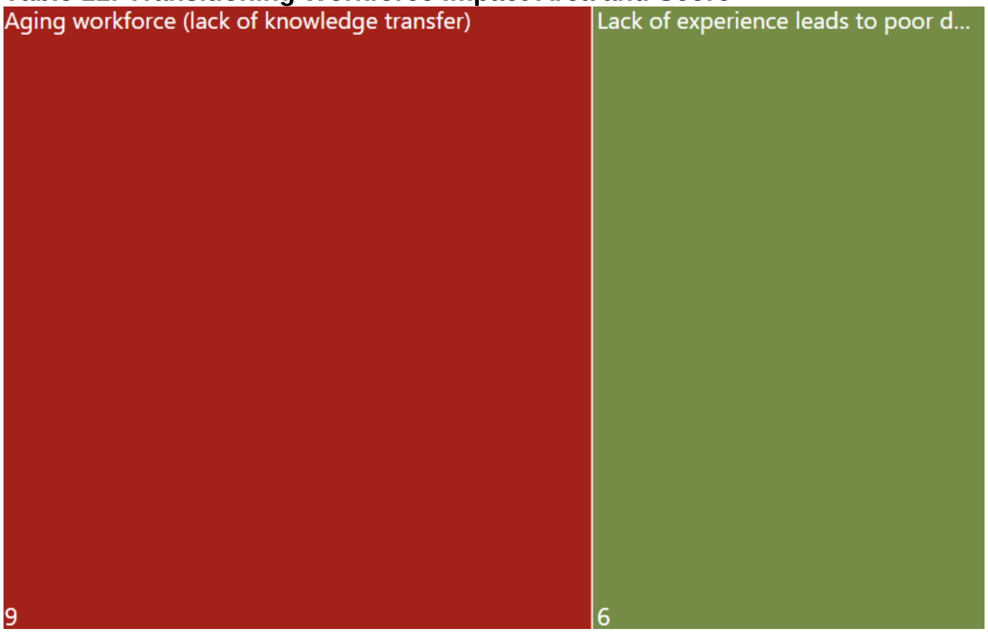
The first of these strategies involved securing a speaker from a SERC member to share lessons learned and actions taken from the NERC Single Point of Disruption (SPOD) Report. During the 2018 Fall Technical Committee Meeting, a presenter from Southern Company Transmission presented key takeaways from Southern Company's studies, which they performed as a result of the SPOD report. The presentation contained valuable information regarding study logistics and the importance of building and retaining collaborative partnerships with fuel providers, and including them in the study process. This presentation has been shared with SERC OC members. To gain additional insight specific to how the operation of natural gas infrastructure affects utility-scale generation dispatch, the RRWG recommends that information be sought to gain awareness of Operational Flow Orders (OFOs) and their impact on generation dispatch. The SERC OC should seek to understand the trend of OFOs, including cause and effect of such orders. Additionally, the OC should track efforts and information pertaining to the NERC Electric-Gas Working Group (EGWG). Finally, there should be an annual review of trends associated with generation resources based on fuel type to gain better awareness of fuel sensitivities.

Additional strategies—that are still ongoing—include the use of existing tools, such as Conservative System Operations, to manage effectively capacity constraints, as well as ensuring that the operations perspective continues to be included in long term planning scenarios.

5.2.2.4 Transitioning Workforce

Lack of experience leads to poor decision making/delayed actions to resolve emergencies. Knowledge transfer from the Aging Workforce can mitigate this lack of experience.

Table 11: Transitioning Workforce Impact Area and Score*



***Please refer to Appendix B to see the detailed description of the impact area categories*

Risk Mitigation Status

In response to this risk, the Operating Committee (OC) and the System Operator Subcommittee (now the System Operator Working Group (SOWG)) developed a Training Framework and Reference Document in 2017[7]. The SOWG helped address the knowledge transfer concerns by developing a framework for initial training and a guideline for industry use.

The process suggests taking into account:

- Trainers per operator
- Set time period for new operators to learn a defined set of topics or test out
- Certification
- Qualification on tasks (Reliability Risk Tasks)
- Peer review
    - Written Exams
    - Demonstrated ability evaluation including simulation
- Management review – oral board
- Testing mechanisms and examples: written, simulation, demonstration, interview by panel
- Demonstrate performance, structured on-the-job training
- Continuing Education plan
- Operating experience
- Performance management
- Structured and performance-based On the Job (OJT)

---

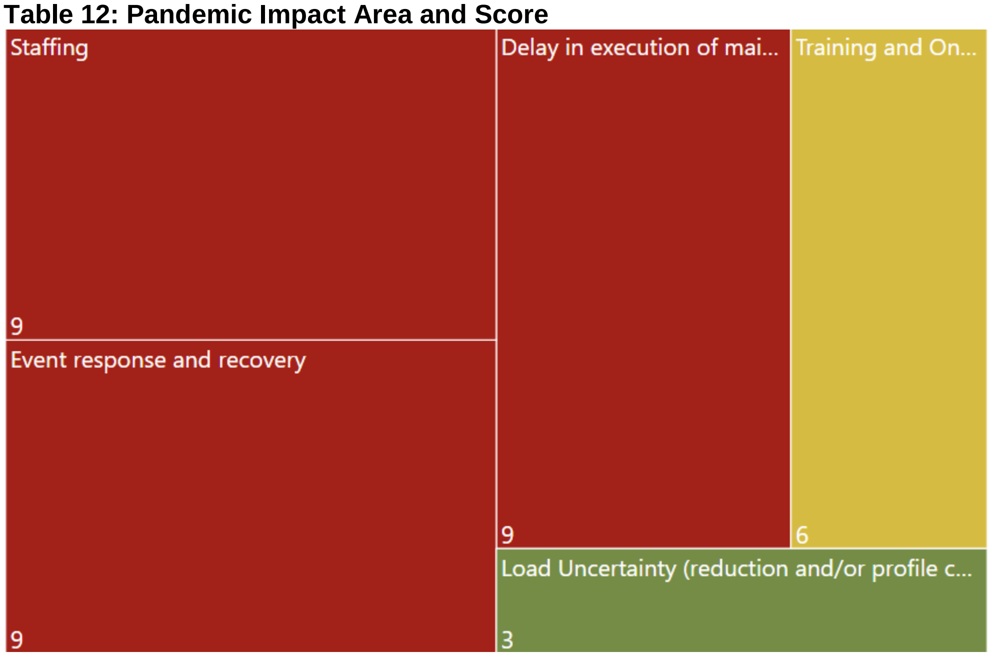
7 https://portal.serc1.org/Attachment/EditAttachment/858784?tableAsset=Committee&tableKey=10&tablePropertyName=DocumentGroupId SERC Operating Committee (OC) System Operator Subcommittee (SOS) Training Framework and Reference Document

Along with the above steps taken by the SOWG and OC in 2017, there have been a number of industry improvements to NERC Standards PER-003, PER-005, and PER-006, The primary focus of PER-005 – Operations Personnel Training is to train individuals on company-specific reliability-related tasks (RRT) and to verify the System Operator's ability to perform these tasks before operating independently at the System Operator's respective company. This standard requires additional training to improve the knowledge and competency for company-specific, reliability-related tasks so that the individual will become fully qualified for an operating desk position. Advancements in technology assist trainers in training operators through computer based training (CBT), simulators, online classrooms, and virtual training. The efforts by the SOWG and by the industry continue to evolve and assist in the development of the next generation of system operators; however, the need to monitor this situation will continue.

5.2.2.5 Pandemic

The COVID-19 pandemic has affected staffing levels; caused business and manufacturing load reductions while raising residential load because of work at home; contributed uncertainty to load forecasting; and resulted in a slowdown in maintenance and capital projects. Uncertainty with this unprecedented situation is the biggest risk.

Table 12: Pandemic Impact Area and Score



***Please refer to Appendix B to see the detailed description of the impact area categories*

Risk Mitigation Status

In response to this risk, utilities are revising short-term load forecasting using data gathered from the months already experienced during the COVID-19 changes. Long-term load forecasting will take into account known load reductions and projections for the economic recovery. New and innovative methods for onboarding and meeting operator training and drill requirements are being implemented. Maintenance and capital project development has returned to normal levels with extra personal protections in place. More experience will reduce the uncertainty in the future. Although individual companies previously had pandemic response plans in place, the lessons learned in response to COVID-19 have caused improvements to those. At the industry level, a number of efforts have been initiated to aggregate the lessons learned across the industry. These efforts, and reports generated from them, should be monitored to identify opportunities to incorporate that information into appropriate NERC and SERC guidelines and other communication methods for member entities. The SERC RCWG bi-weekly COVID-19 calls are an example.

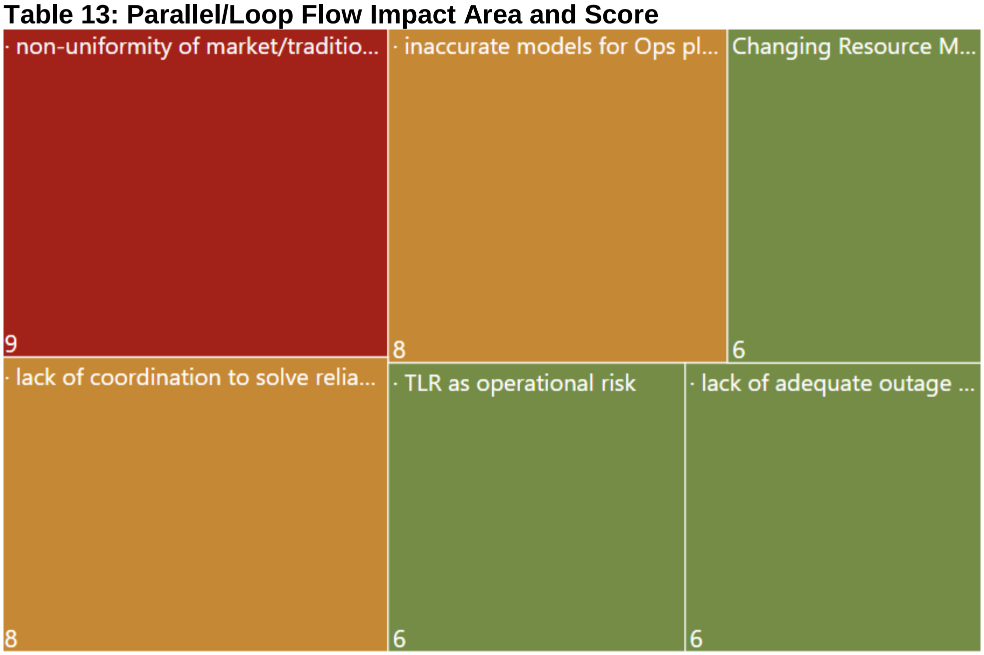
5.2.2.6 Parallel/Loop Flow

All SERC RCs confirm that parallel or loop flows represent a major operating risk to the BPS. Analysis of past SERC transmission loading relief (TLR) logs provides information on possible parallel or loop flow impacts. Influences for such flows include:

- The lack of adequate outage coordination for major generation and transmission facilities; and
- The non-uniformity of market and non-market power flows, along with potential inadequate or inaccurate operation planning models.

Parallel/loop flows put firm transactions at risk. These firm transactions usually serve as designated network resources (DNRs) for SERC entity load.

Table 13: Parallel/Loop Flow Impact Area and Score



***Please refer to Appendix B to see the detailed description of the impact area categories*

Risk Mitigation Status

In cooperation with the SERC EC, the Loop Flow Study Task Force (LFSTF) suggested a three-phase approach to better understand and help address the parallel/loop flow risk.

- Phase 1: Incorporate real time data for a TLR5 event into a planning model to simulate loop flows with real time conditions. This task is complete.
- Phase 2: Develop a methodology to adequately study loop flows.
  - Document the Process for data collection.
  - Establish the data stream to allow faster case creation.

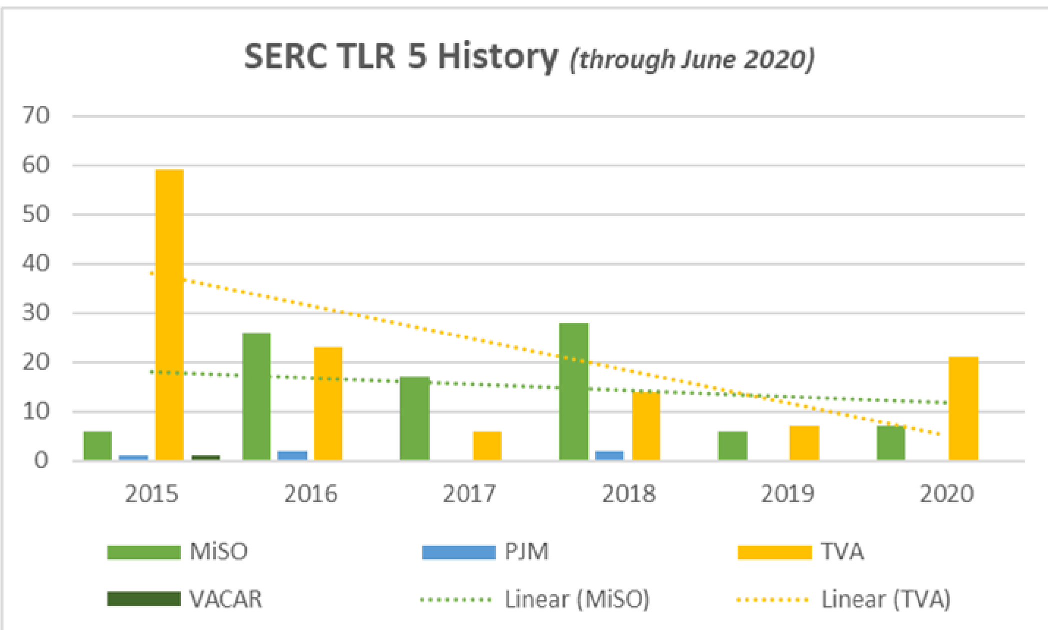
- Refine the assumptions and application of data to minimize post-processing of the resulting case. (This will help in creating a good forward-looking case.)
- Select a new TLR event, preferably with a different interface (*e.g.*, VACAR-S/PJM), and review and refine the methodology.

- Phase 3: Use the methodology in future near-term studies to assess reliability concerns. (Use the methodology in predictive studies.)

All of the phases were completed and the EC disbanded the task force. However, a trial run of the process projected to occur by July 2020 did not occur due to stressed work/committee balance during the ongoing pandemic. The Planning Coordination Subcommittee (PLCS), who manage the deliverables for the NTWG, dropped this item. To determine its readiness to recreate an event using the methodology described in the procedure document, SERC needs to apply the procedure to a chosen TLR event.

Better coordination between the markets and non-markets, as well as better market-to-market tools, are assisting in better understanding and managing this risk area. Though TLR 5 events in the SERC area have trended downward over the last few years (Figure 11), this risk area remains a concern.

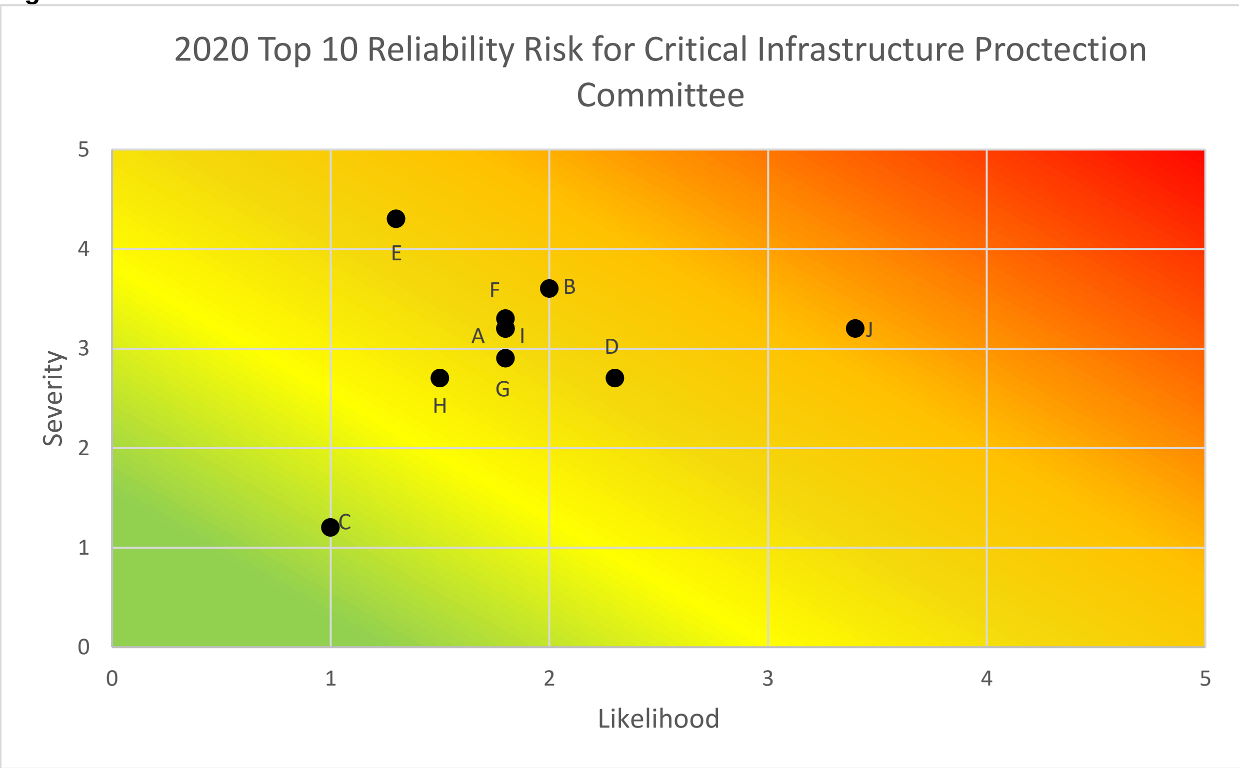
Figure 11: SERC TLR 5 Trends



5.2.3 Critical Infrastructure Protection Committee Risks and Mitigation Strategies

For 2020, 2 risks identified by the Critical Infrastructure Protection Committee made the RRWG top 10 Regional Risk Report. The top 3 Critical Infrastructure risks are identified in the following paragraphs. For a complete set of the CIP risks, see Appendix C.

Figure 12: Critical Infrastructure Protection Committee Ranked Risk Elements



Reliability Risk Heat Map Legend – Critical Infrastructure Protection Committee

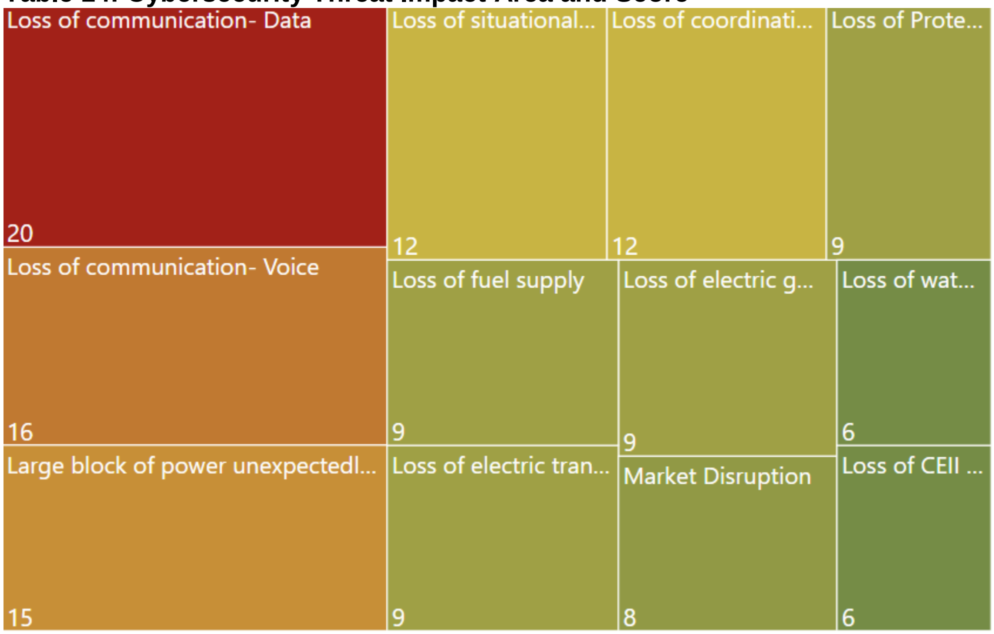
A – Lack of Knowledgeable and Experienced staff in cybersecurity of control systems and supporting IT/OT networks	**F – The rapid growth in sophistication and widespread availability of tools designed to exploit vulnerabilities connected to IT networks**
B – Technologies and Services	**G – Ineffective teamwork and collaboration among agencies can exacerbate cyber events**
C – Physical Events: Vandalism	**H – Physical Events: Attacks**
D – Interdependencies from the critical infrastructure sectors	**I – Legacy Architecture**
E – Physical Events: Sabotage	**J – Cybersecurity threats result from exploitation of both external and internal vulnerabilities**

5.2.3.1 Cybersecurity threats result from exploitation of both external and internal vulnerabilities:

- Exploitation of employee and insider access
- Weak security practices of host utilities, third-party service providers and vendors, and other organizations
- Unknown, undisclosed, or unaddressed vulnerabilities in cyber systems

- Growing sophistication of bad actors, nation states, and collaboration between these groups

Table 14: Cybersecurity Threat Impact Area and Score*



****Please refer to Appendix C to see the detailed description of the impact area categories*

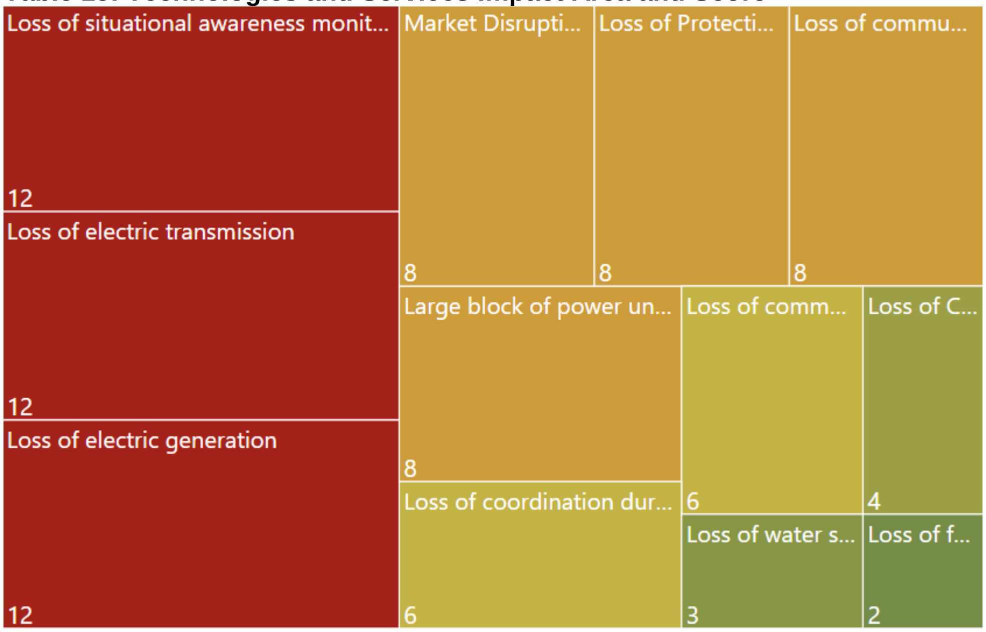
Risk Mitigation Status

The CIPC provides a forum for members to learn best practices by engaging experts in the field who provide the latest information on protecting the members' most sensitive infrastructure. Two subgroups that the CIPC oversees—the Physical Security Subcommittee, and the CIP Tools Working Group—provide more targeted information. While the CIPC provides general information and guidance for both Cyber and Physical Security professionals, the Physical Security Subcommittee focuses specifically on physical security issues. The CIP Tools Working Group provides in-depth information on the tools used in the industry; the effort assists the entity not only to achieve compliance, but also to raise the bar to achieve best practices.

5.2.3.2 Technologies and Services:

- Increased reliance on third party service providers and cloud-based services for BPS operations and support
- Cybersecurity risks in the supply chain: software integrity and authenticity; vendor remote access; information system planning; and vendor risk management and procurement controls; IT/operational technology (OT) control system infrastructure management; out-of-date operating systems; and the lack of patching capability/discipline

Table 15: Technologies and Services Impact Area and Score*



Please refer to Appendix C to see the detailed description of the impact area categories

Risk Mitigation Status

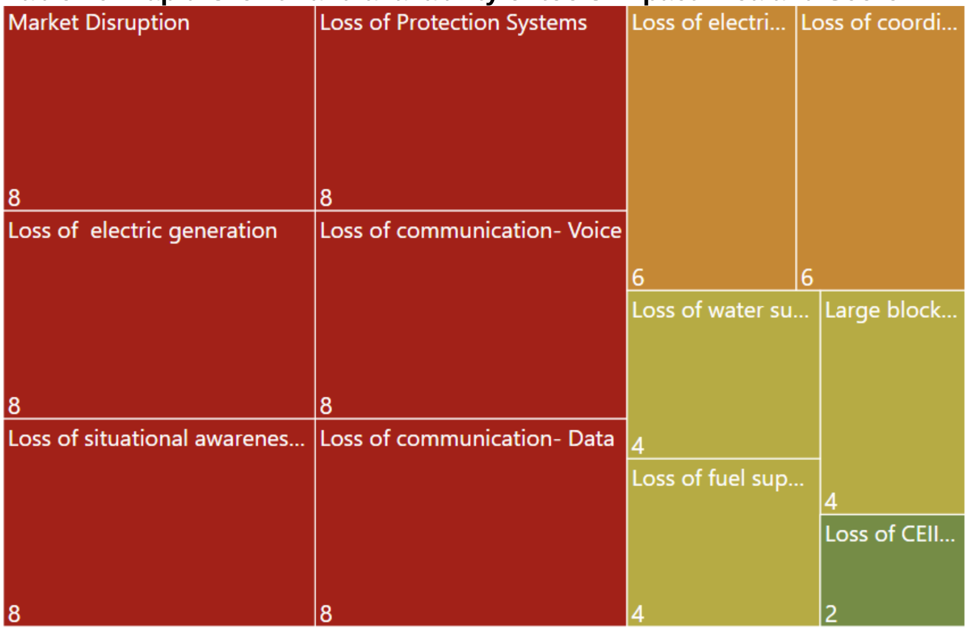
With the implementation of CIP-013, federal government has become involved through the Executive Order on Securing the United States Bulk-Power System and requests for information (RFIs) regarding foreign suppliers. The CIPC is closely monitoring and reporting on these activities. In collaboration with SERC members and the ERO, risks to the supply chain are being monitored and information supplied through the CIPC, its subcommittee, and working group not only for compliance, but to achieve best practices. In addition, this report reflects input from data the CIPC collects.

5.2.3.3 The rapid growth in sophistication and widespread availability of tools and processes designed to exploit vulnerabilities and weaknesses in BPS technologies and in connected IT networks and systems [8]

The rapid growth in sophistication and widespread availability of tools and processes designed to exploit vulnerabilities and weaknesses in networked systems has led to an increase in the development and deployment of ransomware and phishing attacks. In addition, financial and technical support by state actors creates focused, continuous cyber-attacks on the technologies and services supporting the BES.

[8] 2019 ERO Reliability Risk Priorities Report https://www.nerc.com/comm/RISC/Related%20Files%20DL/RISC%20ERO%20Priorities%20Report_Board_Accpeted_November_5_2019.pdf

Table 16: Rapid Growth and availability of tools Impact Area and Score*



Please refer to Appendix C to see the detailed description of the impact area categories

Risk Mitigation Status

To keep pace with the rapid growth of technology and block the ever-expanding pool of bad actors attempting to disrupt the BES, the Critical Infrastructure Protection Committee's CIP Tools Working Group introduces members to new technologies that could allow them to build a more resilient BES infrastructure and provides a common arena to collaborate on these technologies. Collaboration between members allows them to capitalize on the experience of others, learning about best practices and solutions to issues that others have already worked through. Through this exchange of knowledge, the members develop stronger individual systems, and together, strengthen the entire Bulk Electric System.

6.0 Recommendations

While the RRWG identifies SERC risks annually, it is the responsibility of the SERC Technical Committees (CIPC, OC, and EC) to develop and execute mitigation strategies for, at least, the top ten risks identified by the RRWG. The Manage group includes emerging risks where mitigation plans need to be developed and implemented through either SERC or other Industry engagements, or associated inflight mitigation plans need to be completed. The Monitor group includes risks that already have mitigation plans and guidance, which are being implemented. The RRWG will process and update the risk elements based on the mitigation plan devised by the technical committees.

7.0 Enhancements

Scoring improved consistency in impact areas on the number of varying impact areas for each of the Major Risk threats identified. The RRWG cross-functional evaluation from the EC, OC, and CIPC identified several risks that span multiple committees (e.g.: Resource Uncertainty, Pandemic, and Fuel Diversity).

In this report, the RRWG attempted to relate risk to NERC standards or correlated them to Major Risks to NERC family of Standards.

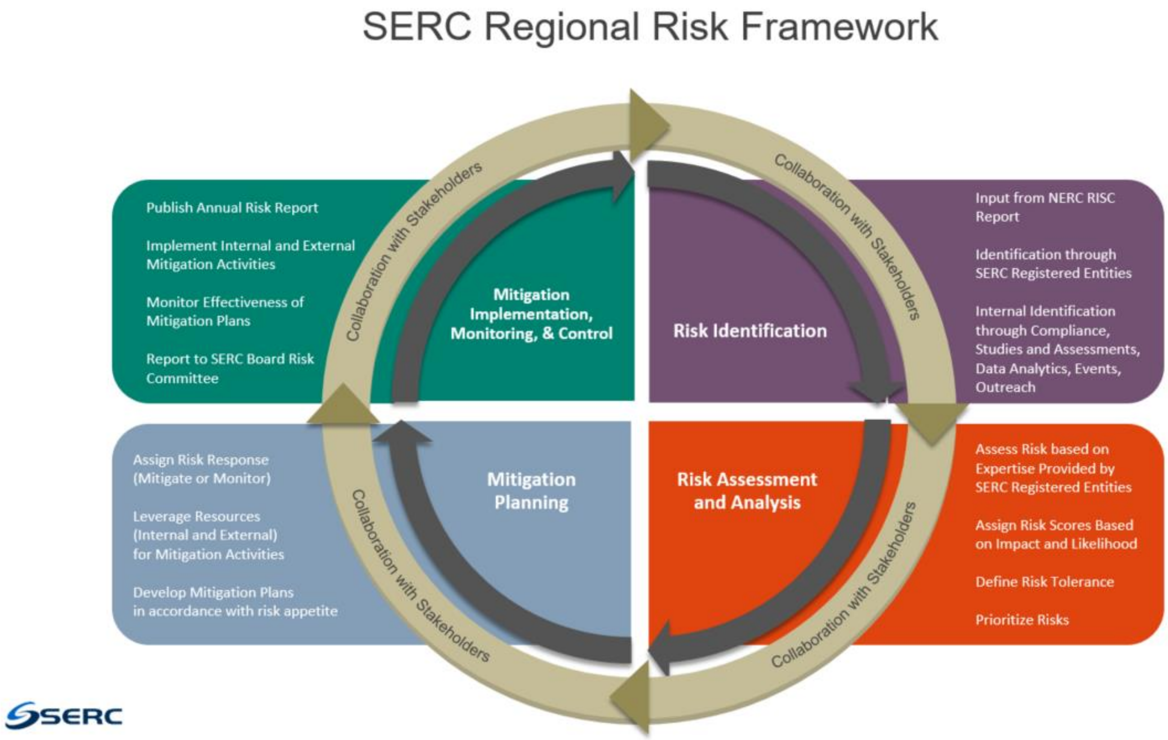
SERC's mission is to reduce risk to reliability and security of the bulk power system for today and the future. In order to achieve this objective, the SERC RRWG develops the annual regional risk registry. It is important to have a clear understanding of risk, mitigation process, stakeholder participation, outreach, and measures of effectiveness to manage the risk to reliability and security of the bulk power system.

A defined risk framework in Figure 13 provides the structure required for efficient resource allocation and prioritization. The framework also helps SERC to evaluate the effectiveness of the deployed mitigation, which in turn informs the future risk prioritization. The structure helps to establish the responsibility and accountability.

SERC, in collaboration with its stakeholders, developed a four-step regional risk framework. Each phase has its own unique set of processes, tools, and engagement with internal and external stakeholders.

1. Risk Identification: SERC and its stakeholder subject matter experts are actively engaged in identifying the current and emerging risks through RRWG engagement. The risk identification also takes into consideration the NERC Reliability Issues Steering Committee (RISC) report, and SERC internal identification through compliance monitoring, studies and assessments, events and outreach.
2. Risk Assessment and Analysis: The SERC data analytics group assesses the risk based on the available data on the subject and analysis of the data. The stakeholders also help provide valuable input in determining the prioritization of the quantified risk by defining the impact areas and probability of occurrence. The framework provides provision to set the risk tolerance for a particular risk.
3. Mitigation Planning: The planning starts with the determination of whether the risk needs to be managed or monitored. If managed, the risk mitigation planning/development is the responsibility of SERC and its stakeholders through the SERC technical committees, subcommittees, and the working groups. The technical committees also take advantage of all the work carried out by ERO Enterprise, trade associations, vendors, and other industry initiatives.
4. Mitigation Implementation, Monitoring, and Control: The SERC technical committees oversee the mitigation implementation, monitoring, and control through their annual work plan development. SERC and the stakeholders also deploy measures to monitor the effectiveness of the mitigation implementation.

Figure 13: SERC Regional Risk Framework



In Figure 13 the outer circle is included to emphasize that SERC is actively engaging and collaborating with stakeholders throughout the entire process.

The RRWG is continuing to look for ways to improve this report and would like to hear ideas and suggestions for enhancing and simplifying this report from those who use it. Please send your ideas or comments to SERC support at support@serc1.org.

Appendix A 2020 Engineering Risk Elements Final

Table A 1: SERC Engineering Risk

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Variable Energy Resources integration	There has been rise in the SERC renewable energy resource portfolio, wind energy in the west and solar in south and southeast. Integration of VERS raises the risk of voltage regulation, dynamic response, and sudden change in dispatch patterns. The changing characteristic of the grid with the growth of VERs will affect how the grid is operated in the future. Since VERs are weather dependent, planning for backup resources in the absence of generation becomes essential to maintain the reliability of the system.	• Maintain sufficient reactive supply and voltage regulation. • Additional reserves required • Must plan and build the system when VERs are not available • Additional scenario planning needed • Accurate load forecasting, metered load • Ramping requirements • Harmonic impact on the system	1	Grid Transformation - A. Bulk Power System Planning/ B. Resource Adequacy and Performance/ F. Changing Resource Mix

Table A 1: SERC Engineering Risk				
Major Risk Examples	**Justification**	**Impact Areas**	**Total Risk Ranking**	**Associated NERC 2019 RISC Risk Profile**
Resource uncertainty/ changing mix along with generation retirements	A transition is taking place in the resource mix within SERC (and nationally) driven by both economics and public policy. While decreasing costs and lower emissions have propelled natural gas dominance as a fuel source (replacing coal), renewables (photovoltaic and to a lesser extent, wind) are making a surge, due to dropping installation costs and state-based subsidies. Existing nuclear generation is struggling to be competitive in some areas.	• Increased coordinated studies required with SERC neighbors. • Potential transmission system expansion and lead time concerns • New SERC nuclear construction may not be completed • Micro grids development implications • Electric storage (battery or other) becomes significant • Increase of DERs and potential lack of visibility • Maintain sufficient reactive supply and voltage regulation. • Increase in VERs requiring additional reserves and need for plan/build of system to accommodate VERs unavailability • Policy or legislation changes could impact fuel prices due to environmental groups, activists and, public perception, PV manufacturing defect impacts a significant % of solar capacity, States remove PV economic incentives Additional scenario planning needed • Additional scenario planning needed • Load forecasting, metered load	2	Grid Transformation - A. Bulk Power System Planning/ B. Resource Adequacy and Performance/ F. Changing Resource Mix

Table A 1: SERC Engineering Risk				
Major Risk Examples	**Justification**	**Impact Areas**	**Total Risk Ranking**	**Associated NERC 2019 RISC Risk Profile**
Generation and Transmission Modeling	Accurate representation of transmission and generation modeling is the key to planning transmission adequacy and to maintaining system reliability in the future. The rise of the renewable generation model and use of inaccurate and black box models introduces errors and significantly affects planning studies. Above normal demand in energy	• Insufficient models, cases, or both • Less clarity in future plans • Inaccurate modeling of the systems	3	Grid Transformation - A. Bulk Power System Planning/ B. Resource Adequacy and Performance
Fuel Diversity/Fuel Availability	Currently, natural gas accounts more than 40% of generation in the SERC region. There will be greater reliance on natural gas generation with baseload coal plant retirement, fuel cost, and environmental policies. This will give rise to a less diverse portfolio, and loss of the ability to respond to loss of fuel type. Lack of coordination between electric and natural gas industry Adequacy of natural gas pipeline infrastructure to serve extreme winter peak load along with traditional firm gas needs	• Resource adequacy and significant resource shortage • Sudden changes in dispatch and operating conditions and need for fast acting units • Changes in the flow path and differing operating conditions	4 (tie)	Grid Transformation - A. Bulk Power System Planning / B. Resource Adequacy and Performance/ F. Changing Resource Mix/Critical Infrastructure Interdependency - D. Natural Gas

Table A 1: SERC Engineering Risk				
Major Risk Examples	**Justification**	**Impact Areas**	**Total Risk Ranking**	**Associated NERC 2019 RISC Risk Profile**
Modeling firm interchange in the short term and long term study models	Failing to correctly model firm transfers raises reliability risks associated with improper assessments of near term operating conditions, as well as development of incorrect expansion plans. The firm transfers associated with many utilities have not been accurately modeled in LTSG/MMWG models and their derivative models used by TOs, TSPs, TPs, and PCs for several years. These models are used for a variety of reliability related studies throughout the Eastern Interconnection. These models are also widely used for evaluation of transfer capability and transmission service requests.	• Operating horizon reliability assessments must be performed accurately to properly equip operators.	4 (tie)	Grid Transformation - B. Resource Adequacy and Performance
Supply Chain Management	The new Executive Order to secure the BPS prohibits any acquisition, importation, transfer, or installation of BPS electric equipment that has a nexus with any foreign adversary and poses an undue risk to national security, the economy, or the safety and security of Americans. While no equipment is actually prohibited at this time (since the Secretary of Energy has not issued regulations to implement the Order), there is a possibility that prohibited equipment may be identified within SERC's footprint at a later point in time.	• Potential transmission system expansion and lead time concerns	4 (tie)	Grid Transformation - A. Bulk Power System Planning/ B. Resource Adequacy and Performance

Table A 1: SERC Engineering Risk				
Major Risk Examples	**Justification**	**Impact Areas**	**Total Risk Ranking**	**Associated NERC 2019 RISC Risk Profile**
Generator Governor Frequency Response	Accurate governor deadband and droop settings are important to operate the bulk energy system reliably.	• Arrest and stabilize the system frequency during an event • Long frequency recovery time • Machine trip due to under frequency • Accurate models are necessary to correctly plan and expand the system • Transfer capability and availability of transmission service must be determined accurately	7	Grid Transformation - B. Resource Adequacy and Performance/ C. Increased Complexity in Protection and Control Systems
FAC-008	SERC has noted a pattern of ratings that do not follow the Entities' Facility Ratings Methodology. In particular, a trend has been noted where the Most Limiting Element (MLE) was not account for in the rating calculation, so the Entity was operating to a higher limit than accurate.	• Inaccurate modeling and additional planning needed • Possibility of wide spread outage • Cascading and system collapse • Possibility of localized outages • SOL and IROL violations, and voltage collapse	8	Grid Transformation - A. Bulk Power System Planning/ F. Changing Resource Mix
Flood or Drought for extended period of time	SERC region has faced mild to severe drought conditions for multiple years.	• Loss of hydro generation • Decreased generation capacity due to higher ambient temperature for cooling • Weakened vegetation, possibly causing transmission outages • Disruption of fuel	9	Extreme Natural Events - B. Other Extreme Natural Events
Loss of large unit during shoulder (70-80% of summer peak load) peak load with planned outages.	Identified in 2011 Southwest blackout report	• Unscheduled power flow • Voltage regulation • Maintain reactive reserve	10 (tie)	Grid Transformation - A. Bulk Power System Planning/ B. Resource

Table A 1: SERC Engineering Risk

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
		• Different unfamiliar power flow scenarios		Adequacy and Performance
Protection system and single points of failure	The rate of protection misoperations in the SERC Region is around 7.5% of the total operation. This is high.	• Possibility of wide-spread outage • Cascading and system collapse	10 (tie)	Grid Transformation – Increasing Complexity in Protection and Control Systems

Appendix B 2020 Operational Risk Elements Final

Table B 1: Operational Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Extreme Weather	SERC region is susceptible to severe weather such as tornadoes (spring 2011) and hurricanes (e.g., Hugo, Fran, Katrina, Matthew, Michael, Florence, Irma), extreme hot weather (summer 2007), severe cold weather (Polar Vortex), drought (2007), and flooding (2005, 2010, 2015, 2016, 2018). Extreme weather has resulted in two losses of NPP offsite power in SERC due to tornadoes in the last 5 years (Surry and Browns Ferry); two losses of off-site power during Hurricane Matthew; and several transmission circuits lost during Hurricane Matthew	• Use of alternate tools or manual operation of the system • Loss of communication - data • Loss of communication - voice • Interruption of natural gas (NG) pipeline supply • NG and electricity interdependency • Generation and transmission forced outage impact • Loss of situational awareness • Large unscheduled power flows (System Operating Limit (SOL) and IROL exceedances) • Gas breaker issues • Adequate load forecasting for extreme event	1	Extreme Natural Events - B. Other Extreme Natural Events

Table B 1: Operational Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Resource uncertainty/ changing mix, along with generation retirements	A transition is taking place in the resource mix within SERC (and nationally) driven by both economics and public policy. Renewables (photovoltaic and to a lesser extent, wind) are making a surge, due to dropping installation costs and state-based subsidies.	• Increase in renewables (VERs and DERs) • Micro grids development implications • Electric storage (battery or other) becomes significant • Lack of visibility of distributed energy resources (DERS) and its effect on load forecasting, metered load, and state estimation • Greater commitment/dispatch challenges for operators, (ramping requirements, plus others) • Additional reserves required to address VERS; increase in need to plan and build the system when VERs are not available • Additional scenario planning needed	2	Grid Transformation - A. Bulk Power System Planning

Table B 1: Operational Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Fuel Diversity/Fuel Availability	Currently natural gas accounts more than 40% of generation in SERC region. There will be greater reliance on natural gas generation with baseload coal plant retirement, fuel cost, and environmental policies. This will give rise to less diverse portfolio, and loss of the ability to respond to loss of fuel type. Natural Gas infrastructure affecting dispatch to generation Volatility in natural gas prices Adequacy of the natural gas pipeline infrastructure to serve extreme winter peak load along with traditional firm gas need Policy or legislation changes could impact fuel prices due to environmental groups, activists and, public perception	• Resource adequacy • Sudden changes in dispatch and operating conditions • Forced operating conditions • Need for fast acting capabilities of existing units • More reliance on natural gas • Significant event that would affect a certain fuel type • New SERC nuclear construction may not be completed	3	Grid Transformation - C. Increased Complexity in Protection and Control Systems
Transitioning Workforce	Lack of experience leads to poor decision making/delayed actions for resolving emergencies. Knowledge transfer from the Aging Workforce can mitigate this lack of experience.	• Lack of experience leads to poor decision making/delayed actions for resolving emergencies • Aging workforce (lack of knowledge transfer)	4	Grid Transformation - E. Human Performance and Skilled Workforce

Table B 1: Operational Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Parallel and loop flow issues	Parallel/loop flows put firm transactions at risk. These firm transactions are used most often as Designated Network Resource (DNRs) for SERC entity load.	• Lack of adequate outage coordination for generation and transmission facilities • Non-uniformity of market or traditional flow formulas • Lack of coordination to solve reliability issues • Inaccurate models for Ops planning (loop flows, and unit commitment need access to RTO generation dispatch) • Changing Resource Mix and Capacity Market resources creating unscheduled power flows • Transmission Loading Relief (TLR) as an operation risk	5 (tie)	Grid Transformation - F. Changing Resource Mix
Pandemic	COVID-19 impacts affect staffing levels; cause load reductions; influence the load profile; and affect maintenance and capital project plans	• Load Uncertainty (reduction and/or profile changes) • Staffing • Training and Onboarding • Event response and recovery • Delay in execution of maintenance and capital project improvement plans	5 (tie)	Extreme Natural Events - B. Other Extreme Natural Events

Table B 1: Operational Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Loss of Major Application (EMS/SCADA)	Event Reports indicate more loss of EMS events have occurred in the last 2 years for SERC entities.	• Extended Loss of Situational Awareness (greater than two hours) • Short-term loss of situational awareness (less than two hours or partial)	7	Grid Transformation - E. Human Performance and Skilled Workforce
AC Equipment Failure compounded by relay misoperations	Voltage depression events point to the consequences associated with this compound risk.	• System blackout • Voltage depression or collapse	8	Grid Transformation - C. Increased Complexity in Protection and Control Systems
Loss of large unit during shoulder (70-80% of summer peak load) peak load with planned outages.	Identified in 2011 Southwest blackout report	• Unscheduled power flow	9	Grid Transformation - B. Resource Adequacy and Performance
Vegetation causing cascade event	Vegetation mismanagement could cause cascading outages.	• Forced transmission outages resulting in a cascade event	10	Grid Transformation - A. Bulk Power System Planning

Appendix C 2020 Critical Infrastructure Protection Risk Elements Final

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Cybersecurity threats result from exploitation of both external and internal vulnerabilities 1. Exploitation of employee and insider access 2. Weak security practices of host utilities, third-party service providers and vendors, and other organizations 3. Unknown, undisclosed, or unaddressed vulnerabilities in cyber systems 4. Growing sophistication of bad actors, nation states, and collaboration between these groups	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	1	Security Risks - B. Cyber

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Technologies and services 1. Increased reliance on third party service providers and cloud-based services for BPS operations and support 2. Cybersecurity risks in the supply chain: software integrity and authenticity; vendor remote access; information system planning; and vendor risk management and procurement controls	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	2	Security Risks - B. Cyber
The rapid growth in sophistication and widespread availability of tools and processes designed to exploit vulnerabilities and weaknesses in BPS technologies and in connected IT networks and systems	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	3	Security Risks - B. Cyber

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Interdependencies from the critical infrastructure sectors, such as Communications, Financial Services, Oil and Natural Gas Subsector, and Water, where sector-specific vulnerabilities can affect BPS reliability.	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	4	Security Risks - B. Cyber
Extreme Physical Events (Man-Made): Sabotage Note: Sabotage is deliberate, well planned, and often has an insider component to it and has the greatest potential for impact.	• 2019 NERC RISC Report • E-ISAC Watch list & Reports • FBI Bulletins & Flash Alerts • US-CERT • ICS-CERT	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	5	Security Risks - A. Physical

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
A lack of staff that is knowledgeable and experienced in cybersecurity of control systems and supporting IT/OT networks (historically separate organizations and skillsets) - This is symptomatic across all industries and is a risk because it hinders an organization's ability to prevent, detect, and respond to cyber incidents due to organizational silos.	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	6	Security Risks - B. Cyber

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Legacy architecture coupled with the increased connectivity of the grid expands the attack surface of BPS protection and control systems: 1. Increased automation of the BPS through control systems implementation 2. The trend toward increased integration of IT operating systems may increase the attack surface and associated attack risk 3. IT/operational technology (OT) control system infrastructure management, out-of-date operating systems, and the lack of patching capability/discipline	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	7	Security Risks - B. Cyber

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Ineffective teamwork and collaboration among the federal, provincial, state, local government, private sector, and critical infrastructure owners can exacerbate cyber events.	• 2019 NERC RISC Report	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	8	Security Risks - B. Cyber
Extreme Physical Events (Man-Made): Attack Note: Physical attacks are often connected to a grievance of some kind and present the potential for moderate impact. (Insider Physical Threat)	• 2019 NERC RISC Report • E-ISAC Watch list & Reports • FBI Bulletins & Flash Alerts • US-CERT • ICS-CERT	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	9	Security Risks - A. Physical

Table C 1: CIP Risks

Major Risk Examples	Justification	Impact Areas	Total Risk Ranking	Associated NERC 2019 RISC Risk Profile
Extreme Physical Events (Man-Made): Vandalism Note: Vandalism is random and opportunity-based; although it occurs most frequently, its results are most likely of low impact.	• 2019 NERC RISC Report • E-ISAC Watch list & Reports • FBI Bulletins & Flash Alerts • US-CERT • ICS-CERT	• Loss of Situational awareness monitoring • Loss of coordination during event and restoration • Large block of power unexpectedly flowing through SERC • Loss of communication - Data • Loss of communication - Voice • Loss of protection systems • Loss of electric generation • Loss of electric transmission • Loss of fuel supply • Market Disruption • Loss of CEII and NTI data • Loss of water supply/coolant	10	Security Risks - A. Physical

Appendix D Definitions

Term or Acronym	Definition
BA	Balancing Authority
BPS	Bulk-Power System
BPSA	Bulk-Power Situational Awareness
CEII	Critical Energy Infrastructure Information
CIPC	Critical Infrastructure Protection Committee
CMEP	Compliance Monitoring and Enforcement Program
CMEP IP	Compliance Monitoring and Enforcement Program Implementation Plan
CPP	Clean Power Plan
CRISP	Cyber Risk Information Sharing Program
CRPA	Cybersecurity Risk Assessment Program
CS	Control System
DER	Distributed Energy Resource
DNR	Designated Network Resource
DP	Distribution Provider
E-ISAC	Electricity Information Sharing and Analysis Center
EC	Engineering Committee
EIPC	Eastern Interconnection Planning Collaborative
EGWG	Electric-Gas Working Group
EMS	Energy Management System
EPA	Environmental Protection Agency
ERAG	Eastern Interconnection Reliability Assessment Group
ERO	Electric Reliability Organization
ESP	Electronic Security Perimeter
FBI	Federal Bureau of Investigation
FERC	Federal Energy Regulatory Commission
FFR	Faster Frequency Response

Term or Acronym	Definition
GO	Generator Owner
GOP	Generator Operator
ICS	Industrial Control Systems
IROL	Interconnection Reliability Operating Limit
IPP	Independent Power Producer
IS	Information System
ISO	Independent System Operator
IT	Information Technology
LFSTR	Loop Flow Study Task Force
LTSG	Long Term Study Group
LTWG	Long Term Working Group
MLE	Most Limiting Element
MMWG	Multi-regional Modeling Working Group
NERC	North American Electric Reliability Corporation
NG	Natural Gas
NPP	Nuclear Power Plant
NTI	Non-public Transmission Function Information
OC	Operating Committee
OFO	Operational Flow Order
OPSEC	Operations, Planning, and Security Executive Committee
OT	Operational Technology
PC	Planning Coordinator
PCS	Protection & Control Systems
PV	Photovoltaic
RAWG	Resource Adequacy Working Group
RC	Reliability Coordinator
RE	Regional Entities
RISC	Reliability Issues Steering Committee

Term or Acronym	Definition
RISTF	Renewable Impact Study Task Force
RRWG	Reliability Risk Working Group
RTCA	Real-Time Contingency Analysis
RTO	Regional Transmission Organization
SA	Situational Awareness
SCADA	Supervisory Control and Data Acquisition
SERC	SERC Reliability Corporation
SIR	System Inertial Response
SME	Subject Matter Expert
SOL	System Operating Limit
SOWG	System Operator Working Group
SPOD	Single Point of Disruption
TLR	Transmission Loading Relief
TO	Transmission Owner
TOP	Transmission Operator
TP	Transmission Planner
TSP	Transmission Service Provider
UEA	Unauthorized Electronic Access
VER	Variable Energy Resource
VERWG	Variable Energy Resources Working Group