NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Definition approved by Operating Committee and Planning Committee at their December 2007 OC and PC meetings

Definition of "Adequate Level of Reliability"

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Preface

In its January 18, 2007 Order on Compliance Filing, the Federal Energy Regulatory Commission directed NERC to file a plan for defining the term "adequate level of reliability."[1] The Commission explained that it intended to use this definition when judging the merits of NERC's Reliability Standards against the requirements of Section 215 (c) of the Federal Power Act. The Act requires Reliability Standards "that provide for an ***adequate level of reliability*** of the ***bulk-power system*** [emphasis added]."[2]

The Commission required NERC's plan to include two broad objectives and address several questions:

- First, the plan needed to develop a definition of adequate level of reliability using a stakeholder process. The Commission asked whether the proposed definition be applied to all Reliability Standards, certain sets of standards, or, in some cases, be tailored for each standard. The Commission also asked NERC to consider opportunities to develop and apply metrics that can form the basis for broadly defining an adequate level of reliability.
- Second, the plan needed to "propose a continuing improvement process to consider 'adequate level of reliability' when developing new or modified Reliability Standards."

In its March 19, 2007 response to the order, NERC explained that it directed its Operating Committee and Planning Committee to develop the definition of adequate level of reliability through a stakeholder process and provide that definition to the NERC Board of Trustees.[3] NERC also explained that it would "integrate the approved definition into its three-year standards work plan and standards development process, as well as its compliance monitoring and enforcement program as appropriate."

This document, prepared by the NERC Operating Committee and Planning Committee, fulfills NERC's commitment to provide a definition of adequate level of reliability to the Board of Trustees.

[1] *Order on Compliance Filing*, 118 FERC ¶61,030, paragraph 16.

[2] The definition of Bulk-Power System, as it appears in Section 215(a)(1) is: "the facilities and control systems necessary for operating an interconnected electric energy transmission network or any portion thereof; and the electric energy from generation facilities needed to maintain transmission system reliability."

[3] *Compliance Filing of the North American Reliability Corporation in Response to January 18, 2007 Order and March 9, 2007 Order*, March 19, 2007, Docket Nos. RR06-01-003 and RR06-01-005, pp. 4-7.

Introduction

NERC prepared this document to define the term "adequate level of reliability" as requested by the Federal Energy Regulatory Commission. While the definition itself is succinct, the fundamental concepts from which NERC derived the definition are complex and deserve discussion, which we have provided in this document.

The document begins by discussing the term "reliability" that NERC has used since its creation in 1968. It then explains how the Federal Power Act's definition of "reliability" as it pertains to NERC's standards differs from NERC's broader, traditional definition.

The definition of adequate level of reliability follows. Then the document explains the concepts behind each statement in the definition.

Capitalized terms are terms defined in the NERC *Glossary of Terms Used in Reliability Standards* (NERC *Glossary*) or in Section 215 of the Federal Power Act.

Definition of "Reliability"

NERC's traditional definition of "reliability" was ubiquitous throughout the electric utility industry, and consists of two fundamental concepts—adequacy and operating reliability:

> **Adequacy** is the ability of the electric system to supply the aggregate electric power and energy requirements of the electricity consumers at all times, taking into account scheduled and reasonably expected unscheduled outages of system components.[4]
>
> **Operating reliability**[5] is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system components.

The NERC Operating Policies and Planning Standards were based on these concepts, and most of those policies and standards were translated into NERC's Reliability Standards.

We will be using the Section 215 term "Bulk-Power System" instead of the NERC *Glossary* definition "Bulk Electric System" because, as cited in the preface, the first expression is specifically used in Section 215(c) in the context of "adequate level of reliability." However, in Order 693 (March 16, 2007), the Commission stated that "for at least an initial period, the Commission will rely on the NERC definition of bulk electric system and NERC's registration process to provide as much certainty as possible regarding the applicability to and the responsibility of specific entities to comply with the Reliability Standards in the start-up phase of a mandatory Reliability Standard regime."

More recently, the term *adequacy* has prompted considerable discussion among NERC members. In Section 215 to the Federal Power Act, NERC and FERC are not authorized "to set and enforce compliance with standards for adequacy … of electric facilities or services."[6] In the U.S., states may set adequacy requirements. On the other hand, the Act requires NERC to *assess* the future adequacy and reliability of the Bulk-Power System.

NERC continues to believe the term *reliability* must include the concept of adequacy. Therefore, our definition addresses adequacy.

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[4] From the May 2007 NERC Glossary of Terms

[5] NERC had used the term "security" until September 2001 when security became synonymous with homeland protection in general and critical infrastructure protection in particular. To remedy the increasing confusion over what we meant by security, NERC replaced that term with "operating reliability." Operating reliability is not a definition in the NERC Glossary of Terms but instead is a reliability concept that predates the ERO.

[6] Section 215(h)(i)(2). The term "adequacy" is not defined in the Section 215. For this reason, we are not capitalizing the term in this document even though it is defined in the NERC Glossary of Terms.

Definition of "Adequate Level of Reliability"

The Bulk-Power System ("System") will achieve an adequate level of reliability when it possesses following characteristics:

1. The System is controlled to stay within acceptable limits during normal conditions;
2. The System performs acceptably after credible Contingencies;
3. The System limits the impact and scope of instability and cascading outages when they occur;
4. The System's Facilities are protected from unacceptable damage by operating them within Facility Ratings;
5. The System's integrity can be restored promptly if it is lost; and
6. The System has the ability to supply the aggregate electric power and energy requirements of the electricity consumers at all times, taking into account scheduled and reasonably expected unscheduled outages of system components

General Discussion

The System exhibits an adequate level of reliability when it possesses these six characteristics. Some of the terms such as "acceptable limits" and "acceptable performance" require specificity in order to be applied. These specifics will be included in the Reliability Standards that support each objective. We recognize that NERC's standards cannot require a specific level of adequacy for "electric facilities or services."[7]

Metrics

The definition of adequate level of reliability is broad enough to apply to all possible NERC standards, and therefore it is not based on specific metrics. However, NERC will develop metrics at the System level that will track performance of these characteristics. These System performance metrics will be different from metrics in a standard which are used to determine compliance. System performance metrics will provide feedback for improving the Reliability Standards. They will help identify reliability gaps and point to existing standards that need to be modified or new standards that need to be developed.

Cost effectiveness

The definition of adequate level of reliability does not mention any specific measure of "cost effectiveness" because costs versus benefits, including societal benefits, can only be determined by the individual users, owners, and operators. They will have different perspectives on what is "cost effective" for them, and they will exercise their judgments by participating in the standards

[7] Ibid.

drafting process, and ultimately, when they cast their ballots to approve or reject a standard.[8] A goal of the standards is to achieve an adequate level of reliability across North America. For various reasons, some users, owners or operators may choose to plan and operate their portion of the System to achieve a level of reliability that is above the standards.

[8] In the NERC Rules of Procedure, Section 302 (3) addresses performance requirements for standards and references "costs and benefits." It states: "Each [performance] requirement is not a "lowest common denominator" compromise, but instead achieves an objective that is the best approach for bulk power system reliability, taking account of the costs and benefits of implementing the proposal." These "cost and benefits" are not explicitly developed. Ultimately, the ballot body, which decides on standards, decides on its cost effectiveness.

Technical Discussion

This section explains each characteristic in the definition.

1. The System is controlled to stay within acceptable limits during normal conditions.

Acceptable limits include voltage and frequency limits as well as System Operating Limits. System Operating Limits specify the ranges of line flows, system voltages, and generator loading that must be followed to maintain operating reliability. The system planner must design the System so it can be operated within all limits (voltage, frequency, and System Operating), but the operator must operate within limits in real time that are based upon existing conditions.

2. The System performs acceptably after credible Contingencies.

System planners and operators cannot prevent Contingencies from happening. But they can plan and operate the System so that when credible Contingencies do occur, their effects are manageable, and the consequences are acceptable. In essence, planners and operators design and operate the System to minimize the risk that credible Contingencies (as defined by NERC's standards) will result in unacceptable performance.

Are acts of nature Contingencies? Not per se. They are events that trigger Contingencies. Lightning, a contaminated insulator, a brush fire, or an airplane crash can all trigger a line fault. Depending upon the probability of occurrence, the triggered Contingencies may or may not be classified as "credible."

The generation and transmission systems are finite and limited and always will be. At some point, the failure of a significant number of transmission Elements will cause part of the System to become unstable and lose its integrity[9], regardless of automatic protection systems or system operator actions that attempt to contain the event. Such extreme events are generally not considered credible. While managing (or minimizing) risk is the goal, it is unreasonable to assume that utilities can build or operate the System to eliminate *all* risks. However, by focusing on credible Contingencies, we define the risks we want to manage.

It is also unreasonable to assume that every disturbance, event, or equipment failure will result in unacceptable performance. For example, if we know (not simply assume) the failure of a particular Element (line, breaker, transformer, etc.) has little or no effect on the integrity of the surrounding transmission network and does not impact service (except for service directly associated with the failed Element), then the risk if the Element fails is acceptable. Likewise, the loss of firm load does not always equate to unacceptable performance. At times, operators must shed firm load to maintain the integrity of the System or protect equipment from unacceptable damage. The measures of acceptable performance and categories of credible Contingencies, and

[9] By "integrity," we mean the synchronous connectivity of the generators and network connectivity of the transmission lines.

how they relate to each other, are specified in the Reliability Standards. The standards will define what is "credible" and "acceptable" and what is not.

3. The System limits the impact and scope of instability and cascading outages when they occur.

System planners design the System so that events such as transmission line and transformer faults, breaker and switch failures, and generator trips are contained to prevent these events from Cascading and causing the system to lose its integrity. For example, substation circuit breaker configurations are designed to isolate transmission equipment failures so their impact is limited and the failures do not cascade into widespread System failures. Back-up relays are employed to isolate an Element in the event that the primary protection scheme fails. Underfrequency and undervoltage load shedding systems help limit instability and cascading outages.

It does not matter whether the triggering event causing instability and cascading outages was a credible Contingency (that should have been contained) or an extreme event. We still want to limit its impact and scope.

4. The System's Facilities are protected from unacceptable damage by operating them within Facility Ratings.

Protecting generation and transmission equipment from unacceptable damage may be obvious because NERC establishes standards on operating within Facility Ratings. The definition of adequate level of reliability specifically states this important characteristic because failure to protect equipment could result in unacceptable reliability for weeks or months due to the long-lead time for replacing or repairing equipment.

Not withstanding characteristics 1 and 2, this characteristic is necessary. Extreme events not addressed in other characteristics can destroy or severely damage Facilities unless properly designed and maintained protection and control systems are employed. If necessary, operators must be able to shed firm load to protect Facilities from unacceptable damage.

5. The System's integrity can be restored promptly if it is lost.

The System must be planned and operated so that it can also be restored promptly, whether after a cascading outage or widespread damage from natural disasters. System planners must include blackstart and synchronizing facilities in their plans. System operators must have a restoration plan ahead of time, and know from studies, training, on-line tools, and experience the operating limits they need to stay within while restoring the system, and how those limits change through the stages of reestablishing system integrity, and up to normal interconnected operations. During the restoration process, they must protect generation and transmission system equipment from unacceptable damage by operating within Facility Ratings, not jeopardize adjacent parts of the System that are operating normally, and coordinate their restoration efforts with other interconnected entities, including Load-Serving Entities.

6. The System has the ability to supply the aggregate electric power and energy requirements of the electricity consumers at all times, taking into account scheduled and reasonably expected unscheduled outages of system components.

This characteristic implies the concept of "adequacy" as defined in NERC's *Glossary*, and includes generation and transmission assets as well as Demand-Side Management. As written, the use of the phrase "at all times" does not imply 100% reliability since it is premised upon "scheduled and ***reasonably expected*** unscheduled outages of system components [emphasis added]." A System that has adequate resources (generation, Demand-Side Management, and transmission) and that also meets the other five characteristics above would have an "adequate level of reliability." NERC is required to assess and report on the adequacy and reliability of the System under Section 215(g).