NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

"Remedial Action Scheme" Definition Development

Background and Frequently Asked Questions

Project 2010-05.2 – Special Protection Systems

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RELIABILITY | ACCOUNTABILITY




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Introduction

The Project 2010-05.2 – Special Protection Systems Standard Drafting Team (SDT) developed this background and Frequently Asked Questions (FAQ) document to explain the key concepts incorporated into the revised definition, as well as the team's approach and intent. This document will remain available as part of the official project record for the Remedial Action Scheme (RAS) definition. ~~In addition to providing individual responses to commenters for the first formal comment period conducted June-July, 2014, t~~The drafting team has updated this ~~Frequently Asked Questions~~ (FAQ) document to reflect all revisions made to the RAS definition based on stakeholder feedback.

Contact the Standards Developer, Al McMeekin, at 404-446-9675 or at al.mcmeekin@nerc.net with any comments or questions.

Background and FAQ – RAS Definition Development

Existing Glossary of Terms Used in NERC Reliability Standards Definitions

The existing Glossary of Terms Used in NERC Reliability Standards defines **SPS** or **RAS** as: "An automatic protection system designed to detect abnormal or predetermined system conditions, and take corrective actions other than and/or in addition to the isolation of faulted components to maintain system reliability. Such action may include changes in demand, generation (MW and Mvar), or system configuration to maintain system stability, acceptable voltage, or power flows. An SPS does not include (a) underfrequency or undervoltage load shedding or (b) fault conditions that must be isolated or (c) out-of-step relaying (not designed as an integral part of an SPS). Also called Remedial Action Scheme."

The Glossary of Terms Used in NERC Reliability Standards defines a **Protection System** as:

- Protective relays which respond to electrical quantities,
- Communications systems necessary for correct operation of protective functions,
- Voltage and current sensing devices providing inputs to protective relays,
- Station dc supply associated with protective functions (including batteries, battery chargers, and non-battery-based dc supply), and
- Control circuitry associated with protective functions through the trip coil(s) of the circuit breakers or other interrupting devices.

Revision of the Glossary of Terms Used in NERC Reliability Standards Definition

Purpose of Revision of the Glossary of Terms Used in NERC Reliability Standards SPS or RAS

The existing Glossary of Terms Used in NERC Reliability Standards definition for an SPS/RAS lacks the clarity and specificity necessary to consistently identify what equipment or schemes qualify as an SPS/RAS across the eight NERC Regions. This confusion leads to inconsistent application of the SPS/RAS-related NERC Reliability Standards.

The existing definition also lacks clarity in the actions stipulated as characteristics of an SPS/RAS. The actions listed in the definition are so broad that the definition may unintentionally include schemes whose purpose is not expressly related to preserving system reliability in response to predetermined system conditions. Inclusion of any scheme taking "corrective action other than isolation of faulted components to maintain system reliability" could be interpreted to mean that devices such as voltage regulators and switching controls for shunt capacitors should be included. This inclusion would then make these devices subject to requirements such as those addressing single-component failure considerations (sometimes referred to as redundancy considerations) in the SPS/RAS-related NERC Reliability Standards.

Recommendation to Change the Term to RAS Only

Currently, both terms, SPS and RAS, are used in the eight NERC Regions. The SDT contends that a single term promotes consistency. The SDT therefore recommends that the term RAS be retained as the industry-recognized term and that the term SPS ultimately be retired. The term RAS is more descriptive of the purpose for which the scheme is installed.

The term RAS also eliminates the confusion associated with the two defined terms, "Special Protection System" and "Protection System." The inclusion of Protection System in the term Special Protection System implies that SPS are a subset of Protection Systems.

Effects of Using Only the Term RAS in the Existing NERC Reliability Standards

The existing NERC Reliability Standards and Glossary of Terms Used in NERC Reliability Standards use the terms, SPS and RAS interchangeably. In most cases, both terms are included in the standards and written as: "SPS or RAS." The SDT evaluated the existing standards and recommended any necessary revisions to retain the single term "RAS". Many of the same changes would be required regardless of which single term is retained. A summary of the occurrences of the terms is included in the posted document *Uses of "Special Protection System" and "Remedial Action Scheme" in Reliability Standards.*

Proposed Definition of RAS

Remedial Action Scheme: A scheme designed to detect predetermined System conditions and automatically take corrective actions that may include, but are not limited to, adjusting or tripping generation (MW and Mvar), tripping load, or reconfiguring a System(s). RAS accomplish objectives such as:

- Meet requirements identified in the NERC Reliability Standards;
- Maintain Bulk Electric System (BES) stability;
- Maintain acceptable BES voltages;
- Maintain acceptable BES power flows;
- Limit the impact of Cascading or extreme events.

The following do not individually constitute a RAS:

a. Protection Systems installed for the purpose of detecting Faults on BES Elements and isolating the faulted Elements

b. Schemes for automatic underfrequency load shedding (UFLS) and automatic undervoltage load shedding (UVLS) comprised of only distributed relays

c. Out-of-step tripping and power swing blocking

d. Automatic ~~R~~reclosing schemes

e. Schemes applied on an Element for non-Fault conditions, such as, but not limited to, generator loss-of-field, transformer top-oil temperature, overvoltage, or overload to protect the Element against damage by removing it from service

f. Controllers that switch or regulate one or more of the following: series or shunt reactive devices, flexible alternating current transmission system (FACTS) devices, phase-shifting transformers, variable-frequency transformers, or tap-changing transformers; and, that are located at and monitor quantities solely at the same station as the Element being switched or regulated

g. FACTS controllers that remotely switch static shunt reactive devices located at other stations to regulate the output of a single FACTS device

h. Schemes or controllers that remotely switch shunt reactors and shunt capacitors for voltage regulation that would otherwise be manually switched

i. Schemes that automatically de-energize a line for a non-Fault operation when one end of the line is open

j. Schemes that provide anti-islanding protection (e.g., protect load from effects of being isolated with generation that may not be capable of maintaining acceptable frequency and voltage)

k. Automatic sequences that proceed when manually initiated solely by a System Operator

l. Modulation of HVdc or FACTS via supplementary controls, such as angle damping or frequency damping applied to damp local or inter-area oscillations

m. Sub-synchronous resonance (SSR) protection schemes that directly detect sub-synchronous quantities (e.g., currents or torsional oscillations)

n. Generator controls such as, but not limited to, automatic generation control (AGC), generation excitation [e.g. automatic voltage regulation (AVR) and power system stabilizers (PSS)], fast valving, and speed governing

Exclusion List Explanations

a. Protection Systems installed for the purpose of detecting Faults on BES Elements and isolating the faulted Elements

The existing Glossary of Terms Used in NERC Reliability Standards definition of SPS/RAS excludes the isolation of faulted components because that is a protective function. Protection Systems installed for the purpose of detecting Faults on non-BES Elements are not RAS, and are not subject to NERC Reliability Standards. The SDT accepts this exclusion consistent with industry practice.

b. Schemes for automatic underfrequency load shedding (UFLS) and automatic undervoltage load shedding (UVLS) comprised of only distributed relays

The existing Glossary of Terms Used in NERC Reliability Standards definition of SPS/RAS excludes UFLS and UVLS because they are protective functions that have unique design and implementation considerations that are covered by NERC Reliability Standards PRC-006-1 and PRC-010-1. This exclusion emphasizes "distributed" UVLS relays to highlight that the exclusion covers UVLS Programs. The SDT accepts this exclusion consistent with industry practice.

Centrally controlled undervoltage-based load shedding is a RAS.

c. Out-of-step tripping and power swing blocking

The existing Glossary of Terms Used in NERC Reliability Standards definition of SPS/RAS excludes out-of-step relaying because it is a protective function. The SDT maintained the exclusion but changed the wording from "out-of-step relaying" to "out-of-step tripping and power swing blocking" to reflect current industry terminology.

d. Automatic ~~R~~reclosing schemes

Automatic reclosing schemes, whether single-pole or three-pole, are used to minimize system impacts and restoration efforts by System Operators. Automatic reclosing, in itself, is not a RAS; however, if integrated into a larger scheme that performs additional corrective actions to accomplish the objective(s) listed in the RAS definition, then it would be part of a RAS. For example, a scheme that rejects or runs back generation to avoid instability or thermal overloads in addition to initiating automatic reclosing would constitute a RAS. The drafting team contends that auto-sectionalizing for restoration following a Fault would typically fall under exclusion (d) ~~Automatic~~ automatic ~~R~~reclosing schemes.~~;~~ Automatic reclosing schemes that restore load to an alternate source would typically not be a RAS; however, system reconfiguration which transfers the load to another source for purposes other than load restoration typically would be a RAS.

e. Schemes applied on an Element for non-Fault conditions, such as, but not limited to, generator loss-of-field, transformer top-oil temperature, overvoltage, or overload to protect the Element against damage by removing it from service

Schemes applied on a single Element to protect it from damage from non-Fault conditions are protective functions and are not RAS. Other examples of schemes that would qualify within this exclusion are reverse power, volts/hertz, winding temperature, and loss of cooling. The SDT accepts this exclusion consistent with industry practice.

f. Controllers that switch or regulate one or more of the following: series or shunt reactive devices, flexible alternating current transmission system (FACTS) devices, phase-shifting transformers, variable-frequency transformers, or tap-changing transformers; and, that are located at and monitor quantities solely at the same station as the Element being switched or regulated

Controllers that switch or regulate these devices are not RAS. The SDT accepts this exclusion consistent with industry practice. Exclusions (f) and (g) are complementary in that (f) provides a broad exception for local controls at the same station while (g) provides a specific exclusion for FACTS control of shunt devices at one or more other stations.

g. FACTS controllers that remotely switch static shunt reactive devices located at other stations to regulate the output of a single FACTS device

The purpose of such controllers is to switch shunt devices to restore an acceptable operating range of a single FACTS device. Exclusions (f) and (g) are complementary in that (f) provides a broad exception for local controls at the same station while (g) provides a specific exclusion for FACTS control of shunt devices at one or more other stations. The SDT accepts this exclusion consistent with industry practice.

h. Schemes or controllers that remotely switch shunt reactors and shunt capacitors for voltage regulation that would otherwise be manually switched

Schemes or controllers that assist a System Operator in coordinating the switching of shunt reactors and shunt capacitors that would otherwise be manually switched are not remedial in the sense of being mitigations in response to predetermined System conditions, but are for general application to all System conditions, e.g. optimizing voltage profiles or minimizing losses. The SDT accepts this exclusion consistent with industry practice.

i. Schemes that automatically de-energize a line for a non-Fault operation when one end of the line is open

When one end of a line is open, unacceptable voltage levels can occur. Opening the remote terminal(s) to de-energize the transmission line removes this voltage rise. Alternatively, restoration conditions may require energization or synchronizing at a specific terminal. These schemes have not historically been regarded as RAS, and the SDT accepts this exclusion consistent with industry practice.

j. Schemes that provide anti-islanding protection (e.g., protect load from effects of being isolated with generation that may not be capable of maintaining acceptable frequency and voltage)

These schemes are designed to protect load in an electrical island that might otherwise operate at an off-nominal frequency or voltage, or facilitate restoration. Actions taken on islanded facilities will not impact the interconnected BES because the facilities are isolated. The SDT accepts this exclusion consistent with industry practice.

k. Automatic sequences that proceed when manually initiated solely by a System Operator

Automated sequences created to simplify the actions of a System Operator are not RAS because the decision to activate a specific sequence is left to the System Operator. If the automated sequence fails to execute correctly, the System Operator has the option to manually set those actions in motion. The SDT accepts this exclusion consistent with industry practice.

The arming of a RAS by a System Operator is not the same as manual initiation of an automatic sequence. Arming enables the scheme but the RAS must still detect the critical conditions it was designed to mitigate and then take action.

l. Modulation of HVdc or FACTS via supplementary controls such as angle damping or frequency damping applied to damp local or inter-area oscillations

Modulation of HVdc and FACTS via supplementary controls is occasionally used for damping local or inter-area oscillations. It is similar in function to a Power System Stabilizer (PSS), which is a component of excitation controls in a generating unit. PSS are also not classified as RAS. The SDT accepts these HVdc and FACTS exclusions consistent with industry practice.

m. Sub-synchronous resonance (SSR) protection schemes that directly detect sub-synchronous quantities; (e.g., currents or torsional oscillations)

Historically, SSR protection schemes that directly detect sub-synchronous quantities and the related mitigation are not RAS. The SDT accepts this exclusion consistent with industry practice.

However, SSR protection schemes installed to detect distinct System configurations and loading conditions (that studies have shown may make a generator vulnerable to SSR), and take action to trip the generator or bypass the series capacitor, are classified as RAS.

n. Generator controls such as, but not limited to, automatic generation control (AGC), generation excitation [e.g. automatic voltage regulation (AVR) and power system stabilizers (PSS)], fast valving, and speed governing

These traditional generator and turbine controls are not RAS. The SDT accepts this exclusion consistent with industry practice.

Explanations Regarding Changes from the Exclusion List Cited in the SAMS-SPCS Report

The SDT revised the straw man definition proposed in the SAMS-SPCS report; however, the proposed definition is consistent with the SAMS-SPCS intent. As a result of the revisions, it is no longer necessary to explicitly state the following exclusions.

1. **Schemes that prevent high line voltage by automatically switching the affected line**

   These schemes are now addressed by exclusion (e) (protection from overvoltage) and exclusion (i) (automatic de-energization of a line when one end is open) in the proposed definition.

2. **Protection schemes that operate local breakers other than those on the faulted circuit to facilitate Fault clearing, such as, but not limited to, opening a circuit breaker to remove infeed so protection at a remote terminal can detect a Fault or to reduce fault duty**

   These schemes are now addressed by exclusion (a) in the proposed definition.

3. **Blanket exclusion for SSR protection schemes**

   The proposed definition excludes schemes that directly detect sub-synchronous quantities; however, SSR mitigation schemes installed to detect distinct System configurations and loading conditions (that studies have shown may make a generator vulnerable to SSR), and take action to trip the generator or bypass the series capacitor, are classified as RAS.

4. **A Protection System that includes multiple elements within its zone of protection, or that isolates more than the faulted element because an interrupting device is not provided between the faulted element and one or more other elements**

   These schemes are now addressed by exclusion (a) in the proposed definition.

Frequently Asked Questions

What is the relationship between a Remedial Action Scheme and a Protection System?

The existing ~~NERC Glossary of Terms~~ definition of a Protection System in the Glossary of Terms Used in NERC Reliability Standards is a component-based definition that was developed in conjunction with NERC Reliability Standard PRC-005-2 Protection System Maintenance. The definition lists components such as "protective relays which respond to electrical quantities" that represent the building blocks of a Protection System. All protective schemes include some combination of these building blocks but not necessarily all of them, for example, many protective schemes do not have the "communications systems…" component. In other cases, protective schemes like RAS may have all of the Protection System components as well as other pieces of equipment such as programmable logic controllers.

Why does the proposed definition have an exclusion list?

The definition must be broad enough to include the variety of System conditions monitored and corrective actions taken by RAS. Without the exclusions, equipment and schemes that should not be considered RAS could be subject to the requirements of the RAS-related NERC Reliability Standards. The exclusion list also assures that commonly applied protection and control systems are not unintentionally included as RAS.

Why did the SDT not propose a screening process to identify RAS?

The SDT contends that a comprehensive definition with specific exclusions is the best way to achieve consistency and immediacy in RAS identification. The SDT asserts that a study-based screening process would be labor-intensive and dependent on assumptions that could vary among the entities performing the studies.

Why does the proposed definition not include the classification types suggested in the SPCS-SAMS report?
The classification of a RAS is not necessary for defining whether or not a scheme qualifies as a RAS. Informal feedback from many stakeholders indicated uncertainty about the classification types. Therefore, the SDT decided not to include RAS classification types within the definition. The classifications are more appropriately addressed concurrently with revisions to the RAS-related Reliability Standards.

Why did the SDT not specifically reference the Transmission Planning (TPL) standards in the proposed definition?
The SDT acknowledges that many RAS are installed to address the performance requirements of the TPL standards; however, they are also installed to address other reliability concerns.

Would automatic actions taken by an Energy Management System (EMS), Supervisory Control and Data Acquisition (SCADA), or Distribution Control System (DCS) be considered a RAS?
The above-mentioned control systems support and enable grid operations by issuing control commands mostly to geographically distributed power System devices. In this normal application, e.g. automatic generation control (AGC), these systems are not considered to be RAS. However, if these systems are configured to detect predetermined conditions and take corrective actions consistent with the RAS definition, these automatic functions (not the entire EMS) would be considered to be part of a RAS. The identification of RAS is not dependent upon the specific hardware or platform utilized in the scheme. For example, an automatic UVLS scheme centrally controlled through an EMS would be a RAS.

Would controllers at the terminals of a High Voltage direct current (HVdc) Facility be considered a RAS?
HVdc terminal controls such as those which maintain proper converter operation, regulate current, voltage or power flow, or that provide protection for the HVdc Facility itself do not meet the definition of RAS. However, an HVdc control scheme designed to take corrective actions based on predetermined System conditions, such as backing down power transfer on an HVdc Facility following a Contingency to avoid overload of another BES Element would be part of a RAS.

Why are local cross-trip schemes RAS?
Switching in the same substation (including transfer- or cross-trip schemes) to trip Elements other than the protected Element is a System reconfiguration and is therefore a RAS. Reconfiguring the System can be a critical factor in reliability and merits the review and oversight associated with RAS.

What are the Implementation Plan time frames?
The effective date of the RAS definition as noted in the Implementation Plan is the first day of the first calendar quarter that is twelve (12) months after the date that the standards and definition are approved by an applicable governmental authority or as otherwise provided for in a jurisdiction where approval by an applicable governmental authority is required for a standard to go into effect. Where approval by an applicable governmental authority is not required, the standards and the definition shall become effective on the first day of the first calendar quarter that is twelve (12) months after the date the standards and definition are adopted by the NERC Board of Trustees or as otherwise provided for in that jurisdiction. The drafting team notes that RAS owners could use this time to evaluate their existing schemes for determining whether they are RAS, based on the new definition.

The Implementation Plan also provides owners of newly identified RAS twenty-four (24) calendar months beyond the effective date of the definition (i.e., at least 36 months after approval by a governmental authority) to be fully compliant with the existing standards applicable to the revised definition of Remedial Action Scheme. The drafting team contends that this time frame provide entities sufficient time to transition schemes to RAS and become compliant with the revised standards outlined in the Implementation Plan.

Note: These timeframes are not applicable to new RAS implemented subsequent to the effective date of the new definition. New RAS must comply with all applicable standards as they are implemented.

Coordination with Project 2008-02 – Undervoltage Load Shedding

As part of the development of PRC-010-1, the Project 2008-02 UVLS SDT ~~is~~ introduced~~ing~~ a new ~~NERC Glossary~~ term, UVLS Program, into the Glossary of Terms Used in NERC Reliability Standards to clearly establish applicability of PRC-010-1:

Undervoltage Load Shedding Program (UVLS Program): An automatic load shedding program, consisting of distributed relays and controls, used to mitigate undervoltage conditions impacting the Bulk Electric System (BES), leading to voltage instability, voltage collapse, or Cascading ~~impacting the Bulk Electric System (BES)~~. Centrally controlled undervoltage-based load shedding is not included.

Note that the definition excludes centrally controlled undervoltage-based load shedding. The UVLS SDT ~~maintains~~ maintained that the design and characteristics of centrally controlled undervoltage-based load shedding are commensurate with RAS (wherein load shedding is the remedial action) and, as such, centrally controlled undervoltage-based load shedding should be subject to RAS-related Reliability Standards.

The Project 2010-05.2 SPS SDT ~~agrees~~ agreed with the Project 2008-02 UVLS SDT that the design and characteristics of centrally controlled undervoltage-based load shedding are more appropriately categorized as RAS. The SPS SDT revised the definition of RAS to clarify that the definition is exclusive of distributed UVLS relays including the newly defined term UVLS Program. Therefore, the definition is inclusive of centrally controlled undervoltage-based load shedding. The SDT ~~is~~ coordinated~~ing~~ this change with the Project 2008-02 UVLS SDT. Collectively, the two definitions will promote consistency in the identification of centrally controlled undervoltage-based load shedding as a RAS. As a result, all NERC Reliability Standards that include the term RAS will be applicable to centrally controlled undervoltage-based load shedding upon the effective date of the revised definition of RAS.

Attachment A – SDT Members

Project 2010-05.2 – Special Protection Systems SDT		
	Participant	**Entity**
Chair	Gene Henneberg	NV Energy / Berkshire Hathaway Energy
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