Transition from SPS to RAS – What will really change?

Hari Singh, Transmission Planning

What is an SPS? What is a RAS?

SPS – **S**pecial **P**rotection **S**cheme…

or is it **S**pecial **P**rotection **S**ystem?

What makes it *"special"*?

Does **SPS** have any relationship to **RAS**?

RAS – **R**emedial **A**ction **S**cheme (**or** **S**ystem?)

Is **SPS** or **RAS** the same as **SIPS**?

SIPS – **S**ystem **I**ntegrity **P**rotection **S**cheme

Existing NERC Definitions

Special Protection System (SPS)

An automatic protection system designed to detect abnormal or predetermined system conditions, and <u>take corrective actions other than and/or in addition to the isolation of faulted components</u> 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.

Existing NERC Definitions

Protection System

- 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 station 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.

Could SPS be a *Special* Protection System?

IEEE PSRC Term

System Integrity Protection Schemes (SIPS)

is a category of protection schemes designed to protect the integrity of the power system from system instability, to maintain overall system connectivity, and/or to avoid serious equipment damage during major events.
The SIPS encompasses Special Protection Schemes (SPS), Remedial Action Schemes (RAS) and varieties of safety nets… as well as additional schemes such as, but not limited to, Underfrequency (UF), Undervoltage (UV), out-of-step (OOS), etc.

Is (NERC defined) SPS or RAS the same as SIPS? *No*

Motivation for Revised Definition

Use of RAS as preferred terminology and its revised definition is expected to:

- ■ **Eliminate confusion caused by existing term SPS due to its similarity with PS and SIPS**

- ■ **Promote consistent understanding of which automatic mitigation action(s) constitute a RAS across all the NERC Regions.**

- ■ **Provide firm basis for the revision/update of relevant Standards (PRC-012 thru PRC-017)**

Industry Initiatives Timeline

April 2013 – NERC Technical Report *"**Special Protection Systems (SPS) and Remedial Action Schemes (RAS):** Assessment of Definition, Regional Practices, and Application of Related Standards'"*

Feb. 2014 – NERC starts drafting the revised (clear & specific) SPS/RAS Definition (NERC Project 2010-05.2 – Phase 2 of Protection Systems)

Nov. 2014 – Revised RAS definition (and retire SPS term) approved by NERC

June 2015 – FERC NOPR to approve RAS definition (Final Rule awaited)

Revised Definition of RAS

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 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:

(list of 14 exclusions)

What Changed?

Existing

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.

… … …

Revised

A scheme designed to detect predetermined System conditions and automatically take corrective actions that may include, but are not limited to, … …

What Changed?

Existing

… … 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:

Revised

… … may include, but are not limited to, adjusting or tripping generation (MW and Mvar), tripping load, or reconfiguring a System(s).

What Changed?

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:

RAS accomplish objectives such as:

• Meet requirements identified in 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:

What Changed?

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).

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

(plus 11 more exclusions)

Additonal RAS Exclusions

d. Automatic 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

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

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

Additonal RAS Exclusions

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

Additonal RAS Exclusions

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)

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

RAS or No RAS?   HVdc Controllers

Controller at HVdc terminal(s) which maintains proper converter operation, regulates current, voltage or power flow, or that provides protection for the HVdc Facility itself.

Not RAS – does not satisfy "*inclusions*" in definition… no corrective actions for predetermined condition(s).

Controller at HVdc terminal(s) ramps down power transfer thru HVdc Facility to avoid post-contingency overload of another BES element

RAS – satisfies definition, and no exception applies.

Revised Definition of RAS

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 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:

(list of 14 exclusions)

RAS or No RAS?   Transfer/Cross Trip

In addition to tripping the monitored/protected element (for predetermined system conditions) – a scheme that transfer-trips other element(s) within the _same_ station/switchyard (aka cross-trip scheme)?

RAS – since cross-tripping of element(s) typically results in system reconfiguration, and no exception applies.

What if cross-tripping is for _shunt device(s) only_?

RAS or No RAS?   Transfer/Cross Trip

What if cross-tripping is for *shunt device(s) only*?

Possibly not a RAS… only if exception (f) applies!

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

Very Likely a RAS – since cross-tripping is likely being done to maintain acceptable BES voltages, and does not align with the intent or the rationale of exception (f)

Hari Singh

303-571-7095

Hari.Singh@xcelenergy.com