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## **Western Interconnection RAS Review**

Remedial Action Scheme Review Subcommittee

September 23, 2019

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## Introduction:

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In anticipation of the upcoming implementation of PRC-012-02, the Remedial Action Scheme Review Subcommittee (RASRS) has developed a transitional remedial action scheme (RAS) review process that meets the requirements of both PRC-012-1 and PRC-012-2. On January 1, 2021, the PRC-012-2 becomes legally enforceable. PRC-012-1 provides the authority for WECC to review and formally approve a RAS. PRC-012-2 gives the authority for the Reliability Coordinator (RC) to review and approve a RAS.

This document provides a framework for submitting RAS information, previously known as a special protection system (SPS), to the WECC RASRS or the affected RC within the Western Interconnection (WI) per the standard in place. The RASRS will also review a RAS at the request of appropriate WECC committees or RC.

Generally, all elements of a RAS, applied at any voltage to remediate performance violations on the Bulk Electric System (BES), are subject to the NERC requirements for RAS. Minimum requirements for system performance are laid out in the transmission planning (TPL) standards and related WECC criteria.

This guide summarizes the information and process necessary to review RAS within the WI. PRC-012-2 also includes extra material on topics of interest.

## What is, and is not, a RAS?

On November 19, 2015, FERC approved a revised definition of a RAS to include in the Glossary of Terms Used in NERC Reliability Standards. This definition became effective April 1, 2017.

A RAS is:

A scheme designed to detect predetermined system conditions and automatically take corrective actions that may include 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;
- BES stability;
- Maintain acceptable BES voltages;
- Maintain acceptable BES power flows; and
- Limit the impact of cascading or extreme events.

The following do not individually constitute a RAS:

1. Protection system is installed for detecting faults on BES elements and isolating the faulted elements;
2. Schemes for automatic underfrequency load shedding (UFLS) and automatic under voltage load shedding (UVLS) composed of only distributed relays;



3. Out-of-step tripping and power swing blocking;
4. Automatic reclosing schemes;
5. Schemes applied on an element for non-fault conditions, such as generator loss-of-field, transformer top-oil temperature, overvoltage, or overload to protect the element against damage by removing it from service;
6. Controllers that switch or regulate one or more of the following:
  - a. Series or shunt reactive devices,
  - b. Flexible alternating current transmission system (FACTS) devices,
  - c. Phase-shifting transformers,
  - d. 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;
7. FACTS controllers that remotely switch static shunt reactive devices located at other stations to regulate the output of a single FACTS device;
8. Schemes or controllers that remotely switch shunt reactors and shunt capacitors for voltage regulation that otherwise would be switched manually;
9. Schemes that automatically de-energize a line for a non-fault operation when one end of the line is open;
10. 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);
11. Automatic sequences that begin when manually initiated solely by a System Operator (SO);
12. Modulation of HVDC or FACTS via additional controls, such as angle damping or frequency damping for local or inter-area oscillations;
13. Sub-synchronous resonance (SSR) protection schemes that detect sub-synchronous quantities (e.g., currents or torsional oscillations); and
14. Generator controls such as automatic generation control (AGC), generation excitation (e.g., automatic voltage regulation (AVR) and power system stabilizers (PSS)), fast valving, and speed governing.

### When is RAS Review Required?

The reliability aspects of RAS are reviewed before placing a new or functionally modified RAS in service or retiring an existing RAS.

1. Before placing a new RAS in service.
2. Before being functionally modified. A functional modification is a change to:
  - a. System conditions or contingencies monitored by the RAS,
  - b. The actions the RAS is designed to initiate,



- c. RAS hardware beyond in-kind replacement (i.e., match the original functionality of existing components),
  - d. RAS logic beyond correcting existing errors,
  - e. Redundancy levels (i.e., addition or removal).
3. If operational deficiency of a scheme for which functional modifications will be necessary. For RC and RASRS review, deficiencies will be considered for such conditions as:
- a. Intended RAS operations that do not meet expected system performance levels,
  - b. Accidental or unintended RAS operations that cause system performance outside performance standards,
  - c. RAS failures that result in system performance outside performance standards.
4. Retirement of a RAS. Schemes proposed for retirement should first be evaluated by the same planning group (or successor group) that reviewed the studies that resulted in the RAS or its most recent modification. Examples include—
- a. WECC Studies Subcommittee (StS) for schemes originally evaluated through the WECC Three-Phase Rating Process or,
  - b. The appropriate Planning Coordinator.

### RAS Classifications and Characteristics

PRC-012-2 recognizes two categories of RAS: limited impact and all other RAS.

A limited impact RAS cannot, by inadvertent operation or failure to operate, cause or contribute to BES cascading, uncontrolled separation, angular instability, voltage instability, voltage collapse, or unacceptably damped oscillations.

Except for limited impact RAS, a single component failure in the RAS when the RAS is supposed to operate does not stop the BES from meeting the same performance requirements<sup>1</sup> as for the events and conditions for which the RAS is designed. For limited impact RAS, WECC and the RCs encourage scheme design to meet the same performance requirements following a single RAS component failure.

### RAS Reviews

The RAS review process for PRC-012-1 assigns the scheme review and approval to the WECC RASRS. The PRC-012-2 assigns approval authority and responsibility to the affected RC.

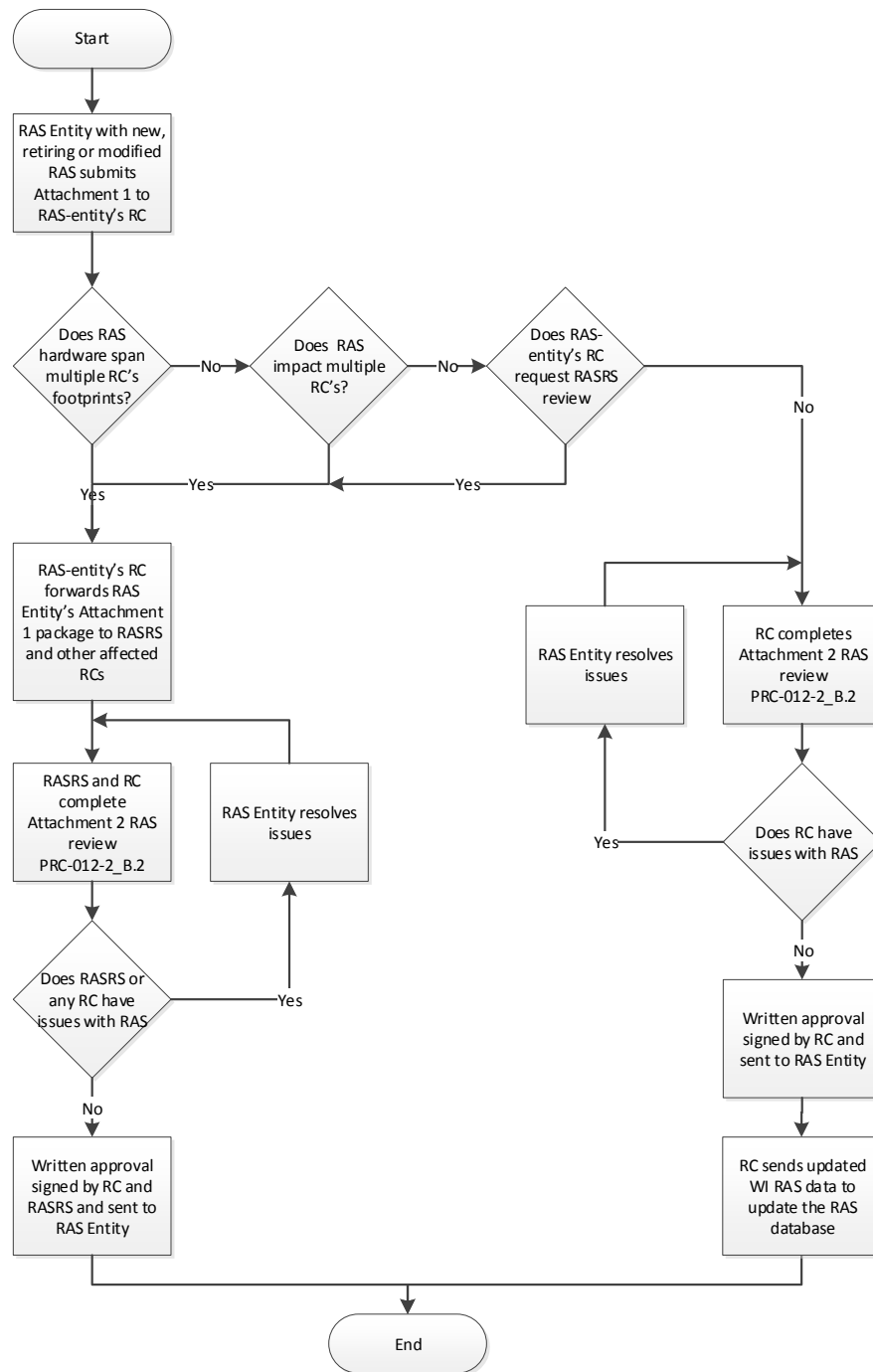
The WI RCs and WECC recognize that the RASRS has provided vital expertise on RAS. The use of RAS within the WI requires coordination between many RCs. As such, WECC will continue to support RAS reviews through the RASRS, which will provide scheme reviews, advice, and recommendations to the RCs to support their responsibilities.

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<sup>1</sup> Defined in Reliability Standard TPL-001-4 or its successor.



Figure 1 – Western Interconnection RAS review process.



WECC and the RCs will use the following criteria to decide which RAS will need review by the RASRS and not just a single affected RC.

Table 1 — System Performance Criteria Outside an RC Area

| Event Type                             | Transient Voltage Dip Limits                                                                  | Minimum Transient Frequency Limits           | Post Transient Voltage Deviation Limits |
|----------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------|
| Single contingency                     | ≤ 20% for > 20 cycles at load buses, or<br>≤ 25% at load buses, or<br>≤ 30% at non-load buses | Not below 59.6 Hz for 6 cycles at a load bus | Not to exceed 5% at any bus             |
| Double or other multiple contingencies | ≤ 30% at any bus or<br>≤ 20% for > 40 cycles at load buses                                    | Not below 59.0 Hz for 6 cycles at a load bus | Not to exceed 10% at any bus            |

**Notes:**

1. Table 1 applies equally to systems with all elements in service or to systems with one element removed and the system adjusted.
2. For example, a single contingency disturbance in one system will not cause a transient voltage dip greater than 20 percent in another system for more than 20 cycles at load buses, or exceed 25 percent at load buses or 30 percent at non-load buses at any time other than during the fault.
3. Load buses include generating unit auxiliary loads.

This classification of RAS is separate from the “limited impact / all others” classification in the PRC-012-2. This provides a separation between RAS that may be reviewed and approved by one affected RC versus those RAS that also need review by the RASRS. The larger RASRS review will be needed for schemes that include any of the following features:

1. RAS hardware spans the footprints of multiple RCs;
2. An affected RC requests review by the RASRS;
3. Failure of RAS to operate when appropriate or an incorrect RAS operation may result in any of the following:
  - a. Violations of the Table 1, System Performance Criteria Outside an RC Area,
  - b. Maximum firm load loss ≥ 300 MW,
  - c. Maximum generation loss ≥ 1000 MW.

The above discussion beginning with Table 1 shows similar criteria as WECC had previously used to define Local-Area Protection Schemes (LAPS), Wide-Area Protection Schemes (WAPS), and Safety Nets (SN). Schemes classified as LAPS by these earlier criteria are “grandfathered” as limited impact schemes by PRC-012-2, but otherwise these earlier classifications are not used.

## Periodic Assessments

Most entities in the WI include RAS installed on their systems in daily outage planning and real-time contingency analysis (RTCA) as well as longer-term system operating limits (SOL) and other



Transmission Planning studies. To ensure the information is up to date, PRC-012-2 R4 requires that the Planning Coordinator review the RAS performance at least every five years. If any performance shortcomings are seen during these studies, a Corrective Action Plan (CAP) must be developed.<sup>2</sup>

Only the RAS entity can authorize and follow through to apply a CAP. The NERC Glossary only says that the CAP must identify a solution that will fix the problem(s) and a timetable when the solution(s) will be applied. If the CAP solutions involve functional modifications to a RAS (see above), then the RC or RASRS must review those modifications through the procedures described in this document.

### WECC RAS Database

PRC-012-2 R9 requires that the RC keep a database of all RAS for which it is responsible. The RASRS has created and keeps the WI RAS database. This database includes the R9 requirements, the RC(s) responsible for each RAS, and other items that each RC considers important enough to track.

The RAS entity for each new or modified RAS must provide the database information. The entity should submit the information electronically as part of the material required for scheme review by the RC and RASRS. An Excel spreadsheet template is provided. Schemes scheduled for removal need only include “SCHEME REMOVED” or a similar phrase in the description for the specific scheme, along with the removal date.

When the RC has reviewed and approved a scheme, the scheme data is incorporated in the WI RAS database. PRC-012-2 allows up to one year for database updates, though they will usually occur more often.

### Closed RAS Review Sessions

RAS often include facilities classified as Critical Assets and, depending on implementation, may contain Critical Cyber Assets, BES Cyber Assets, or BES Cyber Systems as part of putting the scheme into action. The information that the RC(s) and RASRS requests and reviews includes at least some parts of operational procedures, incident response plans, and network topology or similar diagrams. It is also common for presentations to include some floor plan and equipment layout information as pictures or diagrams.

Also, much of the scheme information requested and discussed is of greater sensitivity than the information listed in the NERC CIP Critical Cyber Asset Information (CCAI) requirement, so it is expected to be protected. This may include confidential, restricted, or other non-public documents. Some companies have a requirement that CCAI and other restricted information may only be transmitted with a nondisclosure agreement (NDA) in place. If information of this nature were omitted

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<sup>2</sup> The NERC definition of a Corrective Action Plan is “A list of actions and associated timetable for implementation to remedy a specific problem.”



from the RAS review presentations and discussions, or if it were less detailed, the review process would be hampered and less effective.

The RASRS chair, RC, or RAS entity may propose or request a scheme review in closed session with proper notification in the publicly posted meeting agenda before the review meeting. Closed sessions are subject to a 2/3 vote of RASRS members present. If information to be discussed is covered by an NDA, all individuals present must be signatories to the NDA before the discussions begin. This process is authorized by and further described in the RASRS Charter.

### **Submitting RAS Information for Review**

The RASRS chair will schedule in-person meetings often enough to finish the pending scheme reviews and other RASRS business, typically three per year. RCs will request RAS scheme reviews far enough in advance of each meeting to compile an agenda for the business to be done. If RAS in-service date schedules require it, separate RASRS meetings may be scheduled (either in person or by web or phone).

The RC will supply copies of the RAS documentation, particularly the Attachment 1 and Attachment 3 information (attached) to other affected RC(s) and WECC RASRS, before the presentation date so members have enough time to review, preferably at least two weeks, though PRC-012-2 allows up to four months for a final decision). Electronic documents that can be opened by using standard MS Office or Adobe PDF products are preferred. It is the responsibility of the RAS entity to ensure all submitted materials, attachments, presentation material, and handouts are legible. Electronic documents should be submitted to the RASRS through the WECC website (the procedure is shown under RASRS Approved Documents), or given to the RASRS chair, vice chair, or WECC RASRS support staff for posting on the website.

The RAS will be included in the Western Interconnection RAS database on the WECC RASRS website, but with limited access due to the sensitive nature of the data, for RC operating purposes and for periodic review as part of the WECC-NERC compliance process. The database is updated with Attachment 3 data as new schemes are added or existing schemes are modified or retired. The RAS entity is required to prepare the data describing the RAS for inclusion in the database as part of the documentation submitted for review.

## Attachment 1

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### Supporting Documentation for RAS Review

The following list shows important RAS information for each new or functionally modified RAS, which the RAS entity must document and provide to the RC for review. If an item on this list does not apply to a specific RAS, a response of “not applicable” for that item is appropriate. When RAS are submitted for functional modification review and approval, only the proposed changes to that RAS need review; however, the RAS entity must give a summary of the existing functionality. The RC may request more information on any part of the RAS as well as any reliability issue related to the RAS. More entities, without decision authority, may be part of the RAS review process at the request of the RC.

#### I. General

1. Information such as maps, one-line drawings, substation and schematic drawings that identify the physical and electrical location of the RAS and related facilities.
2. Functionality of new RAS or proposed functional modifications to existing RAS and documentation of the pre- and post-modified functionality of the RAS.
3. The CAP if RAS modifications are proposed in a CAP.
4. Data to populate the RAS database:
  - a. RAS name;
  - b. Each RAS entity and contact information;
  - c. Expected or actual in-service date, most recent RC-approval date (Requirement R3), most recent evaluation date (Requirement R4), and date of retirement, if applicable;
  - d. System performance issue or reason for installing the RAS (e.g., thermal overload, angular instability, poor oscillation damping, voltage instability, under- or overvoltage, or slow voltage recovery);
  - e. Description of the contingencies or system conditions for which the RAS was designed (i.e., initiating conditions);
  - f. Action(s) to be taken by the RAS;
  - g. Identification of limited impact RAS; and
  - h. Any other explanation relevant to high-level understanding of the RAS.

#### II. Functional Description and Transmission Planning Information

1. Contingencies and system conditions that the RAS is meant to remedy.
2. The action(s) to be taken by the RAS in response to disturbance conditions.
3. A summary of technical studies, if applicable, demonstrating that the proposed RAS actions satisfy system performance objectives for the scope of system events and conditions that the RAS is meant to remedy. The technical studies summary will also include information such as



the study year(s), system conditions, and contingencies analyzed on which the RAS design is based, and the date those technical studies were performed.

4. Information regarding any future system plans that will affect the RAS.
5. RAS entity proposal and justification for limited impact designation, if applicable.
6. Documentation describing the system performance resulting from the possible inadvertent operation of the RAS, except for limited impact RAS, caused by any single RAS component malfunction. Single component malfunctions in a RAS not determined to be limited impact must satisfy all the following:
  - a. The BES will remain stable.
  - b. Cascading will not occur.
  - c. Applicable facility ratings will not be exceeded.
  - d. BES voltages will be within post-contingency voltage limits and post-contingency voltage deviation limits as established by the Transmission Planner and the Planning Coordinator.
  - e. Transient voltage responses will be within acceptable limits as established by the Transmission Planner and the Planning Coordinator.
7. An evaluation showing that the RAS settings and operation avoid adverse interactions with other RAS and protection and control systems.
8. Identification of other affected RCs.

### III. Implementation

1. Documentation describing the applicable equipment used for detection, DC supply, communications, transfer trip, logic processing, control actions, and monitoring.
2. Information on detection logic and settings or parameters that control the operation of the RAS.
3. Documentation showing that any multifunction device used to perform RAS function(s), in addition to other functions such as protective relaying or SCADA, does not compromise the reliability of the RAS when the device is not in service or is being maintained.
4. Documentation describing the system performance resulting from a single component failure in the RAS, except for limited impact RAS, when the RAS is meant to operate. A single component failure in a RAS not determined to be limited impact must not prevent the BES from meeting the same performance requirements (defined in Reliability Standard TPL-001-4 or its successor) as those required for the events and conditions for which the RAS is designed. The documentation should describe or illustrate how the design achieves this objective.
5. Documentation describing the functional testing process.

### IV. RAS Retirement

1. The following checklist shows RAS information, which the RAS entity will document and provide to each reviewing RC.



2. Information needed to ensure that the RC understands the physical and electrical location of the RAS and related facilities.
3. A summary of applicable technical studies and technical justifications upon which the decision to retire the RAS is based.
4. Anticipated date of RAS retirement.

### Other Comments



## Attachment 2

### RC RAS Review Checklist

The following checklist shows reliability-related considerations for the RC to review and verify for each new or functionally modified RAS. The RC review is not limited to the checklist items and the RC may request additional information on any aspect of the RAS and any reliability issue related to the RAS. If a checklist item is not relevant to a RAS, it should be noted as “not applicable.” If reliability considerations are identified during the review, the considerations and the proposed resolutions should be documented with the remaining applicable Attachment 2 items.

**RAS Entity:**

**RAS Identifier:**

**Date Submitted:**

### I. Design

| Criteria                                                                                                                                                                                                                                                                                     | Meets Criteria | Notes |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|
| 1. The RAS actions satisfy performance objectives for the scope of events and conditions that the RAS is intended to mitigate.                                                                                                                                                               |                |       |
| 2. The designed timing of RAS operation(s) is appropriate to its BES performance objectives.                                                                                                                                                                                                 |                |       |
| 3. The RAS arming conditions, if applicable, are appropriate to its system performance objectives.                                                                                                                                                                                           |                |       |
| 4. The RAS avoids adverse interactions with other RAS and protection and control systems.                                                                                                                                                                                                    |                |       |
| 5. The effects of incorrectly operating the RAS, including inadvertent operation and failure to operate, have been identified.                                                                                                                                                               |                |       |
| 6. Determine whether the RAS is limited impact. A limited impact RAS cannot, by inadvertent operation or failure to operate, cause or contribute to BES cascading, uncontrolled separation, angular instability, voltage instability, voltage collapse, or unacceptably damped oscillations. |                |       |
| 7. Except for limited impact RAS, the possible inadvertent operation of the RAS resulting from any single RAS component malfunction satisfies all the following:                                                                                                                             |                |       |
| a. The BES will remain stable,                                                                                                                                                                                                                                                               |                |       |



|                                                                                                                                                                                           |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| b. Cascading will not occur,                                                                                                                                                              |  |  |
| c. Applicable facility ratings will not be exceeded,                                                                                                                                      |  |  |
| d. BES voltages will be within post-contingency voltage limits and post-contingency voltage deviation limits as established by the Transmission Planner and the Planning Coordinator, and |  |  |
| e. Transient voltage responses will be within acceptable limits as established by the Transmission Planner and the Planning Coordinator.                                                  |  |  |
| 8. The effects of future BES modifications on the design and operation of the RAS have been identified, where applicable.                                                                 |  |  |

## II. Implementation

| Criteria                                                                                                                                                                                                                  | Meets Criteria | Notes |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|
| 1. The implementation of RAS logic properly correlates desired actions (outputs) with events and conditions (inputs).                                                                                                     |                |       |
| 2. Except for limited impact RAS, a single component failure in a RAS does not stop the BES from meeting the same performance requirements as those required for the events and conditions for which the RAS is designed. |                |       |
| 3. The RAS design facilitates periodic testing and maintenance.                                                                                                                                                           |                |       |
| 4. The mechanism or procedure by which the RAS is armed is described clearly and is appropriate for reliable arming and operation of the RAS for the conditions and events for which it is designed to operate.           |                |       |

## III. RAS Retirement

RAS retirement reviews should ensure that there is adequate justification for why a RAS is no longer needed.

### Notes and Comments

| Ref. | Notes/Comments |
|------|----------------|
|      |                |



## RAS Approvals

| RAS entity's RC          | Affected RC              | Approved                                                         |
|--------------------------|--------------------------|------------------------------------------------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | Alberta Electric System Operator<br><br>_____<br>Date:           |
| <input type="checkbox"/> | <input type="checkbox"/> | British Columbia Hydro<br><br>_____<br>Date:                     |
| <input type="checkbox"/> | <input type="checkbox"/> | Gridforce LLC<br><br>_____<br>Date:                              |
| <input type="checkbox"/> | <input type="checkbox"/> | RC West<br><br>_____<br>Date:                                    |
| <input type="checkbox"/> | <input type="checkbox"/> | Southwest Power Pool<br><br>_____<br>Date:                       |
| NA                       | NA                       | Remedial Action Scheme Review Subcommittee<br><br>_____<br>Date: |

## Attachment 3

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### Western Interconnection RAS Database Information

The RAS entity will give the following information to the RC and RASRS as part of the review data for each RAS. A spreadsheet in the preferred format is provided for consistency and to minimize data maintenance.

1. RAS name;
2. Each RAS entity and contact information;
3. Expected or actual in-service date, most recent RC-approval date (Requirement R3), most recent evaluation date (Requirement R4), and date of retirement, if applicable;
4. System performance issue or reason for installing the RAS (e.g., thermal overload, angular instability, poor oscillation damping, voltage instability, under- or over-voltage, or slow voltage recovery);
5. Description of the contingencies or system conditions for which the RAS was designed (i.e., initiating conditions);
6. Action(s) to be taken by the RAS;
7. Identification of limited impact RAS;
8. Planning Coordinator(s) responsible for periodic evaluations;
9. RC(s) affected by the RAS; and
10. Any other explanation relevant to high-level understanding of the RAS.

**Note:**

Tentatively added Items 8 and 9 to the list in the NERC PRC-012-2 Attachment 3. The draft spreadsheet format also includes a few more items that have been included in either the WECC RAS database or the Peak Reliability RAS database.

