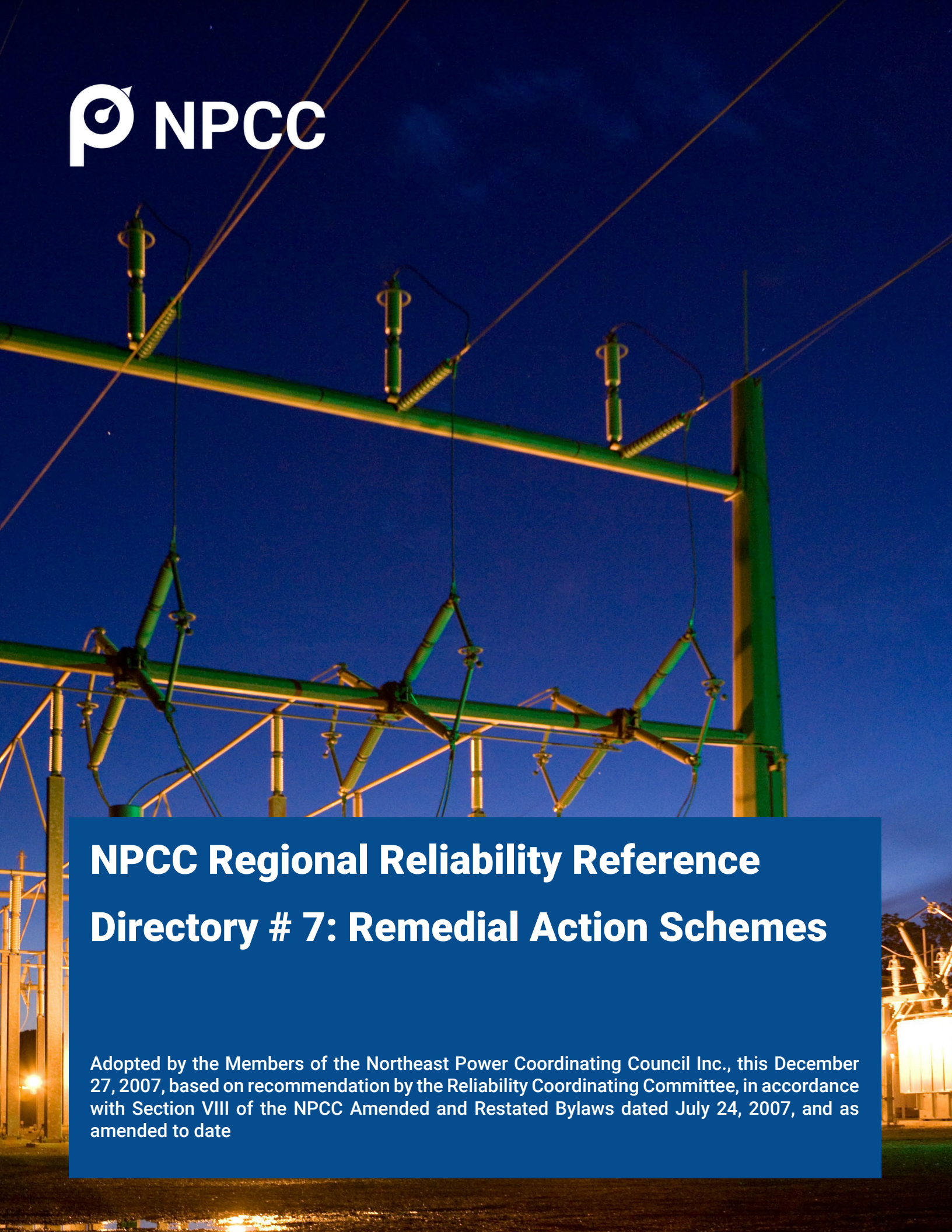

NPCC Regional Reliability Reference Directory # 7: Remedial Action Schemes

Adopted by the Members of the Northeast Power Coordinating Council Inc., this December 27, 2007, based on recommendation by the Reliability Coordinating Committee, in accordance with Section VIII of the NPCC Amended and Restated Bylaws dated July 24, 2007, and as amended to date

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1. Introduction

1.1 Title: ***Remedial Action Schemes***

1.2 Directory Number: 7

1.3 Objective

The term **Remedial Action Scheme (RAS)** and its definition has been adopted by NPCC in place of the term **Special Protection System (SPS)**. For existing documentation, the term **RAS** or **SPS** may be used.

1.4 Effective Date: December 27, 2007

1.5 Background

This Directory establishes the design criteria and review process for a **RAS**. The purpose of the NPCC process is to review the classification and design of a **RAS** according to the power system impact.

All NPCC documentation from the **RAS** review process will be available to the reviewing Reliability Coordinator(s), Planning Coordinator(s) and **RAS**-entity (ies) to meet Directory #7 requirements.

1.6 Applicability

NPCC adopts the NERC **RAS** definition and limited impact **RAS** description where any reference in the NERC **RAS** definition to BES is to be interpreted as **BES** plus **BPS**.

For the purposes of the **RAS** review process, the proposing entity is either the **RAS**-entity or an entity that represents the **RAS**-entity such as the Balancing Authority or Reliability Coordinator as mutually agreed upon, in the **RAS** review process.

Requirements to abide by an NPCC Directory may also reside in external tariff requirements, bilateral contracts and other agreements between facility owners and/or operators and their assigned Reliability Coordinator, Planning Coordinator, Transmission Operator, other Functional Entity and/or Transmission Owner as applicable and may be enforceable through those external tariff requirements, bilateral contracts and other agreements

1.6.1 Functional Entities (Responsible Entities)

- Reliability Coordinator
- Planning Coordinator

- **RAS**-entity: Transmission Owner, Generator Owner, or Distribution
- Provider that owns all or part of a **RAS**
- Other Functional Entities as appropriate

1.6.2 Facilities

1.6.2.1 New Facilities

Each new **RAS** will be submitted for review in accordance with Section 6.

1.6.2.2 Existing Facilities

It is the responsibility of **RAS**-entities to assess their existing **RAS** and to make modifications that are required to meet the intent of these more stringent NPCC criteria as follows:

1.6.2.2.1 Planned Modification or Replacement of RAS equipment to Existing Facilities

If a **RAS**-entity intends to functionally modify a **RAS**[1] or has plans to replace **RAS** equipment, it shall be submitted for review in accordance with Section 6.

If any **RAS** or sub-systems of these facilities are replaced as part of a modification to the facility and do not comply with all of these criteria, then an assessment shall be conducted for those criteria that are not met.

The review and acceptance for exceptions requested to the NPCC more stringent **RAS** criteria will be documented.

1.6.2.2.2 Reclassification of RAS

Any **RAS** that are identified as potentially requiring reclassification shall be submitted for review in accordance with Section 6.

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[1] A functional modification to a **RAS** is defined as any modification to a **RAS** consisting of any of the following: Changes to System conditions or Contingencies monitored by the **RAS** b) Changes to the actions the **RAS** is designed to initiate c) Changes to **RAS** hardware beyond in-kind replacement; i.e., match the original functionality of existing components d) Changes to **RAS** logic beyond correcting existing errors e) Changes to redundancy levels; i.e. addition or removal

For Type I **RAS**, where the **RAS**-entity has determined that the cost and risks involved to implement the more stringent NPCC criteria for physical separation, as per Section 5.12, cannot be justified, the reason for this determination and an assessment shall be reported to the Task Force on System Protection (TFSP). TFSP will review the exception request and approve or reject as per the **RAS** review process in Appendix C.

1.6.2.2.3 Unplanned In-kind Replacement of RAS Equipment

If a component of a **RAS** is replaced "in-kind" as a result of an un-planned event, then it is not required to upgrade the associated **RAS** to comply with these criteria. Reporting in accordance with the procedure stipulated in Appendix B of this Directory is not required.

1.6.3 Classification of a RAS

For application of NPCC criteria, **RAS** are sub-divided into three types.

Type I:

A **RAS**, other than a Limited Impact **RAS**, that recognizes or anticipates abnormal system conditions resulting from design or operating criteria **contingencies**.

Type II:

A **RAS**, other than a Limited Impact **RAS**, that recognizes or anticipates abnormal system conditions resulting from extreme **contingencies** or other extreme causes.

Limited Impact[2]:

A **RAS** that cannot, by inadvertent operation or failure to operate, cause or contribute to **BES** or **BPS** cascading, uncontrolled separation, angular instability, voltage instability, voltage collapse, or unacceptably damped oscillations.[3].

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[2] This classification was formerly known as Type III.

[3] Consistent with PRC-012 Supplemental Information, limited impact **RAS** is intended to act upon/mitigate events that are limited to a "contained area" (similar to "local area" within NPCC).

The criteria contained in Section 5 of this document are required for Type I and Type II **RAS** but are not required for a Limited Impact **RAS**. It should be recognized that a Limited Impact **RAS** may, due to system changes, be reclassified Type I or Type II.

2. Defined Terms

Unless specifically noted in this document, terms in bold typeface are defined in the NPCC Glossary of Terms. Unless specifically noted in this document, terms that are capitalized are defined in the NERC Glossary of Terms.

3. NERC ERO Reliability Standard Requirements

The NERC ERO Reliability Standards contain Requirements that are associated with this Directory include, but may not be limited to:

- **PRC-012:** Remedial Action Schemes
- **PRC-017:** Remedial Action Scheme Maintenance and Testing

4. NPCC Regional Reliability Standard Requirements

None.

5. NPCC Full Member More Stringent Criteria Requirements

These criteria are in addition to and more stringent than or more specific than NERC continent-wide reliability standards.

R5.1 General Criteria

A **RAS** shall be designed to recognize the specific power system conditions associated with its intended function.

Due consideration shall be given to dependability and security. The relative effect on the **BES** or **BPS** due to a failure of a **RAS** to operate when desired versus an unintended operation shall be weighed carefully in selecting design parameters as follows in Sections 5.2, 5.3, and 5.4

R5.2 Criteria for Dependability

To enhance dependability, a **RAS** shall be designed with redundancy such that the **RAS** is capable of performing its intended function while itself experiencing a single component failure.

- Multiple **RAS Groups** that are used to obtain redundancy within a **RAS** shall not share any of the same non-redundant components.

- If multiple **RAS Groups** share redundant component(s) in order to achieve improved reliability, the galvanic isolation and physical separation of the multiple **RAS Groups** shall not be compromised.

These criteria do not apply to Type II **RAS** unless identified as necessary by the Planning Coordinator and **RAS**-entity.

R5.3 Criteria for Security

A **RAS** [Type I or Type II] shall be designed to avoid cascading, uncontrolled separation, angular instability, voltage instability, voltage collapse, or unacceptably damped oscillations, due to unintended operation for any single component malfunction. The single component malfunction scenarios shall be jointly validated by the Planning Coordinator and the **RAS**-entity.

R5.4 Criteria for Dependability and Security

R5.4.1 The thermal capability of all **RAS** components shall be rated to withstand the maximum short time, long time and continuous loading of the associated **protected elements.**

R5.4.2 Position or state of control devices that can disable the **RAS** shall be monitored and annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions. These devices include but are not limited to communication cutoff switches, relay test mode switch, and protection scheme cutoff switches.

R5.4.3 When a Local Area Network (LAN) is used as part of the **RAS**, relay hardware, network paths, network hardware and merging unit shall be continuously monitored and annunciated for software failure, hardware failure and/or communication

failure. These conditions shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.4.4 **RAS** components with redundant power supplies within a single **RAS Group** shall be powered from the same DC battery system.

R5.4.5 Contact outputs used for tripping interrupting devices shall be properly rated to make and carry the DC current for the tripping circuits that they are applied to.

R5.4.6 **RAS** components with self-monitoring capability shall be annunciated. These conditions shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.5 Criteria for Operating Time and Arming

R5.5.1 A **RAS** shall be designed to take corrective action(s) within times determined by studies with due regard to security, dependability, and selectivity.

R5.5.2 A **RAS** shall be equipped with means to enable its arming and to independently verify its arming.

R5.5.3 Status of **RAS** arming shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.6 Current Transformer Criteria

Current transformers (CTs) associated with a **RAS** shall have adequate steady-state and transient characteristics for their intended function as follows:

R5.6.1 The output of each current transformer secondary winding shall be designed to remain within acceptable limits for the connected burdens under all anticipated currents, including **fault** currents, to ensure correct operation of the **RAS**.

R5.6.2 The thermal and mechanical capabilities of the current transformer at the operating tap shall be adequate to prevent damage under maximum **fault** conditions and normal or **emergency** system loading conditions.

R5.6.3 For **RAS Groups** to be independent, they shall be supplied from separate current transformer secondary windings. (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.6.4 Interconnected current transformer secondary wiring shall be grounded at only one point.

R5.7 Voltage Transformer and Potential Device Criteria

Voltage transformers and potential devices associated with a **RAS** shall have adequate steady-state and transient characteristics for their intended function as follows:

R5.7.1 Voltage transformers and potential devices shall have adequate volt-ampere capacity to supply the connected burden while maintaining their rated accuracy over their specified primary voltage range.

R5.7.2 If a **RAS** is designed to have multiple **RAS Groups** at a single location for redundancy, each of the **RAS Groups** shall be supplied from separate voltage sources. (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

The **RAS Groups** may be supplied from separate secondary windings on one transformer or potential device, provided all of the following criteria are met:

R5.7.2.1 Complete loss of that voltage transformer or potential device does not prevent both **RAS Groups** from performing the intended function;

R5.7.2.2 Each secondary winding has sufficient capacity to permit fuse protection of the circuit;

R5.7.2.3 Each secondary winding circuit is adequately fuse protected.

R5.7.3 The wiring from each voltage transformer secondary winding shall not be grounded at more than one point.

R5.8 Battery and Direct Current (DC) Supply Criteria

DC supplies associated with a **RAS** shall be designed to have a high degree of dependability as follows:

R5.8.1 If a **RAS** is designed to have multiple **RAS Groups** at a single location for redundancy, no single battery or DC power supply failure shall prevent both independent **RAS Groups** from performing the intended function. Each battery shall be provided with its own charger. Physical separation shall be maintained between the two station batteries or DC power supplies used to supply the independent **RAS Groups**. (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.8.2 Each battery shall have sufficient capacity to permit operation of a **RAS**, in the event of a loss of its battery charger or the ac supply source, for the period of time necessary to transfer the DC **load** to the other battery or re-establish the supply

source. Each station battery and its associated charger shall have sufficient capacity to supply the total DC load of the station.

R5.8.3 A transfer arrangement shall be provided to permit connecting the total DC load to either station battery without creating areas where, prior to failure of either a station battery or a charger, a single event can disable both DC supplies. (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.8.4 The battery chargers and all DC circuits shall be protected against short circuits. All protective devices shall be coordinated to minimize the number of DC circuits interrupted.

R5.8.5 Each DC supply shall be continuously monitored and independently annunciated to detect abnormal voltage levels (both high and low), DC grounds, and loss of ac to the battery chargers. These conditions shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.8.6 DC supply to the **RAS component** shall be continuously monitored to detect loss of voltage and be independently annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.9 Station Service AC Supply Criteria

If a **RAS** is designed to have multiple **RAS Groups** at a single location for redundancy, there shall be two sources of station service AC supply, each capable of carrying at least all the battery chargers associated with the **RAS**. (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.10 Circuit Breakers Criteria

R5.10.1 Where **RAS** redundancy is achieved by the use of independent **RAS** Groups tripping the same circuit breakers without over arming, which is defined as providing for more corrective action than would be necessary if no failures are considered, each circuit breaker shall be equipped with two independent trip coils. (This criterion does not apply to Type II **RAS**.)

R5.10.2 The design of a breaker with two trip coils shall be such that the breaker will operate if both trip coils are energized simultaneously. The relative polarity between the voltage applied to the two trip coils shall not affect proper breaker operation. The correct operation of this design shall be verified by tests and documented.

R5.10.3 Each trip coil shall be monitored in a fail-safe manner for continuity and presence of corresponding DC voltage and annunciated. These conditions shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions. (This criterion doesn't apply if over arming is used.)

R5.10.3.1 The design for trip coils monitoring shall not introduce a single point of failure in the trip circuits.

5.11 Teleprotection Criteria

R5.11.1 Communication facilities required for **teleprotection** shall be designed to have a level of performance consistent with that required of the **RAS**, and shall meet the following:

R5.11.1.1 Where the design of a **RAS** is composed of multiple **RAS Groups** for redundancy and each group requires a communication channel: (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.11.1.1.1 The equipment for each channel shall be separated physically on non-adjacent panels and designed to minimize the risk of more than one **RAS Group** being disabled simultaneously by a single event or condition. Except as identified otherwise in these criteria, the redundant communication channels shall not share the same **component**.

R5.11.1.1.2 The communication medium outside the substation/plant physical perimeter for each **RAS Group** shall be designed to minimize the risk of both **RAS Groups** being disabled simultaneously by a single event or condition. In addition, physical separation of the communication media outside the substation fence shall be three feet at a minimum.

R5.11.1.2 Teleprotection equipment shall be monitored to detect loss of equipment. These conditions shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.11.1.3 Teleprotection communication channels shall be designed with continuous monitoring and alarming for loss of function. For **teleprotection** communication channels that utilize ON/OFF signaling that cannot be continuously monitored, the design shall provide daily automated testing for the presence of the channel health and alarming for loss of function. These conditions shall be annunciated to a 24-hour Operations center so that operating personnel can respond and can initiate appropriate actions.

R5.11.1.4 Teleprotection equipment shall be provided with means to test for proper signal adequacy where provisions for automated testing are not provided.

R5.11.1.5 Teleprotection equipment shall be powered by the substation batteries or other sources independent from the power system.

R5.11.1.6 Except as identified otherwise in these criteria, the two **teleprotection** groups shall not share the same component. (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.11.1.6.1 The use of a single communication tower for radio communication systems used by the two **RAS Groups** of a **RAS** is permitted as long as diversity of the communication signals is achieved.

R5.11.1.6.2 Where telecommunication route diversity cannot be achieved, over arming of the appropriate **RAS** trip outputs is an acceptable mitigation.

R5.12 Environment (This Section does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.)

R5.12.1 Each **RAS Group** and **teleprotection** of the **RAS** shall be on non-adjacent vertical mounting assemblies or enclosures, except as noted in 5.12.6.

R5.12.2 RAS Group LAN devices for redundant **RAS Groups** shall be on different non-adjacent vertical mounting assemblies or enclosures, except as noted in 5.12.6.

R5.12.3 Wiring for each individual **RAS Group** and **teleprotection** of the **RAS** shall not be in the same cable or terminated in the same panel.

R5.12.4 The use of fiber optics for separate **RAS Groups** and **teleprotections** shall not result in a common mode failure.

R5.12.5 Cabling for separate **RAS Groups** and **teleprotections** shall be physically separated. This can be accomplished by using different raceways, trays, trenches, etc. Cable separation shall be achieved up to the breaker control cabinet or equipment control cabinet.

R5.12.5.1 In the event a common raceway is used, cabling for separate **RAS Groups** shall be separated by a non-flammable barrier.

R5.12.6 Electronic devices physically located outdoor in the substation yard that serve as components of separate **RAS Groups** shall be physically separated. This can be accomplished by separate enclosures, or by a non-flammable barrier.

R5.12.7 An electronic device that serves as a component of a **RAS Group**, and is physically located near the primary equipment and outside of the control house, may be subject to more severe environmental conditions than if it was located inside of a building. These environmental conditions may include extreme temperatures, corrosive atmosphere, and electromagnetic interference (EMI). Electronic device selection and secondary enclosure design ("cabinets") shall ensure that environmental conditions do not reduce **RAS Group** reliability and availability and that the electronic devices contained therein are not subject to the environmental conditions above the accepted limits specified by the IEEE or IEC. Any outdoor enclosure shall be rated appropriately for the most extreme local environmental condition.

R5.12.8 DC distribution panels used to supply **RAS Groups** shall be separated physically and non-adjacent.

R5.13 Grounding Criteria

Each **RAS** entity shall have established as part of its substation/plant design procedures or specifications, a mandatory method of designing the substation/plant ground grid, which:

R5.13.1 Can be traced to a recognized calculation methodology

R5.13.2 Considers cable shielding

R5.13.3 Considers equipment grounding

5.14 Provision for Breaker Failure Criteria

As required by the Planning Coordinator, Type I **RAS** shall include breaker failure protection for each circuit breaker whose operation is critical to the adequacy of the action taken by the **RAS** with due regard to the power system conditions this **RAS** is required to detect. The following are options for breaker failure protection:

R5.14.1 For non-redundant breaker failure protection, initiation by each **RAS** Group that trips the breaker, is required with the optional exception of a breaker failure protection for an adjacent breaker. Tripping both System 1 and System 2 trip coils of adjacent breakers is not required; however, if desired, specific design provisions shall be used to ensure a single point of failure of the trip circuits is not introduced.

R5.14.2 For redundant breaker failure protection, each breaker failure protection shall be initiated only by its respective **RAS Groups** that trip the breaker (i.e.: System 1 **RAS Group** initiates System 1 breaker failure).

R5.14.3 For redundant breaker failure protections, system 1 breaker failure protection shall only operate system 1 trip coil of the associated backup breakers needed to clear

the fault and system 2 breaker failure protection shall only operate system 2 trip coil of the associated backup breakers needed to clear the fault.

R5.14.4 A design that recognizes that the breaker has not achieved or will not achieve the intended function required by the **RAS** and that takes independent action to achieve that function. This provision needs not be duplicated and can be combined with conventional breaker failure schemes if appropriate.

> **R5.14.4.1** A series breaker or combination of multiple breakers can be an acceptable means of mitigating a failed circuit breaker, in lieu of breaker-failure protection.

R5.14.5 Overarming the **RAS** such that adequate action is taken even if a single breaker fails.

R5.14.6 The redundancy afforded by actions taken by other independent schemes or devices.

R5.14.7 Cascading breaker failure protection schemes shall not be permitted.

R5.15 Design to Facilitate Testing and Maintenance

R5.15.1 The design of a **RAS** both in terms of circuitry and physical arrangement shall facilitate periodic testing and maintenance.

R5.15.2 When a Local Area Network (LAN) is used as part of the **RAS Group**, the design shall provide the ability to isolate the operation of **RAS** components, while maintaining a network communication path to give personnel the ability to view **RAS** components response while under test.

R5.15.3 When a Local Area Network (LAN) is used as part of the **RAS**, the network architecture shall provide a dedicated and secure means for personnel to connect to the LAN for testing, troubleshooting and operational purposes.

R5.15.4 Test facilities or test procedures shall be designed such that they do not compromise the independence of the redundant design aspects of the **RAS** (This criterion does not apply to Type II **RAS** unless otherwise noted per criterion 5.2.).

R5.15.5 If a segmented testing approach is used, test procedures and test facilities shall be designed to ensure that related tests properly overlap. Proper overlap is ensured if each portion of circuitry is seen to perform its intended function, such as operating a **RAS** from either a real or test stimulus, while observing some common reliable downstream indicator.

R5.15.6 When a Local Area Network (LAN) is used as part of the **RAS**, network monitoring tools shall be deployed to facilitate troubleshooting/corrective maintenance.

R5.16 Design to Facilitate Analysis of RAS Performance

Event recording capability shall be provided to permit analysis of the **RAS** performance.

R5.17 Commissioning Testing

Each **RAS Group** shall be functionally tested to verify the dependability and security aspects of the design, when initially placed in service and when modifications are made.

6. RAS Review Requirements

R6.1 Each proposing entity, proposing to install a new **RAS**, to modify an existing **RAS**, or to retire an existing **RAS** shall submit documentation to TFCP as requested in Appendix B.

R6.1.1 For Type I and Type II, the proposing entity shall:

R6.1.2.1 Design each new or functionally modified **RAS** in accordance with Section 5 of this document.

R6.1.2.2 Submit to TFSP a statement that the **RAS** is designed according to the existing NPCC criteria with any requested criteria exceptions noted.

R6.1.2.3 Submit to TFSP the information requested in Appendix C.

R6.2 Each proposing entity planning to replace **RAS** equipment of an existing Type I or Type II **RAS** (without a functional modification to the **RAS**), shall submit documentation to TFSP as requested in Appendix B. The proposing entity shall:

R6.2.1 Design **RAS** in accordance with Section 5 of this document.

R6.2.2 Submit to TFSP a statement that the **RAS** is designed according to the existing NPCC criteria with any requested criteria exceptions noted.

R6.2.3 Submit to TFSP the information requested in Appendix C.

R6.3 At least once every five full calendar years, the Planning Coordinator shall:

R6.3.1 Perform an evaluation of each **RAS** within its planning area as part of its Area Transmission Review for the contingencies and conditions for which the **RAS** was designed to determine whether:

R6.3.1.1 The **RAS** mitigates the System condition(s) or **Contingency**(ies) for which it was designed.

R6.3.1.2 The **RAS** avoids adverse interactions with other **RAS**, and protection and control systems.

R6.3.1.3 For Limited Impact **RAS**, the inadvertent operation of the **RAS** or the failure of the **RAS** to operate does not cause or contribute to **BES** or **BPS** Cascading, uncontrolled separation, angular instability voltage instability, voltage collapse, or unacceptably damped oscillations.

R6.3.1.4 Except for Limited Impact **RAS**, the possible inadvertent operation of the **RAS**, resulting from any single **RAS** component malfunction satisfies all of the following:

R6.3.1.4.1 The **BES** and **BPS** shall remain stable.

R6.3.1.4.2 Cascading shall not occur.

R6.3.1.4.3 Applicable Facility Ratings shall not be exceeded.

R6.3.1.4.4 **BES** and **BPS** voltages shall be within post-**Contingency** voltage limits and post-**Contingency** voltage deviation limits as established by the Transmission Planner and the Planning Coordinator.

R6.3.1.4.5 Transient voltage responses shall be within acceptable limits as established by the Transmission Planner and the Planning Coordinator.

R6.3.1.5 Except for Limited Impact **RAS**, a single component failure in the **RAS**, when the **RAS** is intended to operate does not prevent the **BES** or **BPS** from meeting the same performance requirements as those required for the events and conditions for which the **RAS** is designed.

R6.3.2 Provide the results of the **RAS** evaluation including any identified deficiencies in the Area Transmission Review.

7. Compliance

7.1 Compliance Monitoring Process

Compliance with the requirements set forth in this Directory will be in accordance with the NPCC Criteria Compliance and Enforcement Program (CCEP).

NPCC will not enforce a duplicate sanction for the violation of any Directory#7 requirement that is also required for compliance with a NERC Reliability Standard.

Prepared by: Lead Task Force- Task Force on Coordination of Planning.

Review and Approval: Revision to any portion of this Directory will be posted by the lead Task Force in the NPCC Open Process for a 45-day review and comment period. Upon satisfactorily addressing all the comments in this forum, the Directory document will be sent to the remaining Task Forces for their recommendation to seek RCC approval.

Upon approval of the RCC, this Directory will be sent to the Full Member Representatives for their final approval if sections pertaining to the Requirements and Criteria portion have been revised. All voting and approvals will be conducted according to the most current "NPCC Bylaws" in effect at the time the ballots are cast.

Revisions pertaining to the Appendices or any other portion of the document such as Links, Glossary Terms, etc., will only require RCC Member approval of the document. Errata may be corrected by the Lead Task Force at any time and provide the appropriate notifications to the NPCC Inc. membership.

This Directory will be updated at least once every three years and as often as necessary to keep it current and consistent with NERC Regional Reliability Standards and other NPCC documents.

References:

- NPCC Glossary of Terms
- Directory #1: Design and Operation of the Bulk Power System
- Directory #2: Emergency Operations

Appendix A - Guidance for Consideration in Remedial Action Scheme Design

1.0 Introduction

This Appendix provides the guidance for consideration in the implementation of the **RAS** design criteria stipulated in Section 5 of this Directory.

2.0 Design Considerations

2.1 General Considerations

2.1.1 The general objective for any **RAS** is to perform its intended function (generator rejection, load rejection, etc.) in a dependable and secure manner. In this context, dependability relates to the degree of certainty that the **RAS** will operate correctly when required to operate. Security relates to the degree of certainty that the **RAS** will not operate when not required to operate.

2.1.2 The relative effects on the **BES** or **BPS** of a failure to operate when desired versus an unintended operation should be weighed carefully in selecting design parameters. For example, the choice of duplication as a means of providing redundancy improves the dependability of the **RAS** but can also jeopardize security in that it may increase the probability of an unintended operation. This general objective can be met only if the **RAS** can dependably respond to the specific conditions for which it is intended to operate and differentiate these from other conditions for which action must not take place.

2.1.3 Close coordination should be maintained among system planning, design, operating, maintenance, and **protection** functions, since both initially and throughout their life cycle, **RAS** are a multi-discipline concern.

2.1.4 Whenever changes are anticipated in generating sources, transmission facilities, or operating conditions, Generator Owners and Transmission Owners should review those **RAS** applications (i.e., settings, ac, and dc supplies) that can reasonably be expected to be impacted by those changes.

2.2 Issues Affecting Dependability

2.2.1 Dependability of a **RAS** can be provided by designing with redundancy. Redundancy is normally provided by duplication. Some aspects of duplication may be achieved by over arming, which is defined as providing for more corrective action than would be necessary if no failures are considered. The redundancy criteria for a **RAS** apply only with respect to its response to the conditions it is required to detect.

2.2.2 For a **RAS** that is composed of multiple **RAS Groups**, the risk of simultaneous failure of more than one **RAS Group** because of design deficiencies or equipment failure should be considered, particularly if identical equipment is used in each **RAS Group**. The extent and nature of these failures should be recognized in the design and operation of the **RAS**.

2.2.3 In addition to the separation criteria, areas of common exposure should be kept to a minimum to reduce the possibility of all groups being disabled by a single event such as fire, excavation, water leakage, and other such incidents.

2.3 Issues Affecting Security

2.3.1 A **RAS** should be designed to operate only for conditions that require its specific remedial actions.

2.4 Issues Affecting Dependability and Security

2.4.1 RAS should be no more complex than required for any given application.

2.4.2 The components and software used in **RAS** should be of proven quality, as demonstrated either by actual experience or by stringent tests under simulated operating conditions.

2.4.3 RAS should be designed to minimize the possibility of component failure or malfunction due to electrical transients and interference or external effects such as vibration, shock and temperature.

2.4.3.1 Digital relaying and control systems may also be subjected to other signal or noise interference events that may cause transients to be detected as a full contact closure by the protective relay digital input boards and/or cause contact outputs to erroneously conduct. The digital inputs/outputs associated with the protective relays should be designed or modified as necessary to reduce their sensitivity to voltages from transients, signal noise or high resistance contact bridging.

2.4.4 RAS, including **intelligent electronic devices (IEDs)** and communication systems used for **protection**, should comply with applicable industry standards for utility grade **protection** service. Utility Grade **Protection** System Equipments are equipment that are suitable for protecting transmission power system **elements**, that are required to operate reliably, under harsh environments normally found at substations. Utility grade equipment should meet the applicable sections of all or some of the recent versions of the following industry standards, to ensure their suitability for such applications:

- IEEE C37.90.1 (oscillatory surge and fast transient)
- IEEE C37.90.1 (service conditions)
- IEC 60255-22-1 (1 MHz burst, i.e. oscillatory)
- IEC 61000-4-12 (oscillatory surge)
- IEC 61000-4-4 (EFT)
- IEC 60255-22-4 (EFT)
- IEEE C37.90.2 (narrow-band radiation)
- IEC 60255-22-3 (narrow-band radiation)
- IEC 61000-4-3 (narrow-band radiation)
- IEEE 1613 (communications networking devices in Electric power Substations)

2.4.5 RAS circuitry and physical arrangements should be carefully designed so as to minimize the possibility of incorrect operations due to personnel error.

2.4.6 RAS automatic self-checking facilities should be designed so as to not degrade the performance of the **RAS**.

2.4.7 Consideration should be given to the consequences of loss of instrument transformer voltage inputs to **RAS**.

2.4.8 Consideration should be given to the effect of the means of arming on overall security and dependability of a **RAS**. Arming should have a level of security and dependability commensurate with the **RAS** Type.

2.5 Issues Affecting Performance

2.5.1 Control cables and wiring and ancillary control devices should be highly dependable and secure. Due consideration should be given to published codes and standards, fire hazards, current-carrying capacity, voltage drop, insulation level, mechanical strength, routing, shielding, grounding, and environment.

2.5.2 **RAS Group** performance should be evaluated under stressed communication network and failover conditions to ensure that protection coordination and performance is within the acceptable design limits.

2.5.3 Continuous streaming of sampled values may consume a large amount of LAN bandwidth. The network architecture should account for bandwidth-intensive applications and **RAS Group** response, as required by the performance requirements required for the events and conditions for which the **RAS** is designed, should not be impacted by increased traffic during any scenario.

2.5.4 Redundant communications within a **RAS Group** can significantly increase **RAS** availability and reliability.

2.5.5 Sampled values and Generic Object Oriented Substation Events (GOOSE) messages should have the highest priority among all traffic in the network and network interfaces of end-devices.

2.6 Operating Time of a RAS

Adequate time margin should be provided taking into account study inaccuracies, differences in equipment, and protection operating times.

- Network configurations that impact the delivery or latency of GOOSE messages in one **RAS Group** should not momentarily or permanently affect the delivery or latency of GOOSE messages in the redundant **RAS Group** for the same **element**, unless studies demonstrate that the total clearing time including momentary interruption is acceptable.
- The reception and processing of a GOOSE message is time critical, specifically during events and relaying operations. The use of GOOSE messages for **protection** should be configured (dataset priority, how messages are published, VLANS, network configuration, etc.) such that the maximum clearing times as specified by Planning Studies are met.

2.7 Arming of a RAS

Arming is the selection, which may be external to the **RAS**, of desired output action based on power system conditions and recognized contingencies. Arming of a **RAS** is normally based upon the results of system studies, which take into account recognized contingencies, operating policies/procedures, and current power system load/generation conditions. For a simple **RAS**, arming may be an on/off function. A **RAS** can be armed either automatically or manually.

2.7.1 Automatic arming is implemented without human intervention.

2.7.2 Manual arming requires human intervention. Sufficient time, with adequate margin for recognition, analysis, and the taking of corrective action, should be allowed.

2.8 Voltage Transformer and Potential Device

2.8.1 Voltage transformer installations should be designed with due regard to ferroresonance.

2.8.2 Special attention should be given to the physical properties (e.g. resistance to corrosion, moisture, fatigue) of the fuses used in **RAS** voltage circuits.

2.8.3 Relay systems utilizing capacitive voltage transformers should be designed with due regard for transient response.

2.9 RAS Communication

2.9.1 RAS communication systems should be designed to prevent unwanted operations such as those caused by equipment or personnel.

2.9.2 Two identical communication equipment models should not be used in independent **RAS Groups**, due to the risk of simultaneous failure of both **RAS Groups** because of design deficiencies or equipment problems.

2.9.3 Areas of common exposure should be kept to a minimum to reduce the possibility of both **RAS Groups** being disabled by a single event such as fire, excavation, water leakage, and other such incidents.

2.9.4 Communication systems should be designed to mitigate the effects of signal interference from other communication sources and to assure adequate signal transmission during power system disturbances.

2.9.5 The directional diversity for microwave signals for the two independent **RAS Groups** operating for the same condition should be designed to establish an angle difference of at least 60 degrees between the two communication paths. This is to minimize the possibility of a storm cell preventing transmission of both communication channels.

2.10 Grounding

Station grounding is critical to the correct operation of a **RAS**. The design of the ground grid directly impacts proper **RAS** operation and probability of false operation from **fault** currents or transient voltages.

2.11 Battery and Direct Current (DC) Supply

2.11.1 The circuitry between each battery and its first protective device cannot be protected and therefore should be designed so as to minimize the possibility of electrical short circuit.

2.11.2 The design for the regulation of the DC voltage should be such that, under all anticipated charging and loading conditions, voltage within acceptable limits will be supplied to all devices, while minimizing AC ripple and voltage transients.

2.12 Commissioning Testing

2.12.1 Firmware upgrades, automation software updates shall be tested and documented in a controlled, off-line environment prior to being placed into service to determine if there are any adverse impacts that could prevent proper **RAS** system operation. Reference IEEE C37.231

2.12.2 Pre-commissioning testing specific to the entity's design shall be performed to ensure interoperability of IEC 61850 devices. The fact that an **Intelligent Electronic Device (IED)** has a conformance certificate will not guarantee it will inter-operate with other conformance certified IEDs in the same substations.

2.13 RAS System Testing and Maintenance

2.13.1 Test facilities and test procedures should be designed such that they do not compromise the independence of **RAS Groups** operating for the same system condition. Test devices or switches should be used to eliminate the necessity for removing or disconnecting wires during testing.

2.13.2 The configuration of IEC 61850 **RAS** system should remain as simple as possible to minimize the risks associated with test and maintenance.

2.13.3 All GOOSE messages should contain information to uniquely identify its publishing device. GOOSE message identifiers should provide descriptive nomenclature to aid maintenance and troubleshooting activities.

2.13.4 While segmented testing of a **RAS** is acceptable for some commissioning tests, end-to-end testing should be considered to ensure that all interfacing protections perform as designed under dynamic conditions.

2.14 Analysis of RAS

Insofar as possible, each active function within a **RAS** should be included in sequence of events information.

2.15 Logic System

2.15.1 The design should recognize the effects of contact races, spurious operation due to battery grounds, dc transients, radio frequency interference or other such influences.

2.15.2 It is recognized that timing is often critical in logic schemes. Operating times of different devices vary. Known timing differences should be accounted for in the overall design.

2.16 Microprocessor-Based Equipment and Software

A **RAS** may incorporate microprocessor-based equipment. Information from this equipment may support other functions such as **power** system operations. In such cases, the software and the interface should be designed so as to not degrade the **RAS** functions.

2.17 Control Cable, Wiring and Ancillary Control Devices

Control cables and wiring and ancillary control devices should be highly dependable and secure. Due consideration should be given to published codes and standards, fire hazards, current-carrying capacity, voltage drop, insulation level, mechanical strength, routing, shielding, grounding and environment.

Appendix B - Procedure for the Review of a Remedial Action Scheme

1.0 Introduction

1.1 This Appendix provides the procedure to obtain agreement from NPCC if an entity proposes a new **RAS**, or the modification of or the retirement of a **RAS**.

1.2 The proposing entity should allow sufficient lead time in order to accomplish all the steps in the processes outlined herein to meet their desired timelines. The processes are also shown in the attached flow charts.

1.3 The following NPCC groups are involved in the review and approval process of the **RAS**:

- Task Force on Coordination of Operations (TFCO)
- Task Force on Coordination of Planning (TFCP)
- Task Force on System Protection (TFSP)
- Task Force on System Studies (TFSS)

In general, a proposing entity would request NPCC review of a proposed new **RAS**, or modification to a **RAS**, or retirement of an existing **RAS**. Depending on the entity's proposal, the review process would require reviews from various Task Forces. Each Task Force shall act on the information submitted by the proposing entity at its next scheduled meeting following receipt of the submittal.

The following table provides a summary of entity's proposed **RAS** and the required review from the various Task Forces.

Entity's Proposal	**TFCO**	**TFCP**	**TFSP**	**TFSS**
1. New Limited Impact **RAS** or functional modification to an existing Limited Impact **RAS**		✓		✓
2. New Type I or Type II **RAS** or functional modification to an existing Type I or Type II **RAS**	✓	✓	✓	✓
3. Reclassification of a **RAS** to a Type I or Type II **RAS**	✓	✓	✓	✓
4. Reclassification of a Type I or Type II **RAS** to a Limited Impact **RAS**		✓		✓

5.Planned replacement of **RAS** equipment for a Type I or Type II **RAS** (no functional modification)			✓	
6. Retirement of a Type I or Type II **RAS**		✓		✓
7. Retirement of a Limited Impact **RAS**		✓		

2.0 Review and Approval of a proposed new or functionally modified RAS

2.1 Documentation for the review and approval of a proposed new or functionally modified **RAS** should include:

2.1.1 The need and location for the **RAS**. For modification of an existing **RAS**, the current Type, the reason for the change and a descriptive statement of the modification.

2.1.2 The proposed **RAS** Type as defined in Section 1.6.3 of this document and the technical analysis showing that the proposed **RAS** addresses the Contingency(ies) for which the **RAS** is designed to operate and the consequences or impact when the **RAS** fails to operate or when it operates unintentionally.

2.2 For the purpose of this Appendix, a functional modification includes any of the following:

2.2.1 Re-classification of the **RAS** Type

2.2.1.1 A modification that involves the re-classification of the Type for an existing **RAS** is a change to its original functionality such that the results of previous analysis or the study, which was used for the classification of that **RAS**, is no longer representative of the consequences of the **RAS**'s proper operation, its failure to operate, or its unintended operation.

2.2.2 Changes to System conditions or contingencies monitored by the **RAS**

2.2.3 Changes to the actions the **RAS** is designed to initiate

2.2.4 Changes to **RAS** hardware beyond in-kind replacement

2.2.5 Changes to **RAS** logic beyond correcting existing errors or minor modification

2.2.6 Changes to redundancy levels, i.e., addition or removal

2.3 TFCP shall forward the documentation from the proposing entity to TFSS to review and confirm the proposed **RAS** Type.

TFSS shall confirm the proposed **RAS** Type by reviewing the analysis that the proposing entity has provided to determine the consequences of either a failure of the **RAS** to operate when and how it is required, or an inadvertent or unintended operation of the **RAS**. As part of this review, TFSS shall also consider the interaction of the proposed **RAS** with other **RAS** or protection schemes. If necessary, TFSS shall request additional studies.

TFSS shall forward a summary of its findings confirming the Type of the **RAS** to TFCP.

2.4 Proposed New or the Modification of a Type I or Type II **RAS**.

2.4.1 TFCP shall forward the documentation from the proposing entity and the TFSS findings to TFSP and TFCO.

2.4.2 TFSP shall review the information submitted in accordance with Section 6.1.1 and confirm whether the new or modified **RAS** is in conformance with the requirements in Section 5 of NPCC Regional Reliability Reference Directory #7 "Remedial Action Schemes."

TFSP shall forward a summary of its findings to TFCP.

2.4.3 TFCO shall review the operability of the **RAS** and shall assess its impact to operations if the **RAS** were to operate incorrectly or fail to operate, and any potential for unintended interaction with other **RAS**. TFCO shall provide a summary of its conclusions together with a statement accepting or rejecting the proposed installation of the new **RAS** or the modification of the existing **RAS**. TFCO shall include a statement that the new **RAS** or the modification of an existing **RAS** conforms to system operating requirements with respect to Table 3 of the NPCC Regional Reliability Reference Directory #1 "Design and Operation of the Bulk Power System."

TFCO shall forward a summary of its findings to TFCP.

2.4.4 TFCP shall review the technical analysis of the system performance with the proposed new or modified **RAS** demonstrating conformance with transmission planning requirements with respect to Table 1 and Table 2 in NPCC Regional Reliability Reference Directory #1 "Design and Operation of the Bulk Power System." TFCP may request the proposing entity to provide further clarification or additional information.

2.4.5 TFCP shall review the **RAS** proposal in light of all Task Forces reviews and agree with or reject the proposal or remand the **RAS** back to the proposing entity with a recommendation of further action or the need for clarification or for additional information.

2.4.6 TFCP shall prepare a summary report informing RCC of its conclusion.

2.4.7 TFCP shall notify all the Task Forces and the proposing entity of the outcome of the review.

2.4.8 The **RAS** cannot be deployed without TFCP agreement.

2.4.9 TFSS shall update the NPCC **RAS** list/database at the next periodic update.

2.5 Proposed New or Modification to a Limited Impact **RAS**

2.5.1 After review of TFSS's finding and the technical analysis of the **RAS** proposal on the system performance demonstrating conformance with transmission planning requirements with respect to Table 1and Table 2 in NPCC Regional Reliability Reference Directory #1 "Design and Operation of the Bulk Power System," TFCP shall agree with or reject the proposal, or remand the **RAS** back to the proposing entity with a recommendation of further action or the need for clarification or for additional information.

2.5.2 TFCP shall prepare a summary report informing RCC of its conclusion.

2.5.3 TFCP shall notify all the Task Forces and the proposing entity of the outcome of the review.

2.5.4 The **RAS** cannot be deployed without TFCP agreement.

2.5.5 TFSS shall update the NPCC **RAS** list/database at the next periodic update.

3.0 Retirement of a Type I or Type II RAS

3.1 The proposing entity shall notify the TFCP Chairman and Secretary of the intention to retire an existing Type I or Type II **RAS**. The notification shall include technical justification and analysis report.

3.2 TFCP shall forward the analysis report to TFSS for its review. TFCP will also review the analysis that the proposing entity has performed to determine the consequences of the removal of the **RAS** and if the **BES** and **BPS** meet performance requirements. TFSS shall forward a summary of their findings or concerns to TFCP.

3.3 TFCP may request the proposing entity to provide further clarification.

3.4 TFCP shall agree with or reject the proposal or remand the **RAS** back to the proposing entity with a recommendation of further action or the need for clarification or for additional information.

3.5 TFCP shall inform all the Task Forces, the RCC, and the proposing entity of the outcome of the review.

3.6 The **RAS** cannot be retired without TFCP agreement.

3.7 TFSS shall update the NPCC **RAS** list/database at the next periodic update with a notation "to be retired" and the entry for the **RAS** shall be removed when it is actually retired.

4.0 Retirement of a Limited Impact RAS

4.1 The proposing entity shall notify TFCP of the proposed retirement and provide the technical justification, after which the limited impact **RAS** may be retired. A formal agreement is not required.

4.2 TFCP shall inform all the Task Forces and the RCC of the **RAS** retirement.

4.3 TFSS shall update the NPCC **RAS** list/database at the next periodic update.

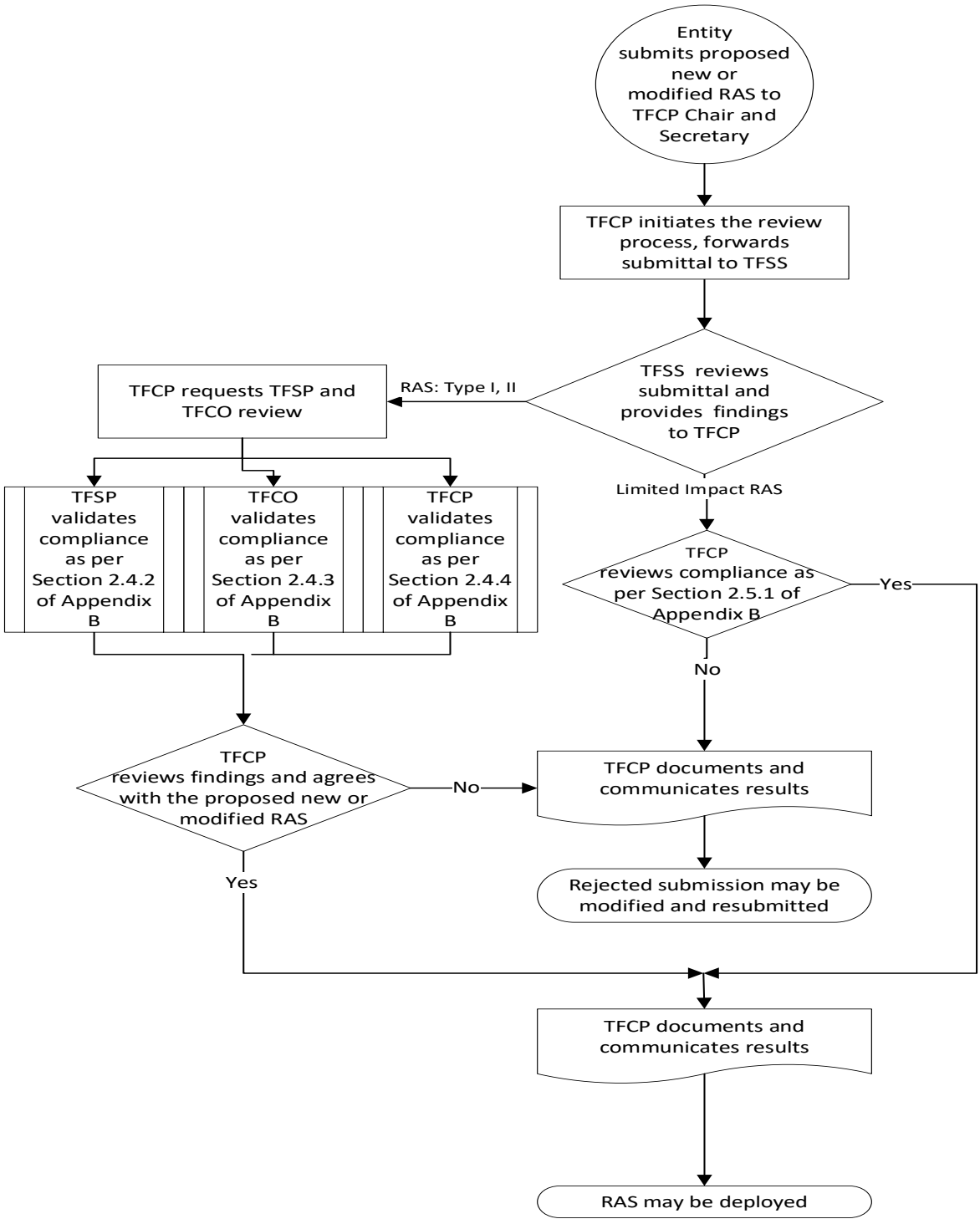
5.0 Review and Approval of proposed planned replacement of RAS equipment for a Type I or Type II RAS (no functional modification)

5.1 The proposing entity shall notify the TFSP Chair and Secretary of its intention to propose a planned replacement of **RAS** equipment and submit information to TFSP in accordance with Section 6.2 and Appendix C.

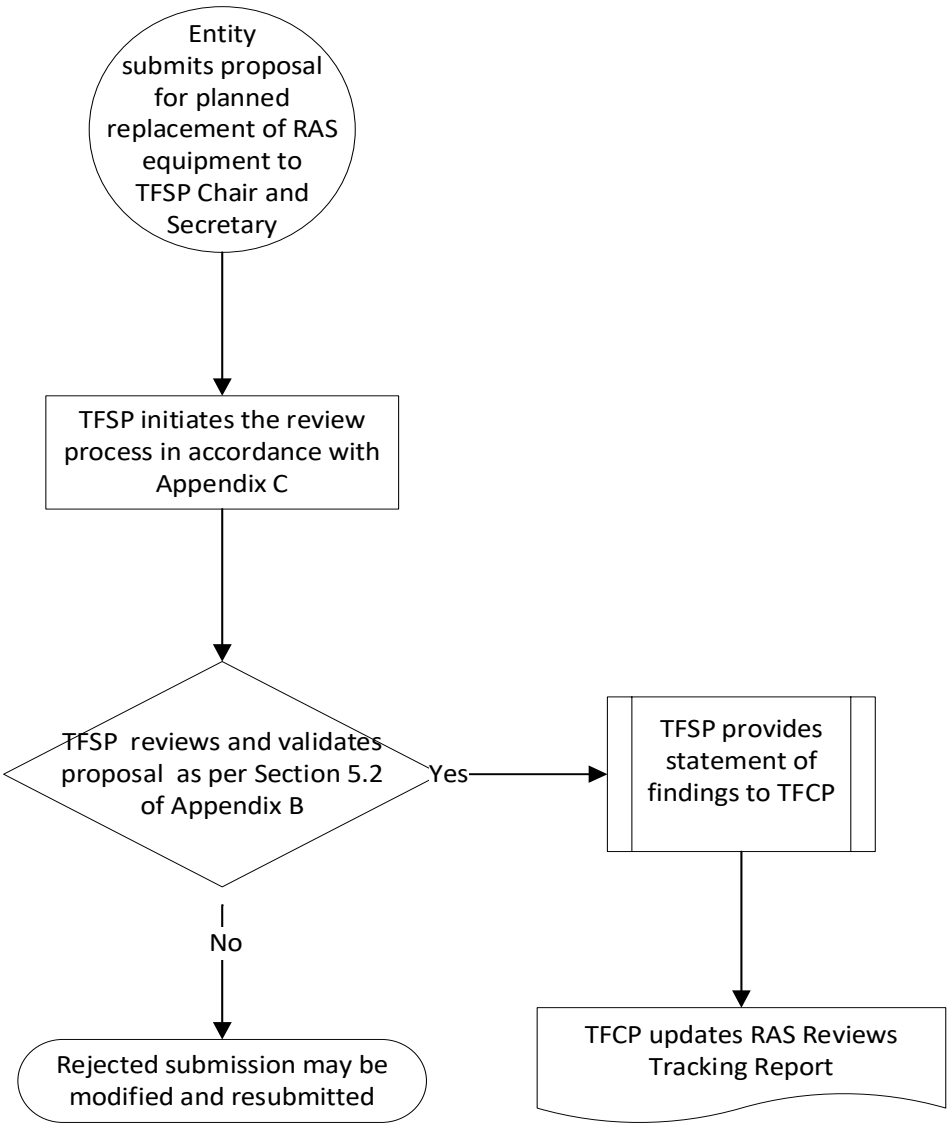
5.2 TFSP shall review and confirm whether the planned replacement of **RAS** equipment is in conformance with the requirements in Section 5 of NPCC Regional Reliability Reference Directory #7 "Remedial Action Schemes."

5.3 TFSP shall forward a summary of its findings to TFCP for information and **RAS** reviews tracking report.

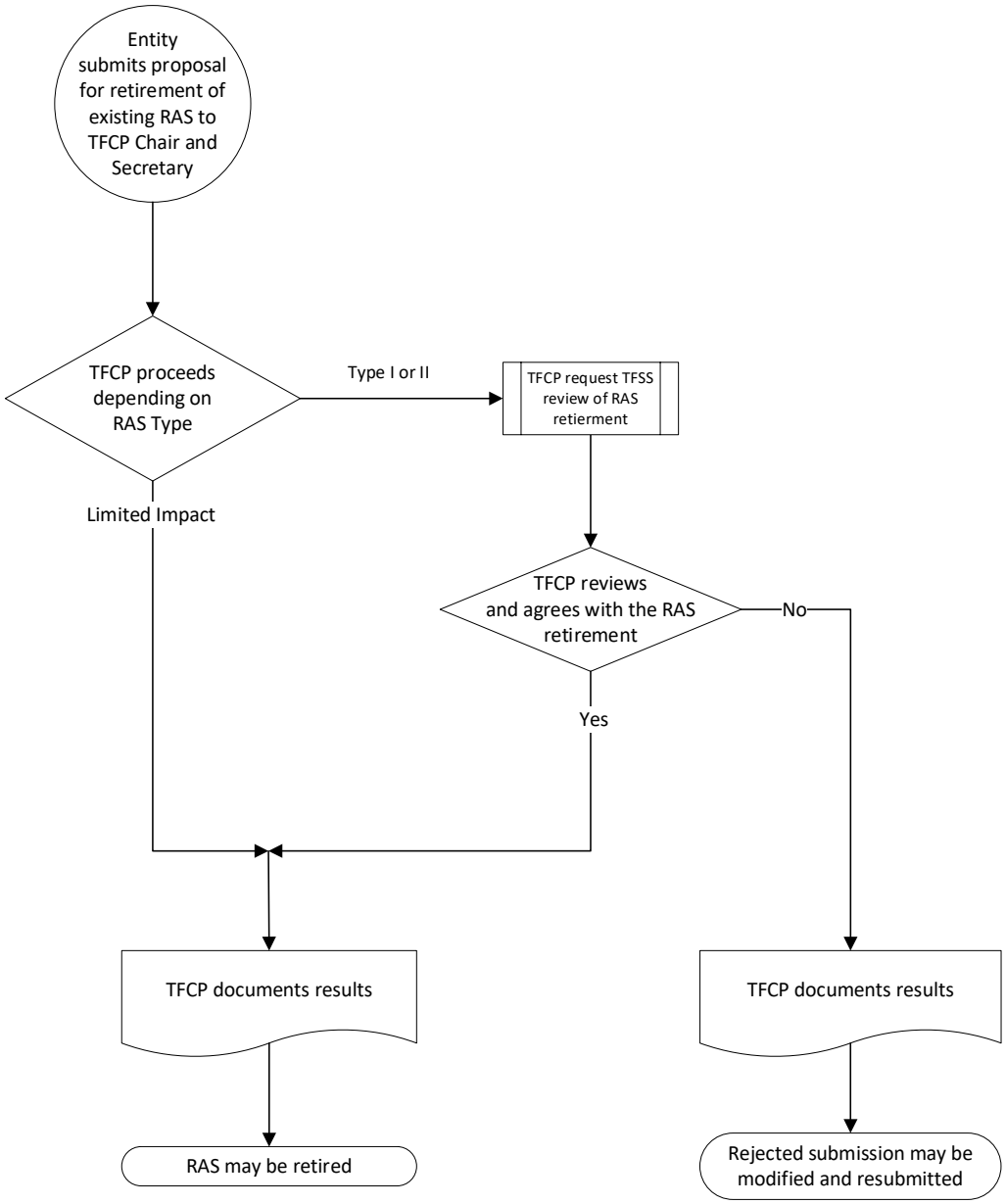
FLOW CHART
FOR THE REVIEW OF NEW RAS OR THE MODIFICATION OF AN EXISTING RAS



FLOW CHART FOR PLANNED REPLACEMENT OF RAS EQUIPMENT (NO FUNCTIONAL MODIFICATION)



FLOW CHART FOR THE RETIREMENT OF A RAS



Appendix C – Procedure for Reporting to TFSP New and Modified Remedial Action Scheme

1.0 Introduction

In accordance with the applicable facilities described in Section 1.6.2 of this Directory, proposing entity should provide the Task Force on Coordination of Planning (TFCP) with advance notification of any of its new **Remedial Action Scheme (RAS)** facilities, significant equipment changes or functional modification in its existing **RAS** facilities. TFCP will forward the request to review the design to TFSP. (With respect to replacement of **RAS** equipment without a functional modification to an existing Type I or Type II **RAS** facility, the proposing entity should notify TFSP directly.) Notification should be made to the TFSP early in the engineering design stage, prior to submitting the information specified in Section 6.1.

2.0 Presentation and Review of RAS

Each new or modified Type I or Type II **RAS** shall be reported to the Task Force on System Protection. A presentation will be made to the TFSP on new **RAS** or a modification to an existing **RAS**.

3.0 Data Required for Presentation and Review

The **RAS**-entity will advise the TFSP of the basic design of the proposed system. The data will be supplied on the "Protection System Review Form" as listed below accompanied by a geographical map, a one-line diagram of all facilities included in the project, and the associated **RAS** function diagrams. A physical layout of the **RAS** control panels, cable tray, yard trench, and batteries for the purpose of illustrating physical separation will also be included.

- Remedial Action Scheme
- Communication links
- Equipment Details
- Current Transformers
- Voltage Transformers
- Station Battery
- Physical Separation
- Breakers
- Disturbance Monitoring Equipment
- Exception Request

3.1 The proposed **RAS** will be explained with due emphasis on any special conditions or design restrictions existing on the particular power system.

4.0 Procedure for Presentation

4.1 The **RAS**-entity will arrange to have a technical presentation made to the TFSP.

4.2 To facilitate scheduling, the chairman of the TFSP will be notified approximately two months prior to the desired date of presentation.

4.3 Copies of materials to be presented will be distributed to TFSP members 30 days prior to the date of the presentation.

5.0 Review by TFSP

The TFSP will review the material presented and develop a response concerning the proposed **RAS**. This statement will indicate one of the following:

5.1 The need for additional information to enable the TFSP to reach a decision.

5.2 Acceptance of the submitted proposal including the **RAS**-entity's statement of conformance to the Directory #7 criteria.

5.3 *Conditional acceptance of the submitted proposal.

5.4 *Rejection of the submitted proposal

* Response to include an indication of areas of departure from the intent of the Directory #7 criteria and suggestions for modifications to bring the **RAS** into conformance with the NPCC criteria.

5.5 The results of the TFSP review will be documented in the following manner.

- A response will be included in the minutes of the meeting at which the proposed **RAS** was reviewed.
- An acceptance letter or a letter outlining areas of non-conformance with the NPCC Directory #7 criteria and recommendations for correction will be submitted to the Chairperson of TFCP and the **RAS**-entity.
- The Task Force will maintain a record of all the reviews it has conducted.

7. Review Record

Task Force on Coordination of Planning Revision Review Record
December 27, 2007
July 9, 2013
December 22, 2020
October 23, 2025

8. Version History

Version	Date	Action	Change Tracking (New, Errata or Revisions)
0	12/27/07	Effective Date	New
1	7/09/13	TFSP review: ensure consistency w/D#4; add Compliance Requirements; retire /modify SPS.	Revisions
2	12/22/20	All Task Force review to establish a single review process to cover the requirements for both D7 and PRC-012 for review and approval of a RAS (formerly known as SPSs)	Revisions
3	1/19/21	Section # 3 List of Associated NERC Standards Updated.	Revisions
4	10/04/2023	RAS Review Form Added to Appendix B	Revisions
5	10/23/2025	Triennial TFCP Review	Revisions

NPCC is dedicated to the continued reliability of the Bulk Power System in Northeastern North America.

NPCC

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