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Managing Water in the West

Facilities Instructions, Standards, and Techniques
Volume 6-4

Protection System Coordination Management



U.S. Department of the Interior
Bureau of Reclamation
Denver, Colorado

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**Facilities Instructions, Standards, and Techniques
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Protection System Coordination Management

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Preface

This document presents instructions for managing and coordinating protection systems applied at Bureau of Reclamation power facilities operated and maintained by Reclamation staff. These instructions provide criteria and procedures that should be utilized by the various offices involved in managing protection systems. These instructions are intended to promote uniformity in the manner that protection systems are managed, documented, and coordinated. This document was developed with input from staff in Reclamation's Denver, regional, and area offices.

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1.0 Introduction

The Bureau of Reclamation relies on protection system devices to sense abnormal or potentially dangerous conditions in its power facilities. These devices, which include protective relays, fuses, thermal, pressure, and level devices, etc., operate individually or in unison with other devices to isolate the specific areas or equipment where an abnormal condition or threshold is detected. To ensure that the isolation is proper and effective, these protection system devices need to be coordinated.

Reclamation requires protection system coordination for all power facilities. Protection systems applied to Reclamation power facilities may provide either primary or backup protection for protection systems of outside entity's facilities. In many situations, where Reclamation's protection systems device zone of protection overlaps with outside entities zone of protection, the two zones must also be coordinated.

This Facilities Instructions, Standards, and Techniques (FIST) is grounded on the principle that regional offices or operating offices, through delegation of authority and assignments, are ultimately responsible for the proper operation of the equipment in their area and for ensuring the protection system settings for the existing protective devices are properly documented. Regional or operating offices, as designated, must authorize and be involved in any change in the protective system configuration, settings, or operation. Technical information used in determining the need for altering the zone of protection for a specific protection system element is not included in this document.

As described in Reclamation Manual Directive and Standard FAC P14, *Power Operations and Maintenance (O&M) Technical Standards*, mandatory FIST procedures, practices, and schedules that appear in red or black, bold and bracketed text are considered Reclamation requirements for the operation and maintenance of equipment in power facilities:

- Mandatory **{red, bold, and bracketed}** text delineates required operations and maintenance requirements that Reclamation has determined should be consistent among all power facilities.
 - A senior executive (generally the Regional Director) may request a deviation from the requirements in **{red, bold, and bracketed}** text by submitting a waiver in accordance with Reclamation Manual Directive and Standard RCD 03-03, *Request for Waiver from a Reclamation Manual Requirement and Approval or Disapproval of the Request*.

- Mandatory [**black, bold, and bracketed**] text also delineates required power operation and maintenance activities.
 - An employee may request a deviation from requirements in [**black, bold, and bracketed**] text through the regional chain of command by submitting a Variance Form (POM-300).

1.1 Scope and Purpose

This document establishes Reclamation's standard practice on the management of protective systems maintained by Reclamation staff, which includes protective system devices, settings, and coordination from initiating events (such as installation of new devices, replacement of existing devices, changes in protection settings, etc.) through completion, including approval and finalization of documentation being uploaded into a centralized database.

This document also provides guidance and requirements of when protective devices and protection system settings are to be coordinated between interconnected entities, approved and documented from initiating events (such as, but not limited to the results of studies, evaluation of device operations, for installation of new devices or relays, replacement of existing devices or relays, changes in protection design, etc.) through completion, including peer review, approval, and finalization of records and documentation uploaded into a centralized database.

1.1.1 Implementation

The implementation of this FIST will be in two parts.

1. Any Reclamation Relay Database (RRD) documentation related to protection systems other than the relay settings will be implemented when the elements in those systems are modified, replaced, reviewed, or evaluated.
2. All other requirements including the RRD relay settings requirement that is in red, bold font in Section 2.1 and Section 3.2 will be implemented within one year after date of publication of this FIST manual.

1.1.2 Historical Practices

Reclamation has relied historically on a combination of the Technical Services Center (TSC) Infrastructure Services Division or regional staff to develop settings and document relay protection. Generally, technical coordination with outside entities has been performed on a case-by-case basis and setting documentation has been maintained by the technical staff performing the technical work. However,

documentation and setting changes have not been maintained in an accessible manner.

In the mid-1990s, the Power Resources Office (PRO) funded the TSC to create a Reclamation-wide database to store information related to all relay devices and settings for the purpose of improving the response time of the TSC in emergency conditions for those regions utilizing the TSC for protection system settings. The scope of the database was expanded, and in 2005 it was made available to Reclamation employees through an intranet-based interface. In addition, the database was renamed the RRD, and an effort was made across Reclamation to update the RRD with installed field settings by those regions that utilize TSC for protection system management. The RRD software and login is now available to any user through a Remote Desktop service that provides the same capability to any user connected to Reclamation's network.

Reclamation's goal is to utilize the RRD system database to document all main power train and station service protective devices and settings for protection system elements (i.e., a Reclamation inventory and equipment history).

1.2 Definitions

1.2.1 Interconnected Utility

An interconnected utility is an entity that has facilities which are physically connected to facilities Reclamation directly operates and maintains that share, receive, or transmit electrical energy and with staff whom Reclamation's protection system staff must coordinate protection systems.

1.2.2 Manager

A manager is the individual that has been delegated authority or assigned the responsibility for the proper operation and maintenance of the respective facility or equipment.

1.2.3 Protection System

A protection system is any combination of protection system elements, irrespective of ownership, that measure or analyze physical or electrical properties to detect abnormal or dangerous conditions which could damage equipment or property and cause the operational status of the equipment to change; including the communication paths or circuitry between devices to the degree that adjustments to the path or circuitry can alter the operational status of the equipment.

1.2.4 Protection System Change Approval

The protection system change approval is a process used to formalize and document the approval or disapproval of protection system changes, based on the results of the protection system evaluation. A documented reason or justification is required if protective system changes are not approved.

1.2.5 Protection System Coordination Management

The process utilized to manage, document, and exchange information associated with the operation of Reclamation protection systems elements.

1.2.6 Protection System Elements

A protection system element is any device (physical or logical) which measures or analyzes physical or electrical properties to detect abnormal or dangerous conditions which could damage equipment or property and causes the operational status of the equipment to change; including the communication paths or circuitry between devices to the degree that adjustments to the path or circuitry can alter the operational status of the equipment.

This also includes any adjustable device which can be used to electrically supervise the status of a device used to detect abnormal or dangerous conditions which could damage equipment or property and initiate isolating actions. Examples of such devices are those listed under the Institute of Electrical and Electronics Engineers device designation (see FIST 3-8, *Operation, Maintenance, and Field Test Procedures for Protective Relays and Associated Circuits*, Appendix B) as well as timers, speed switches (including those performed electronically), pressure switches, flow switches, temperature emulators, and position switches.

1.2.7 Protection System Evaluation

Protection system evaluation is a technical assessment of the adequacy of the equipment associated with a protection system to function properly, in order to reduce the extent and duration of an interruption or outage as well as reduce potential equipment damage or personal injury. This can include design studies, fault analysis studies, review of relay settings, load studies, reviews of equipment ratings and equipment misoperations, and/or any testing, review of information or study performed and the resulting proposals, recommendations, or conclusions to ensure the appropriate equipment, device, relay, etc., is correctly applied and properly coordinated to provide the required protection.

Additionally the protection system evaluation includes an assessment of whether or not technical coordination with a non-Reclamation entity is needed.

1.2.8 Protection System Evaluation Documentation

This documentation includes all information associated with the setting of a protection system element. This includes evidence of informal interconnected utility technical communication, proposed changes, basis for settings, analysis, peer review analysis and concurrence, manager approvals, evidence of implementation of required settings and changes, and formal documentation of interconnected utility correspondence.

1.2.9 Protection System Evaluation Peer Review

An independent review of the documentation resulting from a protection system evaluation to ensure the technical accuracy and completeness of the evaluation results, ensure the information is properly documented, and if coordination with a non-Reclamation entity is needed that the coordination information is documented.

1.2.10 Protection System Evaluation Peer Reviewer

The protection system evaluation peer reviewer is an individual or individuals identified by the manager as having the proper credentials and capability of performing the protection system peer review. A manager may also determine that a contractor has the proper credentials for performing the service, if there is adequate quality control.

Performing peer review of protection systems electrical schemes is essential to the protection of the power system and powerplant and switchyard equipment. Technically sound electrical and mechanical protection devices in the plant and switchyard must be configured to provide maximum protection without unnecessary tripping. The goal of technically sound protection is maximum personnel safety and reliability, availability, and stability of the power system.

1.2.11 Protection System Settings

The point at which a device (or devices) measures or analyzes physical or electrical properties, and the value or point at which the device (or devices) operates to isolate the abnormal or dangerous conditions to limit equipment or property damage. Protection system settings also determine the purpose and capability of a protective device through logic equations, timers, contact assignments, settable bits, taps, dials, etc. This includes all user-programmable information that defines a protective device or element.

1.2.12 Protection System Staff

Staff assigned the duties for performing protection system or protection system element evaluation, developing protection system settings, protection system

technical coordination, or review. It is at the discretion of the manager of that organization to ensure the proper credentials and capability of the staff performing the tasks in this definition. The manager may also determine that a contractor has the proper credentials for performing the service and there is adequate quality control.

1.2.13 Protection System Technical Coordination

The engineering process utilized to derive or evaluate the basis of settings for protection systems elements that interact with other protection systems and protection system elements, including protection system elements of interconnected utilities, to achieve the optimal amount of protection system action.

1.2.14 Reclamation Relay Database

The RRD, which utilizes the Aspen Relay Database Web Extension, is a Reclamation application for a centralized database for all protection system elements owned and operated by Reclamation. The application is administered by the TSC in Denver. The data is managed by the respective organizations, area offices, or specific offices as determined by those respective regions.

2.0 Documentation

2.1 Protection System Elements Documentation

[All protection system elements must be supported with the protection system evaluation documentation.] **{This includes relay settings or proposed setting changes}**, [basis for settings, analysis, peer review analysis and concurrence, manager approval, evidence of implementation of required settings and changes, and formal documentation of interconnected utility correspondence.]

2.2 Communications Requiring Documentation

{Reclamation protection system staff will retain documentation of protection system technical coordination with the interconnected utility for new protective systems, and changes to protective systems.} There are two times during the communication with the interconnected utility where protection system coordination needs to be documented:

1. Document during the informal technical discussions with the interconnected utility protection system staff, when the proposed settings are discussed.

2. Document after the settings have been implemented through formal memorandum. The informal technical discussions are when the development, configuration, determination of settings, review, and protection system design generally occurs.

[Communication related to protection system technical coordination with the interconnected utility must be included with the protection system evaluation documentation.] Coordination documentation is in the form of e-mail confirmations, meeting summaries, or notes of telephone conversations, and descriptions of technical consensus on applicable protection system settings, design, or logic diagrams. **[Formal notification of the implementation of the settings must be submitted to the interconnected utility to memorialize the outcome as described in Section 3.1.5.]**

2.3 Recommended Additional Documentation

In addition to protection system settings and interconnected utility communications items identified in the above sections, it is recommended that any documents, such as facility or relay review reports, testing reports, single-line diagrams,¹ and any other documentation that demonstrates the reasoning behind setting changes, be filed in the RRD.

3.0 Procedure

The following provides an overview of the procedure used in protection system coordination management. This section (3.0) will not contain bold and bracketed text which would be duplicated in other sections of this FIST.

The protection system coordination management process starts with an initiating event (see Section 4.0, Protection System Coordination Flow Chart). Any number of these actions can precipitate the need to evaluate protection system settings. The following are examples of events that can initiate a protection system evaluation:

- Interconnected utility facility changes.
- Protection system event analysis.
- Recurring relay or relay element operation.
- Fault study change.
- New equipment installation.
- Relay replacement (not equal to existing).
- Firmware or software upgrades.

¹ Drawings used in relays settings may be included by reference with revision date rather than storing the drawing in the RRD.

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- Equipment rating change.
- Change in protection philosophy.
- Facility Rating Review.
- Fault and load studies and relay settings required to be evaluated on a five-year cycle in accordance with FIST 3-8, Section 4.1.

The evaluation of the protection system is performed by the protection system staff. This may occur at the local operating office, regional office, or at the TSC. The protection system staff conducts protection system technical coordination with their interconnected utility counterpart as necessary.

The evaluation relies on information derived from numerous sources. Examples include:

- Local or Reclamation protection philosophy.
- Fault study clearing times.
- Interconnected utility protection requirements.
- Equipment ratings.
- Continuous current basic insulation level (i.e., BIL) ratings.
- Stability studies.
- Power flow studies.
- Facility modeling or operations studies.

The evaluation results in one of several possibilities. The protection system is adequate; the settings of one or more of the protection system elements need to be changed; or elements of the protection system need to be added or replaced. The results are documented and become part of the protection system evaluation documentation which is peer reviewed. Once the evaluation passes peer review, the protection system staff provide the evaluation results to the manager. The manager ensures that the evaluation has been peer reviewed, the necessary coordination with the interconnected utility has occurred, and the appropriate documentation exists. The manager may approve the evaluation results if the manager is satisfied that the evaluation results are adequately justified, coordinated, peer reviewed, and there are sufficient resources for implementation; or develop a justification if the result is not approved.

Once the evaluation is approved by the manager, the manager forwards the information to either the plant data administrator or protection system database coordinator as needed. When approved evaluation results involve an action (such as a new setting or other change to the protection system), a work order should be generated in the Capital Asset and Resource Management Application (CARMA) (or appropriate maintenance management system if CARMA is not implemented) to implement the actions described in the evaluation results. By utilizing a specific work order for the change, the protection system plant data administrator will be able to track the progress of the change. When a CARMA work order is utilized to implement a change to the protection system, it needs to be referenced

in the RRD by the protection system plant data administrator. The protection system evaluation documentation is also forwarded to the protection system plant data administrator by the protection system staff.

For those cases where the evaluation results do not require a work order (such as a finding that the settings are adequate, or the protection system is adequate), the protection system evaluation documentation with the approval is forwarded to the protection system plant data administrator by the protection system staff.

The manager should implement a process to ensure the justification is provided to the protection system staff concerning decisions on all evaluation results.

If the evaluation results include informal coordination with the interconnected utility or require action or concurrence by the interconnected utility, then the evaluation results and manager's approval is forwarded to the protection system database coordinator for formal documentation of coordination with the interconnected utility. The protection system database coordinator exchanges formal correspondence with the interconnected utility. This correspondence is added to the protection system evaluation documentation and entered into RRD by the protection system plant data administrator.

A completed work order in CARMA and associated test documentation, if necessary, will signify the action has been completed. The protection system plant data administrator logs the completion in RRD.

Sometimes during the process of implementing protection system changes through CARMA, problems with the approved changes occur. If there are any alterations to the approved changes that revise the manner in which a protective element isolates power equipment the entire process needs to be repeated, including approval of the change. While such an alteration appears minor, it is expected that repeating the process for the change will not take as much time because of the availability of the previous documentation and the nature of the change. More significant alteration may take more time to ensure proper coordination, review, and documentation. In either of these cases, it is essential the basis for the change is documented and approved.

3.1 Functions

This section details the functions involved in all aspects of the protection system evaluation documentation. While specific titles are used, it is the region's or local operating office's responsibility to determine the most suitable position to accomplish the task. In some cases, multiple functions may be assigned to one staff member. **[The tasks identified for the functions in this section must be assigned to specific staff by the respective office in order to ensure proper coordination management and documentation. The staff assigned to these**

tasks must be identified and their contact information must be entered into the RRD under the location record.]

3.1.1 Protection System Evaluation

This function may be performed by any protection system staff. The function includes technical coordination with an interconnected utility counterpart as well as documentation of that correspondence.

The protection system staff conducts evaluations as needed, and relies on other FIST volumes, variances, or other technical documents at their disposal to perform the evaluation.

Included in the function is an assessment if technical coordination with the interconnected utility is needed. If technical coordination is needed, the protection system staff makes the appropriate contact and ensures that technical consensus has been reached with the interconnected utility.

The protection system staff prepares the evaluation results which are a part of the protection system evaluation documentation. **[All evaluation results must be peer reviewed. The protection system staff is responsible for forwarding the evaluation results to the peer reviewer and to address the clarifications that result from the peer review. The results of the peer review must be added to the protection system evaluation documentation by the protection system staff and forwarded to the manager for approval.]**

3.1.2 Peer Review

This function is performed by the peer reviewer. **[The peer reviewer is responsible for ensuring all evaluation results have been adequately documented, are technically sound, and the appropriate technical coordination with the interconnected utility has been documented.]** The peer reviewer is also responsible to notify the protection system staff of any areas in the evaluation results where additional clarification is needed. This may involve a series of reviews if there is not concurrence. The peer review is complete when all clarification or questions have been answered or addressed, and the peer reviewer concurs with the technical adequacy of the final protection system evaluation documentation.

3.1.3 Protection System Evaluation Approval

The evaluation results with peer reviewer's concurrence are forwarded to the manager by the protection system staff. As a result of a peer review, the manager can rely on the documentation as technically sound; however, the manager may still request additional technical review. Approval should occur for any evaluation results that are adequately justified and there are sufficient resources to

implement the actions described in the evaluation results. The manager would be justified to not approve any changes if evaluations have not been peer reviewed, the necessary coordination with the interconnected utility has not occurred, or the appropriate documentation does not exist. **[Any changes, additions, or replacements in the protection system of a facility must have documented approval by the manager. The manager will provide a documented reason or justification if the changes, additions, or replacements are not approved to the protection system staff. Any alterations to the approved changes that revise the manner in which a protective element isolates power equipment will also require approval by the manager.]**

3.1.4 Protection System Plant Data Administrator

[The staff assigned this function must ensure protection system evaluation documentation is entered into the RRD.] This function also tracks the status of approved evaluation results that require action. For those sites that use CARMA as the maintenance management application, the protection system plant data administrator periodically reviews work order status and provides periodic reports to the manager that approved the evaluation results. **[All protection system evaluation documentation must be entered into the RRD.]** The duties of this function include:

- Entering evaluation documentation into the RRD.
- Editing RRD records.
- Periodically reviewing work order status and providing periodic reports to the manager.
- Reviewing and reporting on the status of the installation of new protection systems and changes to existing protection systems.
- Assuring documentation in RRD is accurate and complete.
- Keeping the information and status in the RRD of installed protection system elements and settings up-to-date.
- Informing the protection system database coordinator of all new or modified protection systems for which coordination management with the interconnected utility is needed.
- Coordinating with the manager to determine authorized users and authorized users' access permissions and rights to modify records.
- Coordinating with the RRD administrator to assign RRD access permissions and rights to modify records per coordination with the manager.

3.1.5 Protection System Database Coordinator

The staff assigned this function coordinates the formal documentation with the interconnected utility. **[All conclusions resulting from the protection system technical coordination between the interconnected utility and Reclamation**

protection system staff must be documented in formal correspondence with the interconnected utility.] The duties of this function include:

- Transmitting records of implemented protection system changes to the appropriate Reclamation office.
- Transmitting formal notification of protection system changes to an interconnected utility for acknowledgement.
- Receiving correspondence relating to protection systems from the interconnected utility and forwarding it to the protection system plant data administrator for submission in the RRD.
- Tracking coordination management documentation to ensure acknowledgement of correspondence with the interconnected utility.
- Providing copies of the protection system coordination documentation, when requested.

3.1.6 RRD Administrator

The RRD administrator is responsible for managing Reclamation accounts and assuring that the RRD is available. This function is assigned to the TSC personnel under service agreement with the PRO. The responsibilities include:

- Working with the protection system plant data administrator to add and delete authorized users and staff.
- **[Assigning the RRD permissions to authorized users and staff assigned by the regions.]**
- Making corrections to documents entered into the RRD database when authorized by agreement with the respective office.
- Providing technical support and training to RRD users.
- Developing and maintaining a Web-based RRD User Guide that incorporates the standards and procedures in this document.
- Coordinating outages and maintenance of the RRD computer software application and associated hardware with Department of the Interior Information Technology support.

3.1.7 Authorized Users

Authorized users are individuals granted access rights to the RRD. The specific permissions of RRD authorized users are determined by the protection system plant data administrator, but in general will include access to read and in some cases add data to the RRD. Authorized users may include regional, project, facility, or TSC personnel at the discretion of the region. Their duties include:

- Coordinating any additions or corrections to the RRD with the protection system plant data administrator.
- Reviewing database entries.
- Extracting database reports.

3.2 RRD Data

[The RRD will be used for protection system elements and all protection system evaluation documentation which includes:

- **Protection system technical coordination information;**
- **Records on equipment];**
- **{Settings for protection system elements that are in service, pending installation}, [or removed from service (archived); and**
- **Basis for settings of protection system elements.]**

Current transformer and potential transformer information, generator and transformer ratings, correspondence, and drawings may also be included. The RRD can be used for trip and alarm settings on low voltage power circuit breakers, molded case breaker settings, mechanical limit switches, or auxiliary relaying as determined by the operating office.

3.2.1 Data Retention

The RRD system was designed to store data and historical records for engineering and documentation purposes. All RRD records are considered permanent. **[No records will be deleted except when correcting entry errors or duplicate records. The protection system plant data administrator and RRD administrator (with regional approval) are given rights to delete records.]**

3.2.2 Appropriate Status and Revision Designation

These status designations are used to filter records for reporting, studies, and documentation.

[When updates to the data in the RRD are required, the setting data or documentation history of equipment that is being modified or replaced will not be deleted.] Instead, the equipment will be marked as modified or removed from service and the settings for the equipment will be appropriately marked as modified or archived. This will ensure a complete detailed record of changes for all protection system equipment records and setting requests.

If the manager rescinds approval for a pending setting or a relay is not to be placed in service, its status should be changed to “Archived” or “Removed from Service,” with an appropriate memo comment to explain the change.

[Protection system settings records shall have revision numbers and dates used to track pending and archived settings.] The authorized user will assign the new setting to the next available revision number, when adding new “pending” settings.

3.2.3 Basis and Records

The basis review date is the date of the last documented review of the protection system element setting, e.g., the last time a plant relay review was performed, the initial relay calculations, or any review that was performed when a change was made. In order to ensure the basis for protection system settings can be easily tracked, as in the case of a misoperation of a protection system element, a record contains fields such as Basis Review Date and Record Comments. The Record Comments field should contain the location where the basis can be obtained if scanned copies are not attached to the record.

3.2.4 Memos and Comments

Memo fields are provided in both the protection system element and settings records areas of the RRD and are designed to be used for descriptions of changes. Protection system element and settings memo fields should be kept current and include as much of the following information as is applicable:

- Date of change.
- Reason for change.
- Extent of the change.
- CARMA work order number.
- Names of the individuals involved in the change (names should also be contained in the work order).

An example memo field entry for a protection system element change is: “New SEL-300G relay installed and elements enabled on 01-01-2001 by J. Smith. Work completed under work order #1234.” The memo field can also be used for any other comments that the user considers useful.

Comments fields are also available in the protection system element and settings records area of the RRD that allow a user to easily track changes in large settings files. These comment fields can also be used for notes documenting the basis of the setting.

3.2.5 Appended Files

In order to accommodate data that is not easily entered into the RRD, it is possible to upload digital files. Files should be appended to their associated entry or under their own header. This information should also be contained in the work order. The following files are recommended to be appended:

- Drawings, i.e., single-line diagrams and control schematics.
- Digital photos.
- Facility or relaying reports.
- Test reports.
- Binary relay programming files.
- Correspondence such as memorandums, e-mails, and letters indicating agreement or acknowledgement by the interconnected utility.

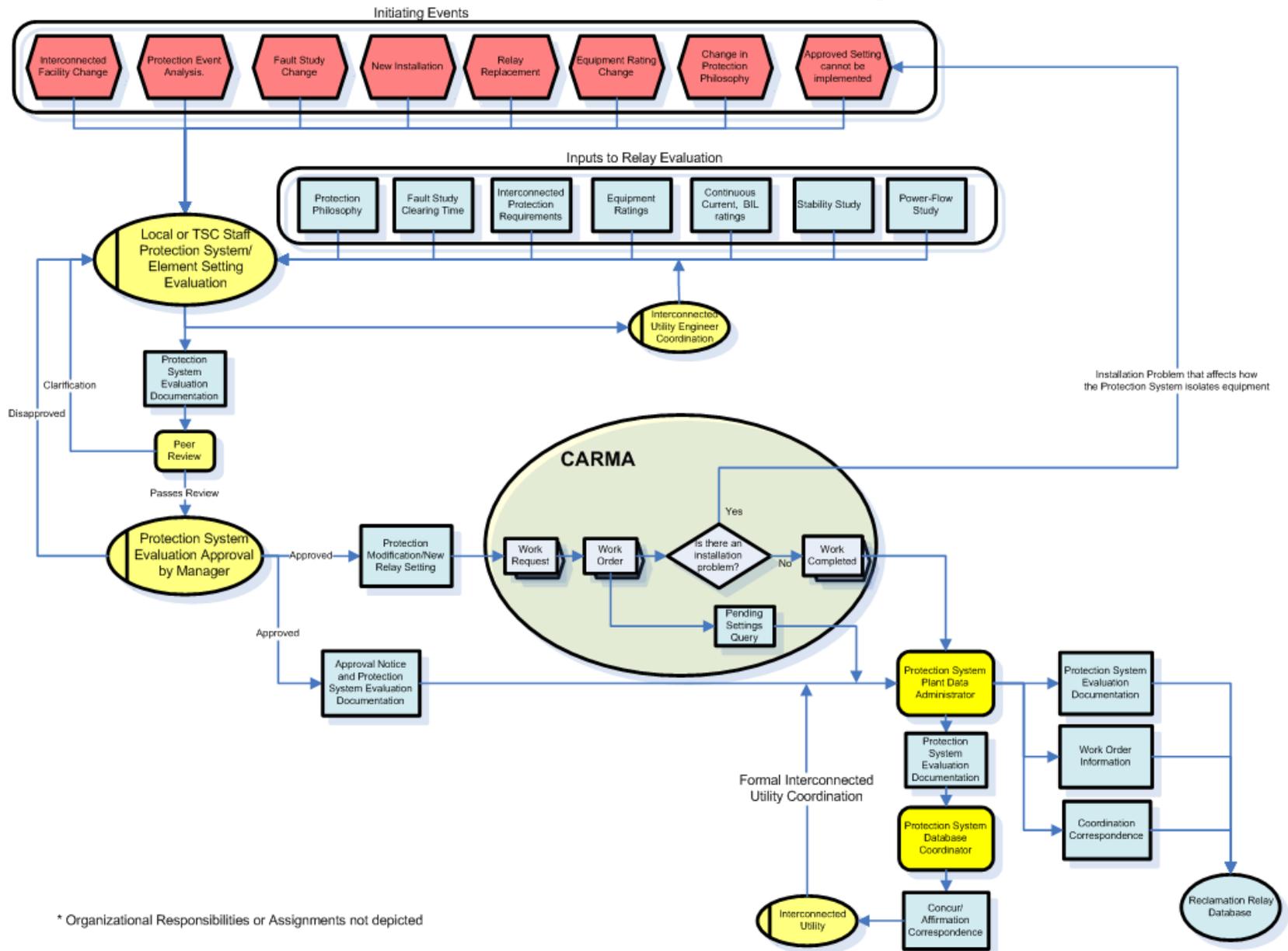
3.2.6 Linked Records

In order to track new and modified protection systems with their correspondence to the interconnected utility, the RRD has linked record capability. This feature allows an authorized user to link correspondence, reports, prints, etc., with associated relay and protection system settings or equipment records, and vice versa (changes in relay or protection system settings or equipment records linked with correspondence, reports, etc.). This is especially useful for providing a documented history of coordination between Reclamation and interconnected utilities. **[All applicable documents and records associated with new protection systems or elements or any changes to existing protections systems or elements must be linked (uploaded) to the corresponding equipment records in the RRD. Protection system technical coordination correspondence associated with relay, relay settings, or equipment between Reclamation and the interconnected utility must also be linked to their corresponding equipment records in RRD.]**

3.3 Digital Signing

Digital signing by the protection system plant data administrator is used to verify that each record has been reviewed, settings or equipment have been placed in service, and all necessary correspondence with the interconnected utility has been performed. Pending settings should not be signed, and archived settings will remain signed (if they had previously been in service).

4.0 Protection System Coordination Management Flow Chart*



* Organizational Responsibilities or Assignments not depicted