White Paper

Establishing Innovative Processes to Comply with PRC-027-1

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There is an increasing demand for utilities to define a relay settings process and check relay coordination which is driven by regulatory requirements such as the North American Electric Reliability Corporation (NERC) PRC-027-1 standard. Traditionally, system solutions have fallen short of producing a good automation solution for relay settings creation or wide-area coordination. In this white paper, we outline the differences between a manual process and a novel, automated process for fulfilling Requirement 1 (R1) and Requirement 2 (R2) of the PRC-027-1 standard. Through the latest development in automation, utilities can use a simple, well-defined relay settings development process and perform wide-area coordination studies regularly to adapt to changes in the power system.

Requirements for PRC-027-1

R1 states that utilities need to have a well-defined and well-documented relay settings development process. R2 states that the protection engineer must perform a wide-area coordination study regularly to account for dynamic changes in the power system. Revising and implementing R1 to increase the reliability of the system fulfills the last requirement, R3 [1]. Figure 1 displays a process diagram of these three requirements for PRC-027-1. As we will discuss, this process can be streamlined by using automation and storage tools.

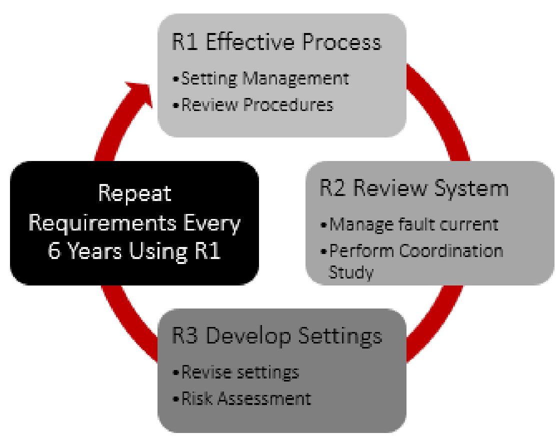

Figure 1: Requirements for PRC-027-1

R1: Relay Settings Development Process

A well-defined process must be implemented to comply with PRC-027-1 R1. This process will consist of an accurate model, a defined protection philosophy, a rigorous review process, and the documentation of the relay settings data. Currently, many companies use a manual process to calculate relay settings. While this may be functional, note that the engineer must manually transfer the settings data at each step.

Manual Process

Figure 2 displays the tedious, manual process for calculating relay settings. This process can be prone to errors due to human management of the data. As we will discuss, the settings engineer creates the model, defines the settings, reviews the calculations, and loads the data into the relay.

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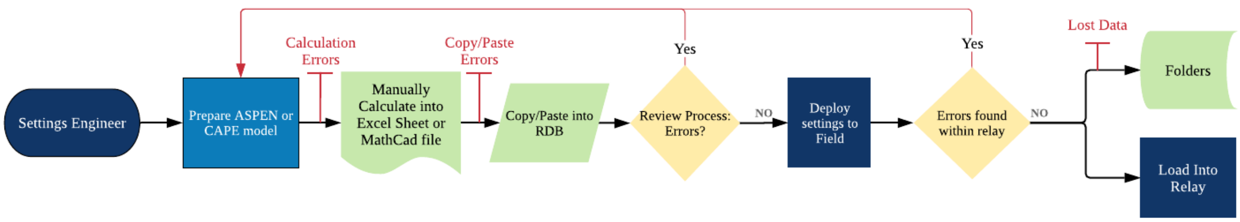

Figure 2: Manual Process for R1

The first step to developing relay settings manually is to prepare the model within a short circuit program (e.g., ASPEN or CAPE). After creating an accurate model, the settings engineer manually places faults along the lines of the grid desired. Since this must be done for every new relay type, it can become very inefficient, especially if there are numerous lines within the grid configuration. This step requires many hours or even days to complete.

The next step after calculating the equations is to apply a protection philosophy that is agreed upon within the utility. Common templates that companies use to represent the philosophy are Excel spreadsheets and Mathcad files. These templates may contain equation errors and can be very complex. In addition, the manual transfer of data calculated from the model into a template can result in copy/paste errors.

A common solution that companies have adopted to address these copy/paste and miscalculation errors is a peer-review process. In an effort to reduce errors, the settings engineer will send the finished calculated template to another engineer who will compare the template with recalculated settings equations. If any errors are found, the data will be sent back to the settings engineer so that it can be updated and revised within the model. If no errors are found, the settings will be deployed to the field. This inefficient peer-review process can take many days to complete and can result in data-transferring errors.

After the settings are updated and deployed to the field, the relay technician will test the relay settings, resulting in the discovery of more errors. After all the settings are verified for the last time, they will either be sent back to the settings engineer so that they can be updated within the model, or they will be loaded into the relay and saved to a folder. In this manual process, the final settings are stored electronically in the relay.

With no central repository for all of the settings, some of the data will be lost. Without the ability to store and track the relay settings, this inefficient process will lack the ability to use existing data. As can be seen, this process is very prone to error due to miscalculations and human management of the data, introducing NERC errors at each step of the manual process.

Automated Process

An automated process for defining relay settings development using innovative tools such as SARA (Setting Automation Relay Assistant) and PowerBase is shown in Figure 3. The settings engineer retrieves or creates a model from PowerBase, applies a template to the model, exports the RDB through SARA, reviews the data, and imports it to the relay and to PowerBase to be stored. The benefits of using this process will be discussed.

Developing new settings starts with preparing the model within a short circuit program. The latest data can be automatically retrieved from PowerBase, minimizing time spent preparing new settings. After retrieving the settings from PowerBase, the engineer can update the model accordingly.

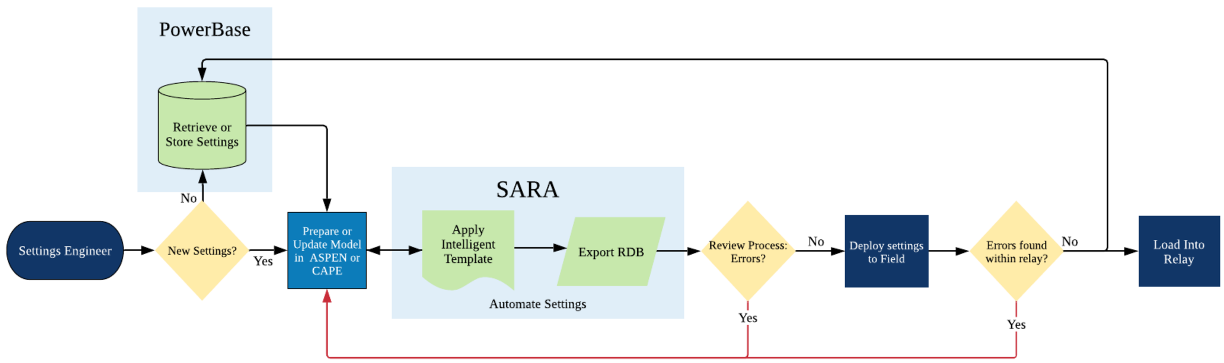

Figure 3: Automated Process for R1

After preparing or updating the model in the short circuit program, the engineer can then define the protection philosophy through a SARA intelligent template. By defining a set of equations and constructing fault study specifications, the engineer can create an intelligent template that fully represents the intent of the protection philosophy. Furthermore, the template can then be used in any line settings application. SARA will bi-directionally communicate with a short circuit program to automatically populate data and export this data into an RDB file, minimizing any potential causes of human calculation errors or errors caused by data transferring.

SARA also systematizes the peer-review process, allowing the review engineer to fully visualize the exact settings equations and values together with fault computations, thus reducing time spent on revising data. Through simple navigation, the engineer can keep track of the process and evaluate any settings without having to reapply all faults and equations a second time, as was previously done in the manual process.

After the changes are resolved, they will be sent to the field where the relay technician will check for errors again. Then, after all the settings are verified for the final time, they will be imported into the relay and saved within PowerBase. In addition, all settings calculations, comments, and flags will be properly documented in SARA's native file. The setting files and report will no longer have to reside in the relay but within the database, allowing the engineer to retrieve the most updated settings. And with SARA, previous processes will be simplified to achieve an efficient method for fulfilling R1 of PRC-027-1.

In summary, SARA has the ability to automatically calculate relay settings, minimizing potential causes of human data management errors. Additionally, SARA can perform fault analysis, provide a simplified peer-review process, and automatically transfer data into a relay file. SARA and PowerBase provide an automated process to simplify and streamline the development system for calculating relay settings while maintaining compliance with NERC PRC-027-1 standards.

R2: Processing Wide-Area Coordination

The purpose of R2 is to avoid misoperations caused by dynamic changes in the power system by performing wide-area coordination at regular intervals. To fulfill R2 of PRC-027-1, this process must be achieved using one of the three options defined in the standard. Option one states that this process shall be repeated every six years. Option two states that this process shall be repeated when there is a 15 percent or greater deviation in fault current values. Option three states that a combination of options one and two can be chosen to fulfill R2 of PRC-027-1 [2]. There are many challenges involved in conducting wide-area coordination studies including the rigorous validation of the model, the proper expertise required to create coordination criteria and verify results, and the tedious task of managing and tracking all violations [5].

Manual Process

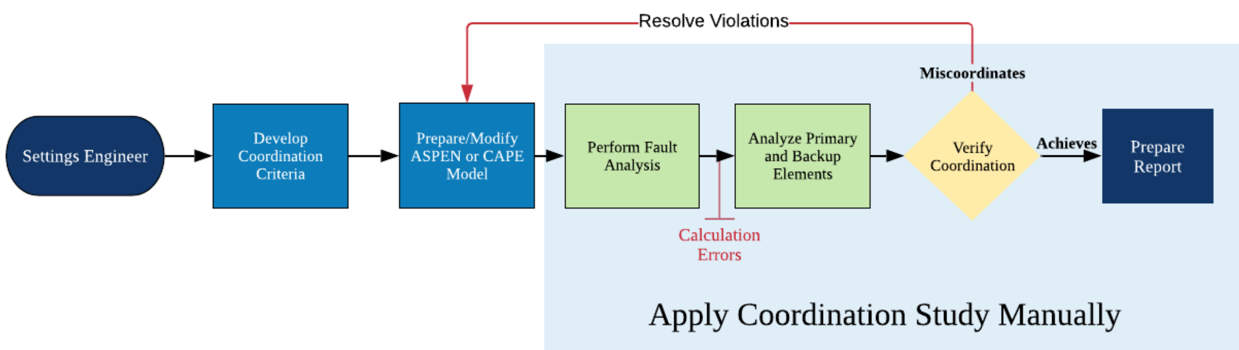

Figure 3: Wide-Area Coordination Manual Process

The manual process starts with developing coordination criteria and verifying the model. In doing so, the protection engineer will manually go through the .txt file exported from the short circuit program. After sifting through numerous lines of data, the engineer must manually record and calculate settings across a large power system. Because of the miscalculation errors and tedious fault analysis, the engineer will review the faults and evaluate the primary and backup elements, resolving any violations and modifying the model accordingly. To eliminate time spent on these errors and increase the reliability of the whole system, innovative tools have been created for performing wide-area coordination studies, as we will discuss below.

Automated Process

SARA and PowerBase offer an automated process for performing wide-area coordination studies. SARA provides an efficient, automated solution for conducting relay coordination studies, reducing the rigorous task of validating the model and tracking violations. PowerBase's ability to track, store, and retrieve the latest settings [3] minimizes unnecessary time spent on retrieving data. The different parts of the automated process are captured in Figure 4 and described below in detail.

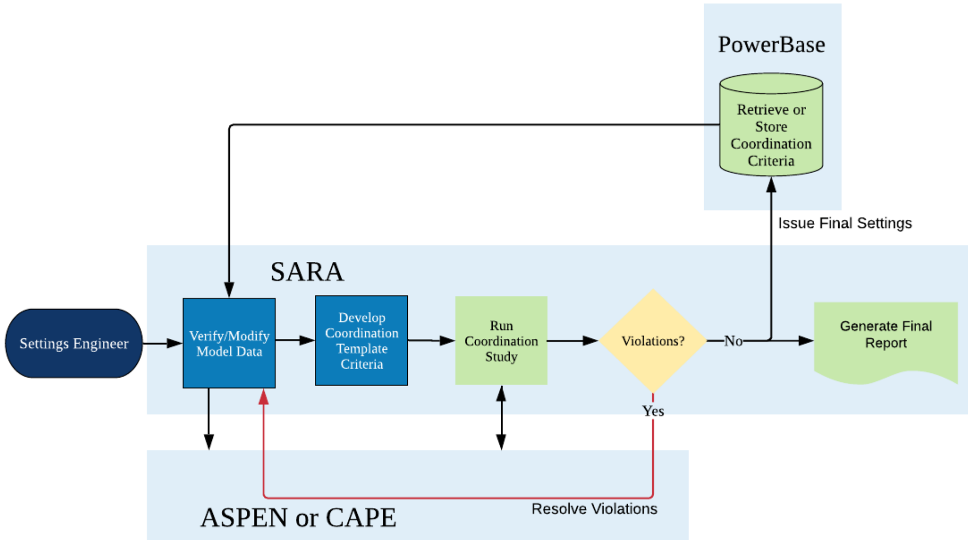

Figure 4: Wide-Area Coordination Automated Process

The automated process begins with the engineer verifying the model. SARA, PowerBase, and the short circuit model all interact when calculating relay settings. After SARA retrieves the latest settings from PowerBase, it can then import this data into the short circuit program, eliminating the need for transporting data between the two mediums.

Next, the approach to the coordination study set by the utility will be defined. After defining the criteria, SARA will bi-directionally communicate with the short circuit program and create a wide-area analysis of the specified region within minutes. SARA will provide the engineer with any violations classified per study or criteria based on the criteria selected. The engineer will then fix the violations within the SARA dashboard (Figure 5) which will automatically resolve the issues in the short circuit program.

Figure 5: SARA Wide-Area Coordination Studies Review

As with the relay settings development process, SARA will generate reports summarizing the violations found and the way they were resolved. SARA will also automatically update the short circuit program case with the changes required for proper coordination, reducing time spent sifting through numerous lines of data. SARA will export an RDB into PowerBase, providing easy access to existing studies. With SARA and PowerBase working together, conducting a wide-area coordination can be simplified and streamlined while still fulfilling NERC PRC-027-1 requirements.

Conclusion

SARA and PowerBase offer a cutting-edge solution to the PRC-027-1 requirements by automating time settings calculations, reducing time spent on calculating and reviewing data, and eliminating the error-prone process of copying/pasting. Given the tremendous amount of labor required by this standard, it is imperative for utilities to use an automated process. Using innovative tools to prepare and apply relay settings development and wide-area coordination studies will fulfill all requirements of the PRC-027-1 standard.

Why SynchroGrid

SynchroGrid offers a solution for wide-area coordination studies that complies with NERC's PRC-027-1 standard by taking advantage of automation tools. Together, SARA and PowerBase provide an intelligent system for organizing protection studies and automating relay settings calculations. With the ability to bi-directionally communicate with short circuit programs, SARA and PowerBase will be able to parse relay data that enables engineers to produce sensitivity analyses and perform peer reviews which are then integrated into the relay database so that the most accurate, up-to-date model is used each time. Protection system development can be reduced to a fraction of the original time necessary by using these innovative tools. SynchroGrid provides a solution to PRC-027-1 by achieving simplicity in system protection.

References

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