GRIDSCALE X ADVANCED PROTECTION ASSESSMENT

Relay Checking Module

Evaluate coordination of your whole system

SIEMENS

At a glance

A protection engineering group typically has no time to review old relay settings in a comprehensive way.

The challenge

The network grows over the years and you suspect that miscoordinations have crept in to threaten your system's security. But how are they to be found? What if there is a miscoordination between primary overcurrent and backup distance protection? What if increased mutual coupling now causes an overcurrent relay many buses away to see a fault it was never intended to protect against? How could you identify all the combinations of faults and relay pairs to study, even if you did have the time?

Our solution

Advanced Protection Assessment Relay Checking does for you. It is one thing to display the operating characteristics of a few relays on a computer screen. It is quite another to model a real protection system with its thousands of relays, its complex arrangement of instrument transformers, its actual contact logic, and its varying breaker operating times, and then to find miscoordinations without knowing where to look. The solution is a stepped-event analysis that models everything and simulates all switching actions, quickly and accurately. This method doesn't depend on relay pairs specified by the user or determined in some other way.
It looks for miscoordinations among all relays.

This kind of analysis could never be performed previously because it requires:

- a comprehensive database,
- detailed device models,
- a versatile short circuit computational engine,
- user-controlled automated fault scenarios, and
- Advanced Protection Assessment 's advanced interface for easy setup.

User-defined checking area

Since the method employed by Relay Checking has never been automated before, there are a few new concepts to understand. The first is the term "checking area," which is some portion (or all) of the network that one wishes to review. It is, ultimately, a set of physical locations where faults will be applied. The checking area may consist of a set of buses, a set of lines and transformers, and a set of distance and instantaneous overcurrent relay elements whose reach points will determine fault locations. Relay Checking enables you to define the checking area in seconds using a mouse and perhaps a few keyboard entries. For example, the checking area can be a region defined by a bus or line at the center out to some depth away. Alternatively, it might be one of the control areas defined in your short circuit data. When you run the coordination review, Relay Checking will apply its fault scenarios only within the checking area.

Dynamic simulation window

The coordination review process conducted by Relay Checking is likely to involve the simulation of hundreds or even thousands of faults throughout the checking area. For each fault location, Relay Checking assembles a temporary set of relay elements whose response it should simulate until the fault is cleared. This set is called the "simulation area" and may be pictured as a dynamic window moved about the checking area as the review proceeds. Relay Checking follows guidelines controlled by you when it assembles the simulation area. You may restrict your study in almost any way imaginable. Most commonly, you may want to consider only certain protection schemes or particular types of relay elements (e.g. overcurrent only), but much more flexibility is provided than that. Simulation area options are specified in the Preferences window.

Fault scenarios

After you have defined your checking area and the options for the moving simulation area, you need to tell Relay Checking what types of fault studies to employ during its coordination review. This is easily done with the help of a form that guides each step. Fault studies may be bus-oriented, line-oriented (e.g. sliding, close-in), or element-oriented (e.g. faults near the reach of a distance or instantaneous overcurrent element). Network contingencies such as line and generator outages, line-end faults, and the grounding of mutually coupled lines may be included. Relay Checking comes with a library of generic studies. You may also write your own with the Advanced Protection Assessment User's Programming Language and add them to the library. If required by a fault study you selected, you will be prompted for values of parameters to be used at run time. An example would be the percent increment to use when a sliding fault is advanced along a line.

Realistic models

The sophisticated stepped-event simulation performed by Advanced Protection Assessment Relay Checking (described below) requires a correspondingly sophisticated set of device models. Partial travel of induction disks in electromechanical overcurrent relays is modeled. Directional element models provide for both voltage and current polarization from realistic arrangements of VTs and CTs. Separate taps and individual minimum-multiple requirements on the operating and polarizing quantities are modeled in addition to the minimum-product pickup taps of these elements. When relevant, the effect of source impedance and load compensation on distance element operation is modeled. At a higher level, internal or external supervision (“torque control”) of one element by another is modeled. Above that, the contact logic of the relay panel controlling a breaker is properly represented. Special forms in Advanced Protection Assessment make it easy to describe this logic and use it repeatedly.

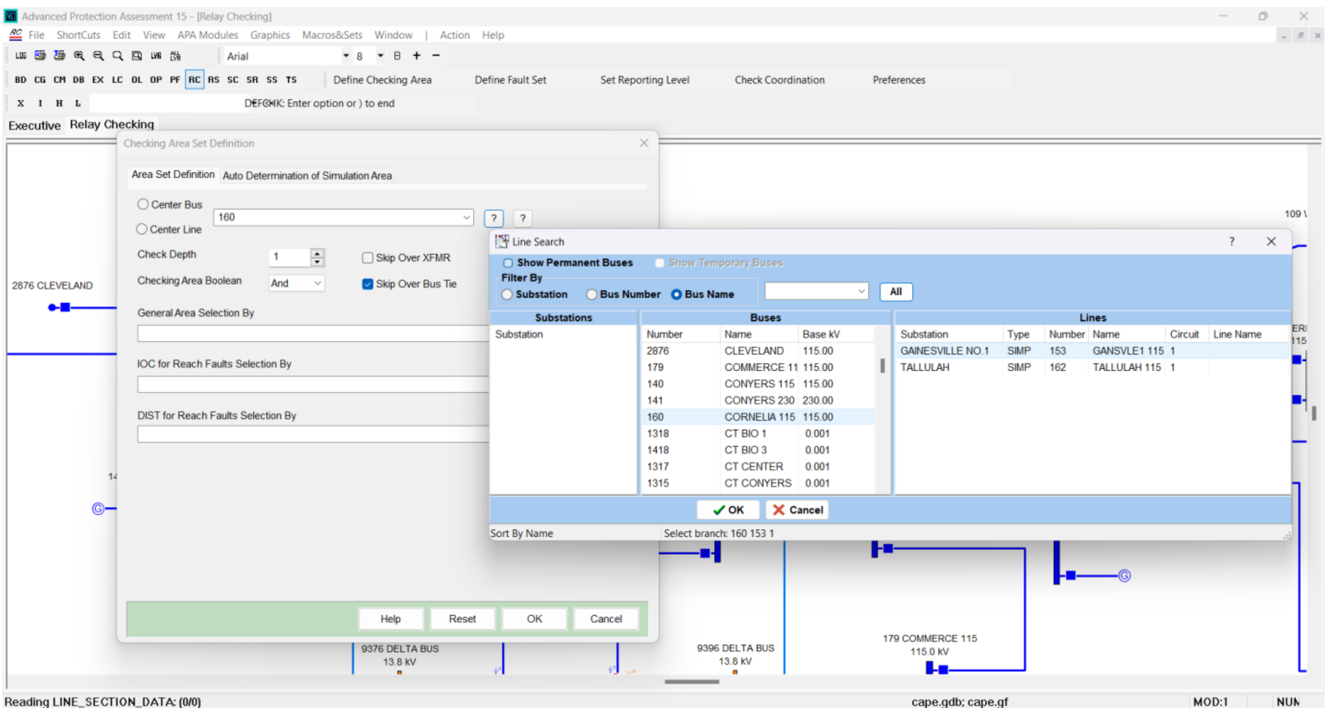

Figure 1: You define the checking area – a set of buses, lines, and transformers. In the coordination review, Relay Checking applies its fault scenarios only within the checking area.

Reliable coordination studies require reliable relay models. When you don't understand the reason for a relay's behavior, this detailed element report can be a lifesaver.

Stepped-event simulation

The crucial component of Relay Checking, the one that enables it to locate miscoordinations so effectively, is its unique stepped-event simulation of the response of every relay element from the time a fault is applied until the last breaker opens to clear it. Before each fault is applied, Relay Checking automatically determines which Local Zones of Protection (LZOPs) provide primary protection. After the fault is applied, Relay Checking evaluates every relay element in the simulation area, determines all the trip logic that is satisfied, calculates when the trip signals would be given, and opens the first breaker (or more, if simultaneous). Partial time-outs of induction disks are computed, fault currents and voltages are recomputed, element supervision is re-evaluated, and the simulation proceeds until the next breaker opens. The simulation continues until finally the fault is cleared or no further breaker operation occurs. Reports with optional levels of detail are generated as the simulation proceeds and are described next.

Miscoordination reports

Detailed coordination reports covering a significant portion of the network could become unwieldy in size, so we have several types of reports. The shortest one is generated by a macro that can supervise the whole review process. It produces just one report line for each fault studied! Our customer who pioneered this approach reported their successful experience with wide-area coordination checking at the Western Protective Relay Conference.

In addition to that single-line report, Relay Checking offers six levels of reporting. The first is a data error report generated by Relay Checking's comprehensive data checking facility; most errors in data entry are caught here (for example, attempting to supply 3V0 from a wye-connected VT secondary). The second and higher levels report miscoordinations only; coordination time interval (CTI) violations and miscoordinations; all breaker operations; a summary table of relay element operations; and detailed reports of every simulated relay element. Miscoordinations are defined as the operation of any breaker other than one associated with the primary protection. CTI violations occur when primary protection operates first but backup protection is predicted to occur too soon thereafter. (You control both the definition of "required CTI" and how the "actual CTI" is computed.) All reports include such important details as the fault condition, the relays that caused a breaker operation ("trip path"), and the time of each operation.

Advanced Protection Assessment offers a summary report of one line per fault to speed your evaluation of wide-area studies that may involve hundreds of conditions.

Teleprotection (pilot) schemes

With the recent addition of a general auxiliary type of element to Advanced Protection Assessment (we call it the AUX element), you may now simulate most forms of teleprotection. Using the AUX element, we have developed receiver and transmitter blocks that can accept any combination of remote or local element contact status, circuit breaker positions, and contact logic. The AUX element may have both pickup and drop-out times associated with it. Our Teleprotection Wizard makes it easy to model teleprotection schemes such as permissive overreach transfer trip (POTT) and directional comparison blocking (DCB). The reports mentioned above have been supplemented with contact logic status and logic timeline displays to give you further insight into your protection system response.

A Teleprotection Wizard makes it easy to model teleprotection schemes such as permissive overreach transfer trip (POTT) and directional comparison blocking (DCB).

Features

- User-defined checking area for coordination review

- Automated, moving simulation window that encompasses distance, overcurrent, voltage, and differential protection together
- Interactively-built fault scenarios
- Realistic models of relay elements, instrument transformer connections, protection scheme contact logic, and breaker operation
- Fully automatic, stepped-event simulation
- Multilevel reports of miscoordinations and violations of a user-defined Coordination Time Interval (CTI)
- Ability to simulate teleprotection (pilot) schemes

Real-life success story

Request a copy of the technical paper describing Red Electrica de Espana's methodology to automatically check a wide area of protection coordination, including the boundaries between transmission and generation and transmission and distribution.

Protection coordination in the transmission system and boundaries – a wide area coordination study

A technical paper presented at the Western Protection Relay Conference describes a methodology created to automatically check protection coordination over a wide area, including the boundaries between transmission and generation, and transmission and distribution.

The authors argue that considering the huge investment in power system assets, it only makes sense to equip utilities with tools that enable automatic detection of lack of coordination and provide assistance with the adjustments needed to resolve them.

This paper describes a project carried out by Red Eléctrica de España (Madrid) in 2006. In this project, protection coordination in one of the most critical transmission network areas, an extensive part of the 220kV and 400kV network in the northeast of Spain, was checked using an automated application of Advanced Protection Assessment software.

To read the whole story, contact us and request the Wide Area Coordination Study technical paper.

"In addition to short circuit calculation, Advanced Protection Assessment's relay models allow us to perform wide area protection coordination studies. Those studies have been critical to improve the security of system protection and, therefore, to increase overall system reliability."

– Santiago López Barba,
Red Eléctrica de España

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