Protection and Control Commissioning: Two Steps Forward, One Step Back

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THE ENERGY INDUSTRY IS MOVING FORWARD AT WARP SPEED ON TECHNOLOGICAL AND INFRASTRUCTURE CHANGES. YET, THE PUSH FOR THESE ADVANCEMENTS HAS CREATED A MAJOR GAP AMONG THE RESOURCES THAT PROVIDE PROTECTION AND CONTROL COMMISSIONING SERVICES ON POWER SYSTEMS, WHICH BOILS DOWN TO LACK OF TRAINING AND SYSTEM KNOWLEDGE.

Photo: RMS Energy

During the past decade, the energy industry has undergone major transformations in infrastructure redevelopment and the introduction of game-changing advancements in power systems technology. With these major leaps forward, the important process of protection and control commissioning, which verifies, documents and places into service newly installed or retrofitted electrical power equipment and systems, has become increasingly critical.

Yet, the push for these advancements has created something of an unfortunate and unforeseen gap in the industry. Many qualified personnel who truly understand protection and control commissioning are becoming harder to find due to retirement of the aging workforce and a smaller number of young professionals entering to replace them. This reduction in experience and knowledge in some quarters occurred as the technology vastly improved, while training and certification programs for technicians substantially lagged behind. In fact, what used to take seven to 10 years of intense education, mentoring and final certification have been compressed into just a few years as a way to catch up. This has created a production line of less qualified technicians who may not possess the required knowledge or comprehension of the commissioning process and the very equipment that needs inspection. Deep understanding of protection and control standards, NERC, new technologies, a reconfigured power grid system and the equipment itself, are requirements among technicians necessary to be proficient and accurate in their commissioning work.

One simply needs to look at the new processes and advances in relay equipment to get a view of how things have changed in commissioning services. The baseline of protection and control standards has always revolved around electromechanical relays, the true marvels of technology that are as old and dependable as those who invented or improved upon them, like Tesla and Edison.

These protective relays work between normal and expected operating conditions and the inevitable system faults that come with any power distribution system. The tried-and-true electromechanical relays detect power system conditions and provide a measured and appropriate fault response with repeatability and reliability during decades of in-service time. Electromechanical relays are still considered to be amazing technology, and those who invented them are responsible for the kind of reliability and safety that our power systems enjoy today.

The Reliability of Electromechanical Relays

There are myriad faults that can be detected by electromechanical relays. Over voltage, under voltage, differential faults and distance sensing for line protection are just a few that will generate the fault condition necessary for the relays to take action. ANSI and IEEE have standardized relay function codes such as "50/51," which speak the power engineers' language for instantaneous overcurrent (50) and time overcurrent (51), signaling a

command to trip a circuit breaker when line current becomes excessive, avoiding severe overheating or even fire.

This dependable relay technology hasn't changed much, as it has been the foundational workhorse for decades; that is, until the advent of solid state and micro-processor-based relays. With all the change in the power industry, the major downside of electromechanical relays has become the limitations of its inherent single-element functionality, which is designed to detect faults for only one particular element. This limited functionality simply requires that far too many relays must perform the fault functions needed to ensure that today's more advanced and complex power distribution systems continue operating at peak efficiency.

Another drawback of electromechanical relays is that they require periodic testing and calibration. These relays depend upon mechanical motion, so maintenance on the relays themselves is required to produce accurate and reliable core operations, such as opening a circuit breaker or tripping a lockout device when needed.

The bottom line is that power systems can run a long time without a fault ever occurring. But with power systems, an industry axiom is that trouble is always brewing. When the time comes for a failure, and it will come, a dependable relay or series of relays are necessary in order to accurately detect the fault, act upon it, and perform the function needed that avoids system damage and costly outages.

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Photo: RMS Energy

Solid State and Microprocessor Relays

The creation of solid-state relays, which don't rely on mechanical motion, was a step forward in replacing the mechanical motion of its predecessor. But the industry did not dwell too long on solid-state relays, because they also required calibration and maintenance.

It was not until the microprocessor became more affordable and dependable that the industry witnessed bigger leaps forward in protection and control. These digital marvels leave the analog world behind, with their ability to rely on more accurate and sustainable digital technology that perform multi-function protection protocols, putting the proverbial "many eggs into one basket." Of course, with so many functions embedded into a single relay, a rare failure of such equipment can produce wider scale and less contained damage compared to electromechanical relays.

Microprocessor relays include a flexible selection of parameters that make them an easier application in the power system, and the provision of more accurate data. There are three important parameters available in such relays, including response characteristics, sensitivity, and selectivity.

Response characteristics are now a family of curves allowing for a variety of customized characteristics that can be monitored and measured. The selection of parameters can provide ***sensitivity*** for a wide range of operating conditions, and ***selectivity*** needed to prioritize response between protective elements and upstream and downstream devices. These microprocessor relay protocols are major advantages within today's complex and more advanced power system solutions.

The complex digital algorithms needed to realize these multi-functional benefits now require another level of understanding for the technician to attain. These attributes, along with the programmable logic elements and the complex communication technologies within microprocessor relays, allow for intricate networking and reporting capabilities and demand a working knowledge in many technical realms.

Integration of supervisory control and data acquisition (SCADA) also creates

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a large pipeline of collected data. Operators are no longer flying blind when such integration provides critical data on operating currents, fault oscillography, power factor, min/max data and other critical parameters.

Required in any successful commissioning effort is complex and up-to-date testing equipment, including multiple independently controlled voltage and current channels; independent phase relationship control of all channels; and accurate reporting of results as the test is being conducted.

Starting with a Good Plan

A good commissioning plan begins with the realization of the benefits of the power systems in play. To realize reliability and predicted response, technicians must test not only the relays involved, but also the system in which they reside. **This is often where industry resources lag, because operating a test set is very different from the essential aspects of understanding what the test set is actually doing *while performing a test* on a particular relay or relay element.**

Technicians who are new to the field or have not had the proper indoctrination into the inner workings of a modern commissioning process will be challenged to create an accurate and positive outcome in even the most basic commissioning projects.
For example, while a relay test system (RTS) can be run for an overcurrent test, a complex power scheme that includes differential protection, energy calculations, and other factors needs to clear through a comprehensive plan to ensure the plan is both solid and valid. This authentication of commissioning plans comes with comprehensive knowledge and deep understanding of the relays and how they relate to complex power systems. Without this knowledge set, the accuracy of the test is relying on the test itself, with little to no input from the technician to guide the analysis toward a comprehensive and successful conclusion of the commissioning project.

Photo: RMS Energy

Understanding Elements of Proper Commissioning

To conduct proper commissioning on any power system, a full understanding of the following elements is essential for a positive and accurate outcome:

Zones of Protection

Current Transformer Characteristics
a. Saturation curves
b. Accuracy class considerations
c. System burden considerations

Breaker response and timing

Redundancy for enhanced reliability

Functional testing – programmable logic elements

Trip equations

SCADA systems
a. Communications capabilities
b. Fiber networks
c. Site DSC considerations

A solid commissioning plan will include a physical checkout from point to point. Testing of wiring and its configurations is the first step in any good plan, to ensure wiring is properly installed. Today, utilities have control houses prebuilt offsite and subsequently dropped into place, a major step in efficiency for both time and money. However, this is where assumptions get made – that wiring is predestined for proper installation. But nothing could be further from the truth. Wiring is where things go wrong both early and often, and not checking every single point and connection upfront will substantially hamper any proper commissioning plan.

Conclusion

Any industry resource that conducts thorough and accurate protection and control commissioning and adheres to proper protection and control standards will employ technicians and other experts who have the proper years of experience to accommodate for the more complex power systems we have today. Commissioning companies must not only recruit the right people and pay them appropriately, but also invest in ongoing development and training to ensure every commissioning job takes on the best and most accurate commissioning approach.

Ensuring the proper outcome of a commissioning project has various aspects that include the right testing equipment and plan, coupled with technicians who have the experience and knowledge to apply to ensure protection and control standards are achieved. It's only a matter of time when the industry catches up and starts to churn out more qualified technical personnel; but until that time, choosing a commissioning partner based on their technicians' expertise and knowledge base is a critical aspect to ensuring the safety and reliability of modern complex power systems.

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Photo: RMS Energy