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Combining Safety with No-Outage Testing

This column focuses on electrical inspection methods and technologies that are performed while the electrical system remains energized. Although no-outage inspections can be very valuable tools, always remember to comply with proper safety guidelines when conducting energized, on-line inspections.

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Introduction

Safety is critical when conducting no-outage testing and statements regarding safety are contained at the beginning of this and all No-Outage Corner articles for that reason. Detailed safety requirements for work on and around energized equipment are clearly defined in NFPA 70E and do not require additional discussion here. Certain types of activities on and around energized equipment are more dangerous than others and while proper safety guidelines must be followed at all times, we must also realize that the chances of an incident occurring during some activities are greater than others. Among these more dangerous activities, switching, racking out circuit breakers, taking voltage measurements, and removing switchgear covers are some of the most common and yet most potentially dangerous tasks.

Switching must be conducted prior to any de-energized maintenance activity, and new technology has allowed this activity to be performed in a much safer manner. Additionally, new no-outage testing technologies can be combined conveniently with this and other new safety technologies to provide valuable and previously unknown equipment condition information.

Figure 1 — Remote breaker trip actuator with magnetic base

Switching

The action of opening a circuit breaker or switch causes the abrupt interruption of power which is inherently dangerous. The severe electrical and mechanical stresses created during this event can be influenced by the equipment condition. An insulation or conductor flaw can impair optimum interruption which can lead to an arc-flash or arc-blast incident. The operator must always be aware that an incident may occur during the act of switching. This is especially unnerving when the operator must stand directly in front of the equipment when performing manual switching.

Fortunately, a series of new actuators (see Figure 1) are available today that allows the operator to perform switching from a safe distance from the equipment. The actuator design varies for different types of equipment. For typical circuit breakers, a magnetic base allows the actuator to be temporarily placed on the circuit breaker. The operator can then open the breaker by standing outside of the exposure zone and trigger the safety device which depresses the breaker's manual open button.

Racking Out

The action of removing or installing a circuit breaker from a hot bus may be as dangerous as switching. The racking action necessitates that the operator stand directly in front of the breaker. As the breaker is methodically extracted from the bus, several potential problems may occur. In addition to typical concealed insulation or conductor flaws, the breaker fingers historically have been a problem by either falling apart during racking out or by misalignment problems during racking in. These problems may result in an incident. Technology has yet again provided an innovative solution to this dangerous procedure by the development of a universal remote breaker racking device as shown in Figure 2.

During typical operation, the operator first selects the appropriate socket that fits the specific breaker racking mechanism and then moves the remote device in place in front of the breaker. After a few adjustments are made, the operator can rack out or rack in the breaker from a safe distance.

Electromagnetic Signals

It is well known that medium- and high-voltage insulation that is failing due to partial discharge and corona activity creates high frequency electromagnetic signals. Similar signals are also produced by arcing from severe conductor problems. These electromagnetic signals which are symptoms of dangerous defects can now be safely detected by placing a simple hand-held test device against the outside of the switchgear as shown in Figure 3. This simple check can be made before racking out or switching off a circuit breaker to detect a high percentage of concealed problems and after racking in or switching on a circuit breaker to detect a high percentage of potential problems such as arcing due to improper breaker alignment.

This test device's versatility goes well beyond just checking switchgear for safety purposes. Equipped with three different types of sensors and a simple multicolored LED display, the test set is capable of performing basic insulation condition surveys of medium- and high-voltage switchgear, cable, transformers, bus duct, motors, generators and many other devices. Due to the recent popularity of this new technology, it will be featured in a future article.

Figure 2 — Trying out a remote breaker racking device at our shop

Figure 3 — Using a simple hand-held partial discharge detector to ensure no electromagnetic signals indicative of insulation failure are occurring within the switchgear enclosure, a wise safety check

First Trip

Typically, circuit breakers remain dormant for very long periods of time, but when called upon to interrupt a fault, they are expected to operate within finite times based upon their protective settings. These settings are derived by conducting coordination and arc-flash studies to optimize electrical system performance and enhance worker safety. Typically, the breaker's lubrication condition

Figure 4—A vibration sensor is attached to a breaker in order to obtain critical operating characteristics.

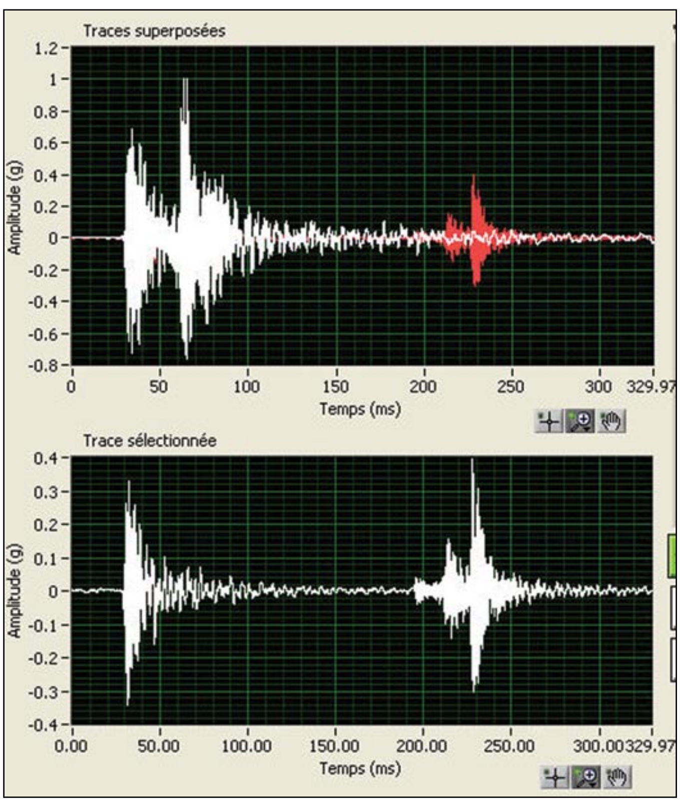

Figure 5 — First trip breaker vibration signature screenshot showing the slow-operating breaker signature (bottom graph) compared to the normal-operating breaker signature (top graph). The grossly inhibited trip timing function of the bottom breaker graph poses several concerns including much greater incident energy exposure than calculated, possible miscoordination with upstream protective devices, and the possibility of exceeding the breaker's duty capability.

changes over time, due to a number of factors, and hardens to a point where the breaker's first trip is inhibited. This first trip represents the breaker's true operating time and often differs greatly from the values expected in the studies thus adversely affecting system performance and exposing the worker to higher levels of incident energy and making the studies invalid.

The only solution to validate the studies and to protect the worker is to frequently verify breaker timing under first trip conditions. Typical maintenance and testing occurs after the breaker has already been tripped once, and thus the critical first trip condition information is lost. Regular exercising of the breaker can help the first trip performance. Frequent maintenance will also help, but these activities do not ensure optimum first trip operation.

Breaker Vibration Signature

A new technology has evolved that efficiently determines breaker first trip performance thus enabling validation of the arc-flash study. This technology has the additional benefit of verifying overall breaker mechanical condition.

A special transducer is magnetically coupled to the front of the breaker as shown in Figure 4. After the technician moves from the exposure zone, the breaker is operated. The transducer sends valuable vibration signals that represent breaker first trip timing and mechanical condition to a handheld analyzer. This unique breaker vibration signature is compared to a database library of known signatures. Posttest analysis can include superimposing the test breaker signature upon good breaker signatures, as shown in Figure 5, to quickly spot potential problems. Should the breaker fail the first trip test in the field, it is necessary to perform complete shop reconditioning or remanufacturing in order to return the breaker to a condition that will ensure proper operation and validate the arc-flash study. Frequent performance of the breaker vibration signature test ensures performance and exercises the breaker mechanism. Further details regarding this new technology will be featured in a future article.

Conclusion

As necessary safety regulations have evolved to better protect the technician, so has grown the array of technologies available to provide better and more practical protection methods. Along with these developments, additional technologies have been developed to efficiently determine equipment condition in conjunction with performing the safety-related tasks. Potentially dangerous electrical work activities can now be performed with greater safety, and these activities create an ideal opportunity to obtain critical equipment condition information.

By adding the following steps to your safety procedures, safety will be enhanced and valuable equipment condition information can be obtained. This valuable equipment condition information can then be utilized to further enhance safety and reliability.

1. Always use appropriate PPE.
2. Test the switchgear for abnormal electromagnetic activity (see figure 3).
3. Set remote actuator (see figure 1) in place.
4. Set vibration transducer (see figure 4) in place.
5. Move out of exposure zone and remotely trip breaker.
6. Set remote racking device (see figure 2) in place.
7. Move out of exposure zone and remotely rack out breaker.

Mr. Genutis received his BSEE from Carnegie Mellon University. He has been a NETA Certified Technician for 15 years and is a Certified Corona Technician. Don's technical training and education are complemented by twenty-five years of practical field and laboratory electrical testing experience. He is presently serving as Vice President of Group CBS Eastern U.S. Operations and acts as Technical Manager for their subsidiary, Circuit Breaker Sales & Service located in Central Florida.