White Paper

Help Mitigate Arc Flash Occurrences With Sequence of Event Recorders

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Introduction

Today, more and more facilities are investing in infrastructure updates and rigorous testing protocols to help mitigate Arc Fault occurrences. In the past, Arc Flash accidents, a by-product of Arc Fault, were widely viewed as a problem that could be managed with better employee training and personal protective equipment (PPE) alone. Critical facilities now realize there are more effective ways to reduce the occurrence and/or severity of an Arc Flash event. Remote testing of circuit breakers is one way to do so. Today's modern electrical power monitoring systems (EPMS) report circuit breaker status in 'real-time' but may have limited information on the actual health and integrity of the device. Therefore, visibility into a breaker that is starting to slow as it transitions may not be available. By adding Sequence of Events Recorders to the EPMS, this crucial information is provided allowing for additional preventative actions to mitigate an arc fault occurrence.

Arc Fault Mitigation

Electrical injuries represent only about 2% of all workplace accidents but can account for roughly 50% of costs associated with accidents. The severity of these accidents can not only result in equipment damage and downtime, but in bodily injury, long term patient care, and litigation. The National Institute for Occupational Safety and Health statistics state that about 3,600 disabling injuries from electrical contact occur every year in the U.S., with one workplace death every day. In the case of an Arc Flash incident, there are several factors that can contribute to the severity of an Arc Flash injury such as the type of PPE used, the amount of time the fault current let through, overall temperature of the Arc Flash, and the proximity to the Arc Blast.

Eliminating all Arc Fault occurrences is impossible. Even the best designed electrical systems can be subject to an Arc Fault incidence. The causes of an Arc Flash can be numerous, including buildup of dust or other obstructions such as liquids, insects or animals, insulation failure, corrosion, equipment failure due to wear and tear, code violations, human error, and others. Although there are many options for reducing the risk of an Arc Flash incident, the more effective arc flash safety programs look to incorporate safety through design and testing. One way of doing so is to adopt a remote operating plan thereby reducing human interaction with electrical equipment. By installing remote monitoring, control and diagnostics software into a facilities overall electrical plan and eliminating personal interaction directly with the equipment, a facility can reduce Arc Flash occurrences, and reduce risks/harm associated with Arc Flash.

Using Sequence of Event Recorders

Adding Sequence of Event Recorders (SERs) to the power monitoring system can be beneficial to any Arc Fault mitigation plan. Cyber Sciences CyTime™ Sequence of Event Recorders provide 2 key functions within an EPMS. First, they synchronize all the Intelligent Electrical Devices with one time clock. Secondly, SERs time-stamp Input/Output signals with time resolutions down to 1 millisecond. By doing so, SERs can record data capturing the exact time of both the relay trip signal and resulting state change in connected breakers. This can give you an advanced warning of breakers slowing down during transition. Over the lifetime of low-voltage and medium voltage breakers mechanical stresses like contact wear, arcing, temperature changes, and poor maintenance can cause ever increasing open and closing times. Thus, the trip characteristics of circuit breakers may change as they age. Slower tripping times may also expose the Automatic

Transfer Switch (ATS) to energy above its tested and marked Withstand Current Rating (WCR), effecting ATS timing as well as any time-current coordination curves implemented. By using SERs during breaker testing you get that data driven indicator of a slowing breaker, reducing the chances of equipment issues as well as arc flash hazards.

Because breaker opening times will vary, due to factors such as specified opening times from the manufacturer, comparing open times under similar load conditions is warranted. Testing examples would be, no load (by manual control switch), normal load (initiated by control scheme) and over-current loads (initiated by relay trip signal). As part of a circuit breaker maintenance program, accurate measurements of operating times are essential.

Verification of Arc Flash Calculations When breaker times exceed rated values it impacts the reliability of published arc flash energy calculations, making advanced warning of slowing circuit breakers crucial. Verification of those energy calculations using the SER to capture the breaker transition times with 1ms time stamp resolution provides the data needed to calculate arc flash over-current levels and test against those calculations over time.

Time-Current Coordination Selective Coordination is a way of adjusting the opening times of over-current protection devices so that the breakers or fuses nearest to the faults should open first, by adjusting and rearranging the time-current curves of protective devices so that their settings or curves have minimum or no overlapping.

NEC article 100 defines Selective coordination as:

“Localization of an over-current condition to restrict outages to the circuit or equipment affected, accomplished by the choice of over-current protective devices and their ratings or settings.”

These time-current coordination studies ensure selectivity of protective devices. Any changes to the devices and/or loads in a power system will more than likely impact study results. When a series of devices open, interrupting a fault, data from that event is recorded in the SER with up to 1 millisecond accuracy and can clarify which breakers opened and in which sequence. Matching waveforms from meters as well as fault current data will verify this event data, either to confirm proper operation or to identify problems.

Capturing Waveforms Waveform capture has been proven to be an essential tool when analyzing power quality issues. Sequence of Event Recorders from Cyber Sciences can help actuate a waveform capture with an associated power quality meter/device. Once you’ve synchronized a Sequence of Event Recorder and the recording instrument on one common precision timeline (provided by the SER), the event data and associated waveform data will be aligned. The resulting data will include a timeline of events (from the SER) and the electrical characteristics (voltage, amperage – frequency, angle) to correlate electrical anomalies with status changes in equipment. This gives the user an unprecedented level of visibility into power quality and performance, exposing potential issues and event patterns not visible with conventional meters. The user also benefits from the preservation of critical incident data for simplifying root cause analysis of a power loss event.

Conclusion

Investment in infrastructure updates and testing protocols like remote testing of circuit breakers can help reduce the occurrence and severity of Arc Flash events. When adding Sequence of Event Recorders, circuit breaker opening times can be measured precisely, then monitored over time for

latency. This helps provide early waring that breaker maintenance or replacement is needed. SERs can also be used to verify Arc Flash calculations, operation counts, time-current coordination, and trigger waveforms for capture with an advanced power meters to evaluate opening times under load/ overload conditions. By adding Sequence of Event Recorders to your electrical power monitoring system you will increase the reliability, efficiency, and safety of your electrical system.

References

[1] G&W Electric, "How Current Limiting Devices for Low-Voltage Applications Can Help Save Lives for Your Organization", July 2019.

[2] Durocher, David B., "Implementation of Arc Flash Mitigating Solutions at Industrial Manufacturing Facilities", August 2015.

[3] Parsons, Anthony, Ph.D., P.E., Tajali, Reza, P.E., "Mitigating Arc Flash Hazards", 2018.

[4] Reeves, Adam P.E., Loucks, David G. Ph.D., P.E., "What You Need to Know About Arc Flash - Understanding and Mitigating the Dangers of Electrical Explosions", August 2018.

[5] Kennedy, Robert A., P.E., "Measuring Circuit Breaker Opening Times with CyTime™ Event Recorders", October 2015.

[6] Rehman, Abdur P.E., "Time Current Characteristics Curves for Selective Coordination", 2022.

[7] Bowman, Marc, Katz, Allen, "Optimizing Data Center Power Management with Advanced Multi-Circuit Monitoring Systems", 2020.

For more information on Sequence of Event Recorders, visit:

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