Arc Flash Reduction Systems—Are They Always a Good Idea?

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Introduction
This data bulletin discusses the merits of using arc flash reduction systems. These systems are intended to protect electrical workers doing live or hot work (working on energized equipment) by reducing the arc flash incident energy levels.

NFPA 70E, Standard for Electrical Safety in the Workplace®, defines the personal protective equipment (PPE) that must be used by workers when doing live work based on the hazard level at the location being worked on. This hazard level, referred to as a hazard/risk category, is calculated based on the prospective arc fault current at the location and the speed of operation of the upstream overcurrent protective device at that current level.

It is assumed that the reader is familiar with arc flash hazard and its related terminology. It is not within the scope of this data bulletin to discuss arc flash hazard, how it is quantified and the related terminology in detail. NFPA 70E should be consulted for that purpose, and IEEE Standard 1584 should be consulted for how to calculate incident energy levels.

What are arc flash reduction systems?
Arc flash reduction systems temporarily lower the potential arc flash incident energy level while live work is being performed in order to protect the workers and allow them to wear less restrictive PPE. These systems may be necessary in electrical installations where the speed of operation of upstream circuit breakers has been intentionally slowed in order to achieve selective coordination. This may have been accomplished by increasing the instantaneous trip level of the circuit breaker or by utilizing a circuit breaker with no instantaneous trip function at all.

Reducing the arc flash hazard, should an arc fault occur, can be achieved through a number of ways. These methods include activating the circuit breaker trip unit instantaneous trip function, setting this function to a lower level, or enabling a special faster acting instantaneous trip function.

What do the codes say?
Selective coordination is required by the National Electrical Code (NEC), NFPA 70, in a number of applications, including two or more elevators fed from a common feeder (620.62), emergency systems (700.27), legally required standby systems (701.18), critical operation power systems (708.54) and essential electrical systems in health care facilities (517.26). Many times, meeting these requirements results in an increase in incident energy levels in these systems. In accordance with NFPA 70E this can result in an increase in the hazard/risk category and thus an increase in the PPE required to do live work.

What is available?
Arc flash reduction systems are available from a number of manufacturers. Not surprisingly, each manufacturer has a slightly different solution, requiring specifiers and users to understand what is being offered and how it works in order to determine whether or not it will result in safe work practices in their application. The following is a brief summary of what is
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available, based on the information published by the manufacturers as of this date.

All of these manufacturers offer systems that allow the instantaneous trip level to be defined when the arc flash reduction system is activated. For some this involves a separate faster acting trip system.

Arc flash reduction is activated by different means by the various manufacturers. These include:

- A lockable switch mounted close to the circuit breaker but not inside its enclosure, so that doors do not need to be opened in order to enable it.
- A manual switching means plus a proximity sensor that will automatically actuate the system when movement is detected within the approach boundary.
- A keypad on the trip unit, by local switching means or remotely via a communications network connection.

Arc flash reduction systems may not be available for all types of circuit breakers. One manufacturer offers it only on their insulated case and low voltage power circuit breakers. Others offer it only on their low voltage power circuit breakers. It is unclear if any offer it on molded case circuit breakers.

Application Considerations

There are a number of aspects of arc flash reduction system operation that should be considered when determining if the use of such a system will result in safe work practices and Code compliance.

Code Compliance

As previously stated, the NEC requires selective coordination in certain applications. Neither current (2008) nor past editions of the Code provide any allowance for defeating the circuit breaker settings necessary to achieve coordination, even temporarily, during periods of maintenance. Can a circuit breaker equipped with an activated arc flash reduction system be considered Code compliant? What implications might this have should an accident occur?

NFPA 70E requires a written work plan, work meeting and special permit when live work is to be done. Will an arc flash reduction system allow the writing of a safe live work plan?

Selective Coordination

Using an arc flash reduction system requires that two coordination studies be done, one under “normal” operating conditions and one under maintenance conditions when the arc flash reduction system will be activated. This latter study is necessary to insure that motor starting, transformer energization and other high current transient conditions will not cause the circuit breaker in question to open. Can this be achieved?

Manual Operation

In those installations where the arc flash reduction system is manually activated, will the worker(s) remember to turn it on before the work begins, and will they remember to turn it off when the work has been completed? Keep in mind that the work to be done may be at equipment that is remotely located from the circuit breaker on which the arc flash reduction system is operating.

LOTO

Safe work practices typically call for lock-out/tag-out (LOTO) procedures to be followed. These procedures usually call for the worker to open a disconnect device, lock it open, and to conduct a voltage test to insure that the circuit or equipment is safe to work on.

While live work by definition does not involve the opening of a disconnect device, it would seem that work with a reduced level of PPE should involve
locking the arc flash reduction system in the activated position and testing to insure that the function has indeed been activated. Can this be done? Is it possible to activate or deactivate the function from multiple locations, and if so, does applying a padlock in one location disable the switching functions in the other locations? Does the system provide feedback indicating that it has been activated?

**Arc Flash Labeling**

NFPA 70E requires that equipment be labeled with the arc flash hazard at that location, specifying the level of PPE required to conduct live work within the approach boundary. If an arc flash reduction system is provided, would this require two labels on the equipment? If there are two labels, could a worker become confused when faced with what may appear to be conflicting information? If the equipment being worked on while energized is remote from the circuit breaker, would the “arc flash reduction active” label need to be at the remote location, instead of with the circuit breaker on which it is operating?

Depending on where the arc flash reduction system is located, the reduced hazard may apply to only a portion of the equipment. For example, if the system is on a main circuit breaker, the hazard reduction would apply to anything downstream, but not upstream, from the main circuit breaker. In other words, while it might be safe to work in a feeder compartment with a reduced level of PPE, it would not in the main breaker or incoming cable compartments. How would the labels read in such a situation and where would they need to be located?

Would these labels potentially create confusion for the worker(s)? What implications might this have should an accident occur?

**Applicable Equipment**

An arc flash reduction system can only reduce the hazard downstream. Would it allow safe work in a downstream (feeder) compartment if it is located in the same equipment as the main circuit breaker? What about cross or riser bus? Would additional barriers or compartmentalization be required? Or can it only reduce the hazard in remotely fed equipment?

**Actuation Methods**

What activation methods are acceptable? A keypad on the trip unit? A switch? A motion sensor? Network communications? Can the method be locked by the padlocks carried by maintenance workers? If two or more workers are working on the equipment, machine or system, can multiple padlocks be used?

If a motion sensor is used and the equipment is rear accessible, will there also be a sensor in the rear? What if the work to be done is on remotely mounted equipment? Is constant motion necessary for actuation? Is inadvertent operation possible?

**Other Arc Flash Reduction Solutions**

Other solutions to reducing the arc flash hazard are available.

**Reduce the Fault Current**

Lowering the prospective fault current can result in the dual benefits of reducing the arc flash hazard and simplifying the task of achieving selective coordination. One of the simplest ways to do this is by reducing the size of transformers feeding a facility, such as utilizing two smaller transformers rather than one large one.

**Zone Selective Interlocking**

Zone Selective Interlocking (ZSI) is available on most full function (LSI or LSIG) low voltage electronic trip circuit breakers and ground fault relays and also on some protective relays for medium voltage circuit breakers. Detailed information about what Zone Selective Interlocking is, how it works and how
to apply it is outside the scope of this document; for more information see data bulletin 3000DB0810.

**Masterpact® Low Arc Flash Low Voltage Power Circuit Breakers**

Masterpact NW and NT low arc flash low voltage power circuit breakers clear faults very quickly and provide comparable arc flash protection to fuses at high currents and better arc flash protection at lower currents. Plus, they eliminate problems common to fused switches and fused circuit breakers. Detailed information about these circuit breakers, how they work and how to apply them is outside the scope of this document; for more information see data bulletin 3000DB0810.

**Differential Relaying**

Differential relaying can also be employed to reduce the arc flash hazard. Once again, detailed information about the design and application of protective schemes employing differential relays is outside the scope of this document.

**Conclusion**

Before specifying equipment with arc flash reduction systems, a thorough study of the safe live work practices to be performed on the electrical system should be conducted in order to determine whether or not arc flash reduction can indeed be effectively used. Such a study should take into account the nature of the work to be performed, where the work will be performed and where the arc flash reduction system needs to be located in order to reduce the hazard at the work location. Consideration should be given to the activation method that should be employed, where it should be located and how equipment in the system will be labeled. Written work procedures and LOTO practices should also be considered. Selective coordination studies with and without the function activated should be conducted.

Finally, passive solutions that eliminate the possibility that the arc flash reduction system will not be activated when needed or activated not needed and that will avoid potentially confusing labeling and work procedures should be considered.