

# TechTopics No. 78

## Personal protective equipment (PPE) required with metal-clad switchgear

There is growing awareness among electrical practitioners of the need for appropriate personal protective equipment (PPE), such as arc-rated (as well as flame-resistant) clothing, face shields, arc flash hoods, dielectric gloves and the like. This interest is a result, at least in part, of the increasing requirements in the regulatory environment (for instance, Occupational Safety and Health Administration (OSHA)) and in the evolution of NFPA 70E®-2012, the Standard for Electrical Safety in the Workplace. The availability of educational forums, and particularly of the annual IEEE Electrical Safety Workshop, has also contributed to increased interest in the field.

As users have considered the implications of PPE, particularly where the incident energy exposure is high, they have been drawn to evaluate the use of arc-resistant, medium-voltage switchgear. Testing of equipment to determine the ability to withstand internal arcing events is in ANSI/IEEE C37.20.7-2007. Testing is conducted at the specified internal arcing current and duration. Normally, the arcing current value is equal to the short-circuit current rating of the equipment, and the preferred arcing duration is 0.5 seconds.

The 2009 and 2012 editions of NFPA 70E recognize reduced PPE requirements for certain operations involving arc-resistant switchgear that has been tested under internal arcing conditions in accordance with ANSI/IEEE C37.20.7.

The recognition of the reduced PPE needed is contingent on meeting two additional conditions:

- Clearing time under arcing conditions must be 0.5 seconds or less
- The prospective fault current must be no higher than the rated arcing current of the equipment.

The first condition requires that the user select settings for the protective relays that will provide a clearing time of less than 0.5 seconds under arcing conditions. The user must determine the settings, and must also consider the interrupting time of the circuit breaker(s) that will have to interrupt the fault. For example, if the interrupting time of the circuit breakers is 5 cycles (83 ms), and several circuit breakers must operate to clear any conceivable fault (thus requiring an interposing lockout relay – device 86), the total clearing time is approximately 83 ms plus 8.3 ms (assumed lockout relay operating time), plus an allowance for margin. For an approximation, this would indicate that the allowable protective relay operating time must be around 0.5 seconds, less 100 ms (0.1 second), or a net of 0.4 seconds relay operating time.

For the assumed five-cycle interrupting time circuit breaker, the following values apply:

- Relay operating time 0.400 s
- Circuit breaker interrupting time 0.083 s
- Interposing or lockout relay operating time 0.008 s
- Allowance for margin 0.009 s
- Total clearing time 0.500 s.

The second condition mandates that the rated internal arcing current of the equipment (in accordance with ANSI/IEEE C37.20.7) must be at least equal to the rated short-circuit current of the equipment, assuming that the equipment is applied on a system that has an available short-circuit current that is approximately the short-circuit rating of the equipment. This is generally the case, as few users would intentionally purchase equipment with a short-circuit current rating that is significantly in excess of the available short-circuit current on the system (including future considerations).

Table 1: Hazard/risk category (HRC) metal-clad switchgear lists some of the operations for which NFPA 70E recognizes a lower PPE level for arc-resistant, metal-clad switchgear than for non-arc-resistant, metal-clad switchgear. Some of the operations listed in Table 1 are not listed in NFPA 70E, but are considered to be consistent with the principles of NFPA 70E.

An example of this extension of the table is the elaboration of additional operations involving ground and test devices (G&T devices), where NFPA 70E only lists the operation for arc-resistant switchgear.

It should also be noted that NFPA 70E does not list operations in exactly the same language, so some of the operations shown have been elaborated from those described in NFPA 70E.

It must be remembered that arc-resistant switchgear is only classified as “arc resistant” when it is in its intended installed condition, with doors and panels closed and securely latched (or bolted, if applicable), and with the actual installation conforming to the instructions of the manufacturer. The equipment is not in its intended installed (arc-resistant) condition when the equipment has open panels or doors, as is the case when a circuit breaker is being inserted into the compartment from outside the unit, or rear cable connection compartments are open for inspection of cables, and the like. Under these conditions, the level of PPE required with arc-resistant equipment is the same as that required for the equivalent non-arc-resistant equipment.

**Table 1: Hazard/risk category (HRC) metal-clad switchgear<sup>1</sup>**

HRC category	Arc-resistant equipment	Non-arc-resistant equipment	HRC category
0	Infrared thermography outside restricted approach boundary (doors closed) <sup>2</sup>	Infrared thermography outside restricted approach boundary	3
0	Circuit breaker operation (door closed)	Circuit breaker operation (door closed)	2
NA	Circuit breaker operation (door open) <sup>3</sup>	Circuit breaker operation (door open)	4
0	Insertion or removal of circuit breaker (door closed)	Insertion or removal (racking) of circuit breaker (door closed)	4
4	Insertion or removal of circuit breaker (door open)	Insertion or removal (racking) of circuit breaker (door open)	4
0	Insertion or removal of voltage transformer (VT) or control power transformer (CPT) on or off the bus (door closed)	Open VT or CPT compartments (for example, to insert or withdraw VT or CPT)	4
0	Insertion or removal (racking) of G&T device (door closed)	Insertion or removal (racking) of G&T device (door closed) <sup>4</sup>	4
4	Insertion or removal (racking) of G&T device (door open)	Insertion or removal (racking) of G&T device (door open) <sup>4</sup>	4

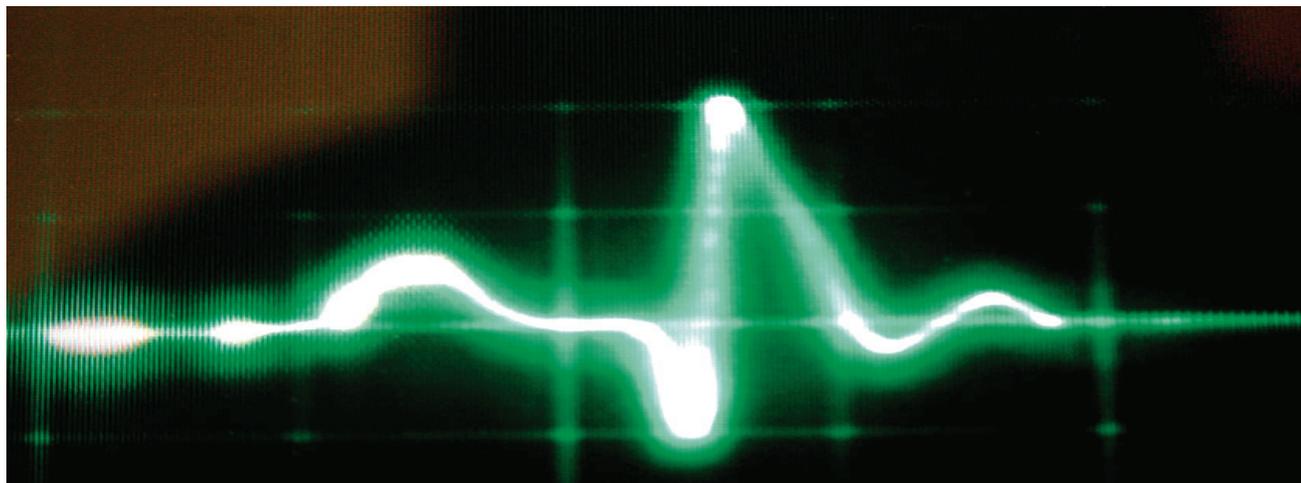
**Footnotes:**

<sup>1</sup> Based on NFPA 70E table 130.7 (C) (9) for operations performed while equipment is energized

<sup>2</sup> Not shown in NFPA 70E. HRC category = 0 inferred as circuit breaker operations with door closed are HRC category = 0 for arc-resistant equipment

<sup>3</sup> NA as door of arc-resistant equipment is interlocked to prevent closing of circuit breaker with door open

<sup>4</sup> Not in NFPA 70E. HRC category = 4 inferred from comparable operations with circuit breaker.



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