WHAT ARE YOU REALLY GETTING WHEN YOU SPECIFY EEMAC ARC RESISTANT SWITCHGEAR?

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The Electrical and Electronics Manufacturers of Canada (EEMAC) produced document G14-1 to serve as the Canadian testing procedure for evaluating metal-clad switchgear for internal arcing faults. It was based on the International Electrotechnical Commission (IEC) 298 Annex AA and included specific procedures and ratings that were unique to the Canadian market. The document has not been modified since it was published in 1987. While it is effectively obsolete, many specifications still include EEMAC G14-1 as the test procedure for rating the arc resistant performance.

In 1987, when G14-1 was written, the circuit breakers used in metal-clad switchgear were rated on an MVA basis, which allowed the short-circuit current to vary based on applied voltage. Circuit breakers based on IEEE C37.06 preferred ratings went to 1000MVA for a 15kV class device. This meant that a 15kV circuit breaker could be applied at 11.5kV and 48kA or at 15kV and 37kA. Since most indoor systems were nominally rated 13.8kV, the short-circuit current was 40kA. While the corresponding switchgear was likely braced for the maximum current, the interrupting device limited the requirement. Testing for an internal arc fault of approximately 40kA was a reasonable approach. Unfortunately, most high power laboratories could not provide that current at full rated voltage for a long duration. Typical short-circuit testing is performed at less than 1000V because it is calibrated as a through current and the voltage is not relevant. The arc fault test is calibrated as a prospective current and full voltage is required to assure the correct current is driven through the impedance of the sample and the arc.

The EEMAC test procedure eliminated some of the difficulties for the labs, by allowing two tests; a 10-cycle pressure test made using peak current and full voltage with a separate and a 1-second burn-through test made with symmetrical current. These two tests could be combined if the lab was capable. It also allowed testing at reduced voltage if the delivered current measured within 10% of the prospective value. Laboratories and manufacturers quickly found out that 10% was a difficult value to hold.

The use of two test durations has some basis in the equipment rating structure. The peak pressure test of 10-cycles is equal to the equipment momentary withstand test duration. However, the 1-second symmetrical test duration is less clear and may be related to a lab capability concession. For the IEC equipment, 1 s is the duration of the short-time current withstand test, but for North American equipment the short-time current withstand is 2 seconds. Unlike the momentary and short-time tests, the destructive nature of the arc fault test mandates that each test be performed on a new, clean sample. This testing approach bears little resemblance to a 1-second arc fault on in-service equipment.

Since the writing of G14-1, the capabilities for switchgear a circuit breakers has increased. 40kA is no longer the typical limit. 63kA equipment is now common. The 1-second duration becomes a serious obstacle for most labs at these current levels. As a result, new equipment testing is being performed to IEEE, IEC, and CSA procedures, not to EEMAC.

So what does this mean to the EEMAC customer? The customer must review the test reports for each application.

The IEEE and CSA tests are very similar to the EEMAC Type A and Type B testing and both Guides contain a test that approximates the EEMAC Type C rating. The IEC test has a number of differences in the basic procedure that make a comparison to EEMAC difficult; the burn indicator placement (placed at
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10 inches, not 4 inches) and the Accessibility Type rating structure (IEC Type A is the closest to EEMAC rating Type B. There are no other similar ratings).

The fundamental differences between EEMAC and the IEEE or CSA test are the removal of the two test option and the introduction of a preferred test duration of 0.5-seconds. While the rated duration does not have to be 0.5-seconds, the laboratory capabilities at higher test currents may dictate shorter test times. The Test Guides allow any duration, as long as it is marked on the equipment nameplate. The user must coordinate the protective scheme to operate within the nameplated duration.

The following items must be identified and confirmed by the equipment manufacturer for the user to make a fair assessment of modern arc resistant designs for EEMAC specified applications:

1. **Accessibility Type** – Since the same designation means different performance levels between the different Test Guides, both the Guide and Accessibility Type must be identified and understood.
2. **Arc Fault Current Level** – Different Test Guides call the tested current level by different names. It is imperative that the actual test current be known; it cannot be assumed to match the equipment Short-Time Current Withstand rating.
3. **Actual Test Duration** – Manufacturers are free to test at any duration as long as the value is on the equipment nameplate. It must be confirmed that the tested duration exceeds the application requirements for safety or protection coordination.
4. **Burn Indicator Placement** – Different distances from the sample are used in different Test Guides. This greatly alters the construction of the equipment. Do not assume internal Burn Indicators are present. If compartment to compartment evaluation is required, the test report should show where internal indicators were placed.
5. **One Test Verses Two** – Testing the fault as a single event is more damaging to the equipment than testing for short duration overpressure (peak current) and long duration burn-through (symmetrical current) in two separate tests on different test samples.
6. **Protection Mechanism** – The user must know what makes this equipment arc resistant. EEMAC testing did not evaluate modern Arc Mitigation devices. The EEMAC test is a mechanical evaluation of an enclosure that withstands and directs the fault byproducts away from the protected areas. Modern Test Guides allow evaluation of installed devices designed to current-limit or direct the current away from the fault. The circuit location and operating times of such devices must be known and coordinated with the circuit protection.

So what do you get when your specifications call for EEMAC G14-1 and the equipment has been tested to another Test Guide?

IEEE C37.20.7 provides the test procedure that is closest to the original EEMAC procedure. The significant difference is the preferred duration. The CSA document follows the IEEE document, but allows some of the test parameters to go outside of the IEEE and EEMAC procedures so they envelope the IEC test procedure. The IEC procedure contains numerous and complicated differences in procedure and ratings when compared to the EEMAC procedure.

Any of the Test Guides mentioned in this brief will provide a method for evaluating metal-clad switchgear for performance under conditions of an internal arcing fault. Successfully passing their requirements will...
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provide an improved performance should an arcing event occur. The user must determine what parameters are most important and select equipment qualified to the Test Guide providing those parameters. All Arc Resistant equipment is not equal.

Michael Wactor, P.E.
Technical Director – Research and Development