PPE and Arc Resistant Switchgear

October 07, 2010

A common misconception made when considering the application of Arc Resistant Switchgear is that it completely eliminates the need for PPE. All of the arc fault test procedures and requirements commonly accepted in North America share a similar evaluation method based on monitoring gas release using cotton burn indicators. High temperature gas may be released from the equipment, but not in a sufficient quantity to cause ignition of the indicators in the specified time. Successful testing literally means that under the conditions of a full short-circuit level 3-phase arc fault, the untreated cotton indicators (cloth weight of 150g/cm²) placed 4” from the gear will not ignite and that the equipment does not break open/burn open or eject parts for a fault duration indicated by the nameplate (typically 0.5s). The implication being that if the indicators do not burn, an operator in the same area will not be burned.

The evaluation measures exposure to “survivable” or “curable” burns verses life-threatening or incurable burns; it does not confirm an injury-free condition. Most AR gear designs do not actually reduce the Incident Energy; they simply redirect the hazardous by-products away from the areas where the operator might be working. Essentially this means the AR design acts like PPE; providing an effective barrier between the operator and the fault. The extent of this barrier is discussed in the 2009 edition of NFPA 70E. Activities that require opening the equipment or operating the equipment outside the established rating for arc fault mitigation will expose the user to hazardous conditions. It is therefore wise to consider some level of PPE when working around or on equipment, even if it carries an Arc Resistant rating.

MV equipment meeting the test requirements of C37.20.7 is recognized in the 2009 edition of NFPA 70E as providing protection from arc energy when the appropriate doors and covers are closed and the clearing times of the circuit protection devices and the prospective fault current are coordinated with the arc resistant rating of the equipment. Refer to NFPA 70E section 130.7(c)(9) on page 33 of the 2009 edition. In this table, the Hazard/Risk Category is identified for performing specific functions on Arc Resistant Switchgear. The Hazard/Risk Category defines the appropriate PPE. The advantage of AR gear is a significant reduction in PPE required by NFPA 70E for the identified activities with MV switchgear. Activities such as circuit breaker operation (opening or closing) and insertion or removal (racking) of the circuit breaker with the doors closed can be classified as Hazard/Risk Category (HRC) 0 for qualified MV switchgear. The recommended protective clothing characteristics for HRC 0 are Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, silk or blends of these materials) with a fabric weight of at least 4.5 oz/yd². There is no minimum arc rating of PPE required. The protective clothing recommended is a long sleeve shirt and long pants. Additionally, PPE recommended is safety glasses or goggles, hearing protection and leather gloves (electrically rated if required).

Arc resistant equipment carrying an IEEE C37.20.7 suffix B rating (Type 1B or 2B) has been tested with the instrument compartment door open. The burn indicators are placed 4” outside the opening of the door to simulate personnel standing in the open doorway. In a successful test the indicators do not ignite, demonstrating that the energy released through the open instrument compartment due to a primary circuit fault is equivalent to the protection provided by closed the doors and covers of the primary circuit compartments. Inside the instrument compartment, the energy level may be higher. This test
PPE and Arc Resistant Switchgear

does not imply that it is safe to work inside the energized equipment as the test does not evaluate faults on components within the compartment. When the voltage in the instrument compartment is higher than 120V, the compartment is considered by NFPA 70E to be an HRC 2 area. A similar argument can be made for equipment carrying a suffix C rating (Type 2C). NFPA 70E makes no distinction between any of the suffix ratings found in IEEE C37.20.7 Annex A. In other words, NFPA 70E does not recognize arc resistant ratings claiming protection between adjacent compartments.

Unfortunately, AR LV gear is not yet recognized by NFPA 70E. Powell has used calorimeters in addition to the IEEE C37.20.7 required cotton indicators for many of our LV equipment arc tests. Our observation is that a successful test never measured more that 2 cal/cm². While this measurement is not in accordance with any test guide and does not provide 100% coverage of the exposed surfaces, the results indicate performance in the 0 Hazard/Risk Category.

For these reasons, it is recommended that the scope of work and risks be thoroughly reviewed before any activity requiring opening a door or removing a panel on energized equipment. Recognizing that an internal arcing fault may release up to 2 cal/cm² in HRC 0 and that arc fault risks exist in the LV circuits of the designated instrument compartments, Powell recommends HRC 1 clothing and PPE as the minimum for any work on energized equipment.

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