POINT EIGHT POWER

information sheet

Arc Resistant Switchgear

What is Arc Fault Damage?

Arc Flash is normally the result of a short circuit that can occur randomly, because of poor maintenance practices, deteriorating insulation creating ionization, tools being left behind on live bus bars, animals, or any such event. The fault can occur between phase and ground or across phases. A series of destructive and life threatening events are set in motion, as illustrated in the four panels to the right. In the worst case, the complete system available short circuit can flash across the fault, causing considerable damage.

Arc Current can flash across the short circuit. A plasma arc is created by this energy, which can create temperatures as high 35,000 ºF within a millisecond. The arc flash can expand with high speed that can exceed 300 feet per second. There is an immediate burst of radiation of visible and invisible light, in the range of 300 to 1500 nm, copper expands and vaporizes by a factor of 67,000.

Arc Blast is immediate, and a powerful pressure wave occurs which can exceed thousands of pounds, accompanied by sound that can exceed 160 db. Material, metal, flames and smoke is expelled away from the arc at speeds exceeding 700 miles per hour, which can create shrapnel that completely penetrates the body. Arc flashes can kill at a distance of 10 feet.

Arc Fault collectively describes the forgoing events.

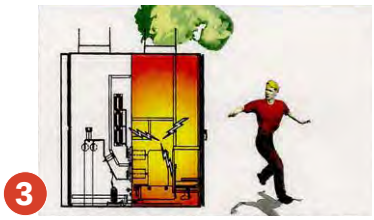
Safety Steps. NFPA 70E requires the use of Personnel Protective Equipment (PPE) when operating switchgear, and IEEE C37.20.7 is the defining Standard for Arc resistant switchgear. PPE clothing is rated from Hazard/ Risk Category 0 to Category 4. The use of Arc-resistant switchgear can materially reduce the Hazard/Risk rating, a result of which could be less stringent (or no) PPE clothing. **Most important however, is that even though PPE can protect against burning, shock, or similar hazards, it CANNOT PREVENT AGAINST INJURIES CAUSED BY THE VIOLENT NATURE OF AN ARC FAULT EXPLOSION.** Arc resistant switchgear can however, contain these violent forces which can mitigate or prevent injuries, or worse. (Certain information above is derived from NFPA 70E)

Representative views of switchgear damaged or destroyed by the effects of an arc fault.

Arc Fault Stages

1. Compression Stage: generally lasts 5-10 ms after the initial arc fault. Gasses are compressed prior to roof pressure relief flaps opening. Total pressure on front door and other panels could exceed 30,000 psi.

2. Expansion Stage: generally happens 5-10 ms after the relief flaps open, reducing the interior pressure. Flame, smoke and blast by-product volume flows through the roof relief flap.



3. Emission Stage: generally lasts 50-100 ms. Superheated smoke debris and by-products burst from the cubicle in contact with air.

4. Thermal Stage: All the of the blast by-products (Superheated smoke, debris, particles, gasses, etc.) are exhausted from the cubicle into air. This condition will last until all the fuel is consumed. Personnel must leave the area due to the gasses, heat, debris, etc. (this can be mitigated by the use of a roof mounted collector plenum).

It is the responsibility of the end-user of electrical switchgear to provide a safe operating environment for their personnel, and to properly train their personnel in the safe operation of switchgear, and in accordance with required safety procedures of relevant regulatory agencies such as OSHA, NFPA, NEC, etc.

1510 Engineers Road, Belle Chasse, LA 70037• 504.394.6100 • 800.284.1522 • www.PointEightPower.com

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Type Testing Criteria

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Controlling the Power You Generate

Sample tests

Test standards require that a thermal indicator rack (2 meters high) containing black cotton fabric be placed in front (and sides/rear for Type 2) of cubicle being tested. If the fabric ignites during a test, this is a failure. During a series of tests, a cubicle may sometimes fail. After investigation, corrections are made (at the lab) on remaining cubicles and the tests continue. Normally, spare cubicles are included for retest. (FIG1)

During a test series, a cubicle failed. Upon investigation it was found that a plug weld was not strong enough for the forces exerted. The plug weld design was changed to stitch welds at the laboratory (and in later production) and the unit was retested. This photo is representative of a bolted short circuit failure that could occur in non-arc resistant switchgear. (FIG 2)

There were several subsequent tests after the welding design change, and they all passed. This photo illustrates how the front of the switchgear has contained the arc fault explosion, and the energy debris has been moved to the top Collector Plenum. In an actual installation this would be vented from via an exhaust duct. (FIG 3)

IEEE C37.20.7-2007 Test Criteria

Following are the IEEE C37.20.7-2007 test criteria assessments required to pass Arc Resistant Type Tests. These tests are conducted in at the high power KEMA test laboratory.

- Arc duration should be maintained for 0.5 seconds.
- No fragmentation of the enclosure occurs within the test time. IEEE allows small parts up to 60 grams to be ejected over the 2 meter height.
- There shall be no burn-through of metal cubicle surfaces (Type 1 & Type 2).
- No cotton indicators shall be ignited. Surface charring is permitted.
- All grounding connections remain effective.

Following discusses Accessibility features described in IEEE C37.20.7-2007:

- Accessibility Type 1: Switchgear with arc-resistant designs or features at the freely accessible front of the equipment only.
- Accessibility Type 2: Switchgear with arc-resistant designs or features at the freely accessible exterior (front, back, and sides) of the equipment only.

Suffix B: This is a new standard that applies to Type 1 and Type 2. It applies specifically to compartments designated as low voltage control , or instrumentation compartments. During testing, "Suffix B" requires that indicators be placed directly in front of such compartments with the doors removed to evaluate the entrance of ionized gases into those compartments.

Suffix C: This suffix is designated for equipment where isolation from the effects of an internal arcing fault is desired between all of the compartments within a vertical switchgear cubicle. An arc fault within a vertical cubicle with compartments would undoubtedly cause bowing and distortion which would render the complete vertical cubicle unusable. Point Eight Power switchgear is constructed with a double 11 gauge wall between cubicles, and the Vertical Isolation Plenum (VIP) separates adjacent vertical cubicles by six inches, minimum. Consequently, since there has never been burn-through between adjacent vertical cubicles, Point Eight Power equipment is offered as Suffix C between adjacent vertical cubicles.

Suffix D: This is a new standard. It is designed for special applications where certain installations would require that flame indicators be placed at the front of the switchgear, and then only those surfaces (sides or rear) that are accessible to personnel.

Additional Comments on IEEE C37.20.7-2007

1.2.4: Allows tests carried out on a particular design to be transferred to another design, if the original design was more severe.
5.1.1, i: Where interior venting tunnels pass through several vertical cubicles in the design, a separate test of 2 meters of the venting tunnel will be performed to check leakage to adjoining cubicles. (Point Eight Power switchgear does not use such venting tunnels).
5.1.2. b: Allows a "generic" cubicle to be used for different purposes (C.B., P.T.'s, etc.) providing the generic cubicle has the most restrictive design configuration.

Annex B.2.4.4: Discusses the use of light & current detection to reduce the arcing time, and mitigate the arc flash. It also discusses the use of partial discharge monitoring to detect corona buildup and prevent Arc Flash. Point Eight Power switchgear is tested without these devices, and recommends them only for fully rated equipment. They are available as optional products.

Some of this information is derived from the IEEE C37.20.7-2007 Guide.

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