An Alternative Approach to Mitigate the Catastrophic Impact of Arc Flash Explosions

By Betty Jackson, Senior Product Manager
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Arc flash explosions are a major cause of death and injury among workers performing routine electrical equipment maintenance and/or inspections. It's estimated that five to 10 arc flash explosions occur every day in the United States, according to the research and consulting firm CapSchell. The US Bureau of Labor Statistics reports that the main cause of electrical worker electrocution from 1992 to 1999 was contact with "live" (energized) equipment and wiring. The hazard exists mostly because of a failure to de-energize and lock out or tag out electrical equipment and wiring.

The potential damage to business is great. An arc flash explosion can destroy equipment, disrupt operations, cause company downtime, delay production and order fulfillment, prompt litigation, and boost workers' compensation claims and premiums. So industry, government and private associations have doubled their efforts to help original equipment manufacturers (OEMs) gain a greater understanding of arc flash hazards, and find ways to protect workers and improve compliance with safety regulations.

According to The National Electric Code Internet Connection by Mike Holt Enterprises (www.mikeholt.com), "Arc Flash is the result of a rapid release of energy due to an arcing fault between a phase bus bar and another phase bus bar, neutral or a ground. During an arc fault the air is the conductor. Arc faults are generally limited to systems where the bus voltage is in excess of 120 volts. Lower voltage levels normally will not sustain an arc. An arc fault is similar to the arc obtained during electric welding and the fault has to be manually started by something creating the path of conduction or a failure such as a breakdown in insulation."

Arc flash explosions, like this one, are the result of a rapid release of energy due to an arcing fault between a phase bus bar and another phase bus bar, neutral or a ground.

"The cause of the short normally burns away during the initial flash and the arc fault is then sustained by the establishment of a highly conductive plasma. The plasma will conduct as much energy as is available and is only limited by the impedance of the arc. This massive energy discharge burns the bus bars, vaporizing the copper and thus causing an explosive volumetric increase, the arc blast, conservatively estimated, as an expansion of 40,000 to 1. This fiery explosion devastates everything in its path, creating deadly shrapnel as it dissipates," according to information on the site.

The Occupational Safety and Health Administration (OSHA) maintains that electrical work should only take place on de-energized equipment. OSHA adopted the National Fire Protection Association's "70E Standards for Electric Safety in the Workplace" as an acceptable means of compliance to meet this requirement.

OSHA can issue citations and levy fines for non-compliance. Section 1910.333 of Subpart S states, "Safety related work practices shall be employed to prevent electrical shock or other injuries resulting from either direct or indirect electrical contacts." Therefore companies take great lengths to ensure that electrical workers are safe from arc-flash dangers. However, understanding NFPA 70E and its terms and calculations can be difficult, and there is no clear course to arc flash mitigation.

Incident energy, defined by NFPA as "the amount of energy impressed on a surface, a certain distance from a source, generated during an electrical arc event," is a key term in understanding arc-flash hazards. Incident energy is a measure of the heat created by the electrical arc and is expressed in calories per centimeter-squared.

According to NFPA 70E Standard for Electrical Safety in the Workplace, 2004 Edition, pages 12 and 28, the two most important numbers to remember are 1.2 and 40. Incident energy levels greater than 1.2 calories per centimeter-squared can produce second-degree burns. The NFPA 70E requires that workers wear personal protective equipment (PPE) when working with 50 volts or more. Arc flash levels above 40 calories per centimeter squared can be fatal and usually result in a massive pressurized blast with sound pressure waves and projectiles. The PPE is available for exposures up to 100 calories per centimeter-squared; however, the force from the pressurized blast can be fatal regardless of the PPE.

"Determining arc flash levels can be daunting," said Tom Fjerstad, Hoffman electrical engineer. "A piece of equipment's arc flash hazard level depends on the level of arc fault current and the time it takes to trip the nearest upstream overcurrent protection device. In most cases, a local utility engineer can determine the fault current levels; however, these fault current values may be based on the impedance of the transformer that serves the facility, and the additional impedances from upstream the transformer can lower the number. If the additional impedances are not included in the calculations, the incident energy levels may be underestimated. This can have an impact on the arc flash warning labels placed outside the equipment that detail the protective device model numbers, feeder lengths, PPE requirements and fault current levels.

"There can be discrepancies in the information listed on the warning label," said Fjerstad. "Short-circuit current levels in electric utility systems are continuously changing and both electricians and maintenance workers replace overcurrent devices. Also, fuses and panel boards can be changed or upgrades can be made to the system. Any of these changes can have an effect on the arc flash energy level, thus making the detailed information on the warning label inaccurate. Arc flash analysis must be updated on a regular basis and when system changes are made."

Even when companies prepare their employees for arc flash hazards and take necessary precautions, accidents can still happen. Contributing factors seem innocent enough; a worker drops a tool or inadvertently touches live components. Even when one might imagine the situation to be safe, an electrician working on components within an enclosure may accidentally contact live voltage. This scenario is easily plausible even after a disconnect switch or circuit breaker is de-energized.

Because there is no single piece of equipment and no one process that can completely eliminate arc flash hazards, professional groups like the IEEE Industrial Applications Solutions (IAS) Committee are passionately pursuing new standards to improve workplace safety. Traditional approaches like safety switches or PPE can have drawbacks.

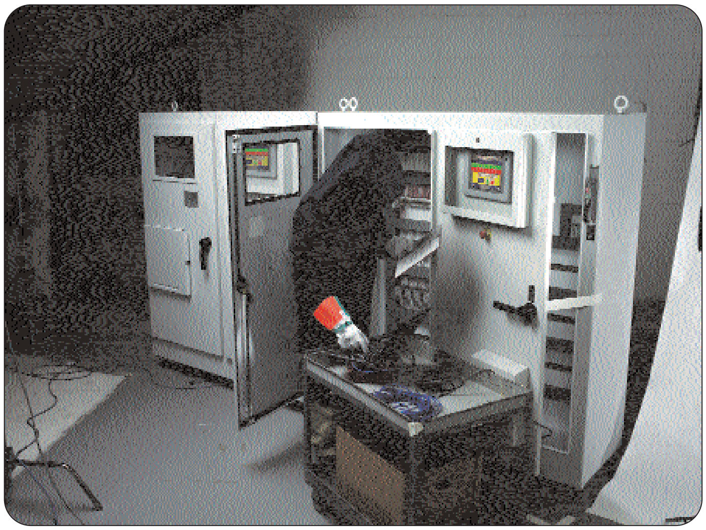
During private discussions, electrical engineers have revealed that, despite their compliance training, they sometimes skirt the PPE rules because the bulky, fire-retardant suit, gloves, face shield/goggles and other gear is hot, uncomfortable and makes service and maintenance time-consuming and cumbersome.

Hoffman, a manufacturer of systems to protect electronics and electrical controls, has been studying arc flash in order to help manufacturers offer additional safety measures to compliment the workplace safety standards outlined by NFPA 70E. In late 2006, Hoffman introduced a power isolation enclosure-a smaller enclosure-interlocked to the main enclosure to isolate, or sequester, the fused disconnect switch or circuit breaker from the main control panel.

The SEQUESTR™ External Disconnect Enclosure attaches to the side of a main control enclosure and houses only the disconnect switch or circuit breaker, physically removing it from the main enclosure. Power passes from SEQUESTR to the main enclosure via a terminal block mounted on the shared enclosure walls. When the disconnect switch is thrown to the off position, there is truly no live power coming into the main control enclosure. The live line side of the disconnect switch is isolated in the SEQUESTR enclosure.

What makes the SEQUESTR a safer and more effective solution? The answer is to compare it with the traditional approach, which is to turn off the power source to the enclosure and require electricians to suit up in PPE. With traditional disconnect enclosures, even when power is turned off, live power is still present on the line side of the disconnect switch. In this scenario, since live power is still being fed upstream to the disconnect switch on the panel, the threat of an arc flash incident remains.

This method is not only potentially hazardous, but it entails considerable compliance costs, since it may require a production shutdown for monitoring controls or initiating a simple programming change.



To deal with possible arc flash explosions, electrical engineers wear bulky, fire-retardant suit, gloves, face shield/goggles. This hot and uncomfortable gears and makes service and maintenance time-consuming and cumbersome.

SEQUESTR affords the highest level of safety for this task, because it isolates the switch in a small, interlocked enclosure. Live power is no longer present in the main control enclosure when power is turned off at the disconnect switch. It completely shuts down the power in the main cabinet, and there is no hazard of power coming into the box. Its system also interlocks the doors of the main control cabinet when the disconnect switch is powered on. This allows users to comply with the disconnect door interlocking requirements of UL 508A, NFPA79, IEC 60204, and HS 1738, the most common electrical standards for industrial machinery.

Hoffman's Sequestr External Disconnect Enclosure isolates the switch in a small, interlocked enclosure so main power is no longer in the cabinet

Because the disconnect switch or circuit breaker is now isolated, SEQUESTR enables technicians to work inside the main enclosure without the need for PPE (after verifying that power on the load side of the switch is not present). This offers manufacturers a solution that supports both work place safety and increased efficiency and productivity.

The SEQUESTR™ External Disconnect Enclosure is available in two offerings: as a complete package for OEMs building new systems with a main control enclosure and a small SEQUESTR enclosure, and as a retrofit kit for upgrading existing installations with the small SEQUESTR™ External Disconnect Enclosure.

The SEQUESTR package supports the defeater feature of the disconnect switch. Its interlocking system meets the following industry standards: Underwriters Laboratories (UL) 508A, UL508, UL Type 12, National Electrical Manufacturers Association (NEMA)/EEMAC Type 12, JIC Standards EGP-1-1967 and EMP-1-1967, Canadian Standards Association (CSA) C22.2 No. 94 Type12 and IEC 60529 IP55.

While it is the responsibility of facility managers to ensure that safe work practices are strictly being followed, Hoffman's SEQUESTR provides an added level of protection to workers and their operations, while ensuring a safer work environment.

Elizabeth (Betty) Jackson is a Senior Product Manager of industrial enclosure segment the leading North American manufacturer of electrical enclosures. For more than 20 years, she has been instrumental in developing and introducing new electrical enclosure platforms. Her varied experience in the design, manufacture, and marketing of enclosures provides a unique background to discuss enclosure specifications.

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Hoffman, based in Anoka, Minn., is a part of the Pentair Technical Products Group. Other businesses in the Technical Products Group include Pentair Electronic Packaging, Schroff, Pentair Enclosures Europe, Pentair Enclosures Asia, and McLean. Hoffman is a leading designer and manufacturer of systems that safely and reliably protect the electronic controls and mission critical electrical systems in industrial, data communications, commercial construction and government applications.

With more than 60 years of experience, extensive technical expertise and a vast distribution network, Hoffman is recognized as an industry leader providing a broad range of standard, modified and custom enclosure solutions, serving customers worldwide. For more information, visit our website at www.hoffmanonline.com.