Arc flash exposure is arguably the most critical safety issue in electrical power distribution equipment and operations – especially in the coal and mining industry, where the dust from coal, mixed with the potential burst of energy from an arc flash event, could be deadly. The explosive release of energy from an arc flash can instantly generate temperatures up to four times the temperature of the sun. It is crucial to use the appropriate UL-tested and certified equipment in every application to reduce risks to personnel safety and to avoid equipment downtime.

10 things about arc flash safety to help protect personnel and operation

Why arc flashes occur
An arc flash is the explosive energy released when an electrical fault, for instance a short circuit, causes an arc. The dangers associated with an arc flash event include heat, flying debris, sound, UV radiation and more.

In an ideal world, work on electrical equipment would be performed with de-energised equipment. In continuous process applications, that approach is not always possible.
Regardless, working on energised equipment should be considered a last resort.

An explosion four times hotter than the sun
The mere drop of a tool or accidental contact with electrical systems can set off an arc flash and instantly generate an energy explosion releasing temperatures in excess of 36 000°F – that is four times hotter than the sun.

The energy discharge from an arc flash is massive, resulting in an energy release at temperatures exceeding that of the sun’s surface, as well as explosive pressure waves, shrapnel and toxic gasses. The destructive power of an arc flash can be immense. An enormous amount of concentrated radiant energy explodes outward from electrical equipment in an arc flash event. Solid copper conductors are vapourised, expanding to 67 000 times their original mass, creating a superheated ball of plasma gas that can severely burn a worker’s body. If the arc releases sufficient energy, a worker’s non-flame-resistant clothing will ignite. Workers wearing flame-resistant clothing can also sustain burns if the arc releases energy above the thermal rating of the flame resistant fabric.

As powerful as an eight-stick dynamite blast
A 10 000 A arc on a 480 V circuit can have the explosive force of eight sticks of dynamite. Another example of the energy in an arc flash: copper expands at 67 000 times its volume during an arc flash event – a small, pea-sized piece of copper would expand to fill the volume of a railroad car!

Power intensive environments are especially vulnerable
In heavy-power continuous-operation industries, such as mining, arc flash poses a very real threat. Environments operating with 125 kVA, or larger, transformers call for special safety measures. Protecting personnel and equipment is everyone’s responsibility.

Employees require education
Electrical workers must be trained and should understand the risks of arc flash safety. This includes reading and understanding arc flash labels and wearing the proper personal protective equipment (PPE) to perform energised work. Codes and standards are always changing and it is imperative that organisations be in compliance.

When working on energised equipment is necessary, a safe work procedure should be defined in accordance with relevant regulations, e.g. the US Occupational Safety and Health Administration (OSHA) Code of Federal Regulations (CFR) 1910 Subpart R or Subpart S and the National Fire Protection Association (NFPA) 70E-2015.

Arc flash labels provide advance warning
Arc flash labels indicate two key pieces of information: the expected incident energy (measured in calories per cm²) at a working distance of 18 in. or 24 in. This drives the proper PPE required for protection. And the distance a worker without PPE must work to avoid a non-curable burn (typically measured in feet).

Equipment must be labelled so the danger is known. Based on an arc-flash-incident energy analysis, equipment is labelled for electrical workers. This provides personnel with important information to comply with the relevant regulations and standards (e.g. the NFPA 70E standard). Each arc flash label provides:
1. Nominal system voltage.
2. Calculated arc flash boundary.
3. Available incident energy and working distance.

Avoiding electrical disasters
Time and distance are the most controllable variables that reduce the risk of arc flash issues. Reducing the time that an event persists by tripping a breaker or blowing a fuse significantly reduces the arc flash incident energy. Increasing distance to the arc flash by remote operation, or with closed doors or protective barriers, protects workers in case an event occurs.

Better equipment can help
Installing the right equipment can help mitigate arc flash hazards. Specially designed low-voltage motor control centres (MCCs) and switchgear can reduce the probability of electrical shock and arc flash energy during maintenance.

The NFPA 70E standard requires that electrical equipment is maintained (and documented) in line with manufacturers’ guidance and relevant codes and standards. The responsibility for maintenance and documentation falls on equipment owners (or their representatives).

Human error is often to blame
The most common cause of electrical accidents is human error. And the majority of those mistakes occur during routine maintenance of power system equipment or troubleshooting controls.

For many decades, the danger of shock hazards or electrocutions have been well understood. An electrical shock occurs when the human body comes into contact with an energised conductor. During a shock event, current travels through the body toward the ground. It takes only milliamperes of current to cause serious injury or death. Perhaps the even greater electrical hazard that is somewhat less understood than shock hazards is arc flash. Unlike a shock incident, 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 system ground. An arc flash event is typically caused by human error as personnel are working on or near energised electrical equipment. An arcing fault is typically caused by a dropped tool or accidental contact of a test probe between an energised conductor and ground.

Good safety optimises operational efficiency
A sound safety policy incorporating arc flash safety solutions will protect personnel and equipment, minimising risk and increasing uptime.
The key things to remember in order to address arc flash hazards are protection, time, distance and exposure. Arc flash hazards can be reduced by:

1. Wearing appropriate PPE.
2. Placing protective physical barriers between a potential arc flash event.
3. Reducing the time or duration of a potential arc flash event.
4. Increasing the distance between personnel and equipment.
5. Reducing incident energy levels personnel.

**MCCs and arc flash prevention**

MCCs are traditionally the most effective way to group motor control, associated control, distribution and industrial communications equipment. That said, MCCs need to be routinely accessed for maintenance, which means that electrical safety is crucial as personnel are working on equipment.

The latest MCC technology can help enhance safety and prevent arc flash events in new ways. MCCs require regular maintenance and have higher instances of user interaction than most other electrical equipment. For that reason, safety during maintenance and longevity are typically top considerations when looking for new equipment or updating existing installations. Specifically, industry-leading MCC technology, which is designed to both prevent an arc flash event and protect personnel if an arc flash occurs, is now available. Arc-preventative and arc-resistant technology can now be combined within a single MCC.

Eaton’s FlashGard® arc-resistant MCC builds on nearly a decade of more than 10,000 installations and establishes new levels of protection for personnel and equipment in a wide range of new and retrofit industrial applications. The technology is one of more than 55 Eaton solutions designed to help prevent arc-flash hazards and the company continues to invest in R&D to deliver products that foster safer, more reliable work environments.

In 2007, the first arc-preventative motor control solution designed to help prevent and protect personnel and equipment from the dangers of arc flashes was available. Unlike conventional MCCs, this technology enables units to be disconnected and reconnected to the vertical bus with the unit door closed, maintaining a dead-front barrier during maintenance operations, which helps enhance operator safety. The solution also incorporated a retracting-stab mechanism, which is designed to provide bus isolation, stab indication and lockout features to actively prevent the initiation of an arc flash event.

Today, solutions are available that are engineered to provide the added benefit of National Electrical Manufacturers Association (NEMA) Type 2 arc-resistant construction, meaning that arc resistant designs or features are present on the front, back and sides of the assembly. This Type 2 rating translates to enhanced safety around the entire perimeter of the MCC should an arc flash event occur. Arc-resistant MCCs need to be tested and verified per the criteria found in the Institute of Electrical and Electronics Engineers (IEEE) guideline C37.20.7 and Canadian Standards Association (CSA) standard C22.2 No. 0.22-11. Additionally, these MCCs should be Underwriters Laboratory (UL) 845 approved.

In addition, circuit breakers can be equipped with technology that reduces incident energy levels – this kind of technology can help reduce fault-clearing time at work locations downstream of the device. For added protection, an optional remote-operated racking device can advance and retract the bus connections from a distance of up to 25 ft to keep operators well outside of the arc flash boundary.

In other words, equipment already in the field can be effectively modified to enhance arc flash safety. It is imperative MCCs have third-party testing, especially to ensure products are not counterfeit. These gray market solutions could pose great threat to the safety of operations and personnel. When peoples’ lives are on the line, certified products are crucial. 

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Eaton provides a variety of power distribution and controls assemblies that address arc flash safety.