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Help Protect Yourself and Your Personel from the Dangers of Arc Flash

A guide to Getting Smart about Arc Flash Prevention

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What is Arc Flash?

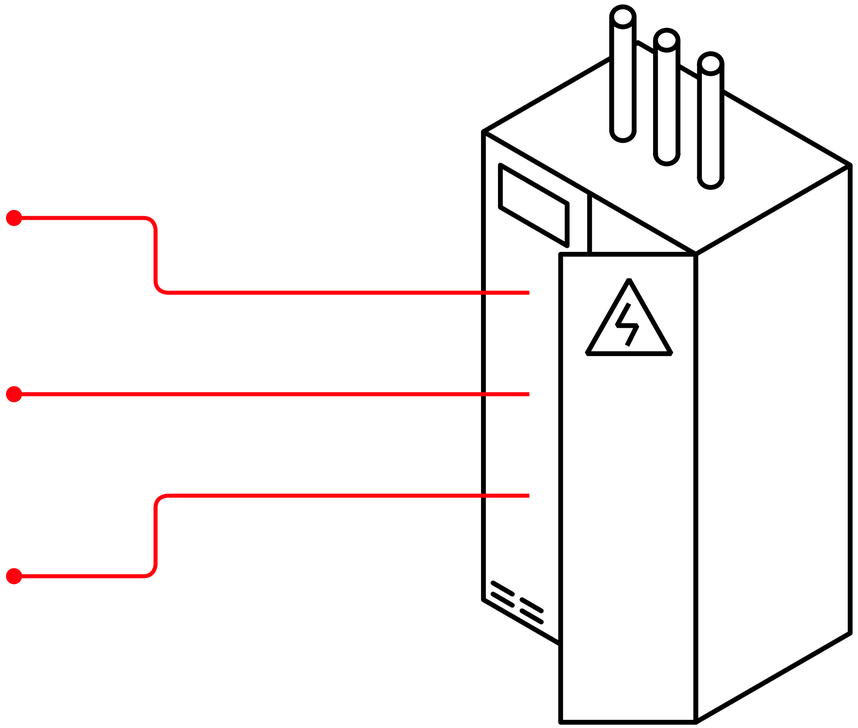
The textbook explanation of arc flash is an event occurring during an electrical fault or short circuit that passes through a physical air gap, or bridge, between two electrodes.

The real-world story is that an arc flash incident is dangerous, and even deadly, and can cause severe harm to the people and equipment involved.

Temperatures can reach
35 000 degrees Fahrenheit
hotter than the surface of the sun

The sound it creates is
64 times louder
than a passing freight train

Costs incurred by
arc flash damage can reach
the millions in employee claims, insurance costs, equipment replacement and lost productivity



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Experience Arc Flash

Arc flash is a very dangerous and even deadly event that you never want to experience in real life. But if you did, what would it be like? What precautions should you take to help prevent arc flash, and what should you know before working on electrical equipment? We take you through the entire experience right now.

Do the study

An arc flash study is based on recommendations set forth by the National Fire Protection Association (NFPA) but also relies on mandated industry standards and regulations from OSHA, the Institute of Electric and Electronics Engineers (IEEE) and the National Electric Code (NEC). The study looks at the electrical system design, equipment, system specifications and safe practice procedures. Calculations are used to determine the arc flash incident energy within specific boundaries of the equipment and measure the degrees of risk.

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Safety first

Electrical panel maintenance crews must wear Personal Protective Equipment, or PPE, before working on a panel. PPE consists of flame-resistant clothing, voltage-rated gloves, face shields, full-coverage flash suits, insulated blankets, ear plugs and safety glasses that help protect personnel from the light, heat, sound and explosion of an arc flash. PPE should be considered the last line of defense against arc flash.

When should you wear PPE?

There are different levels of PPE required depending on the calculated incident energy of an arc flash. Coming into contact with an electrical panel containing energized conductors, such as standing within even a few feet of an open electrical panel, carries a risk of arc flash and requires the appropriate level of PPE. While PPE can be an important safety measure, it should be noted the best way to protect yourself and your employees from arc flash hazards is to de-energize the electrical equipment before working on it.

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Know the boundary

There are four arc flash boundaries that are calculated to help determine the level of bodily harm you could sustain based on your physical distance from an arc flash. Boundaries are determined through the arc flash study that calculates the amount of power the arc flash could have, as well as how long it could last.



Flash Protection Boundary

1

You could sustain second-degree burns, which are a significant injury but would likely fully heal.

Limited Approach Boundary

2

This boundary should only be approached by qualified workers wearing PPE as it encompasses an area in which an arc flash shock hazard could occur.

Restricted Approach Boundary

3

This area carries an increased risk of arc flash due to accidents made while working on the panel, and should only be approached by qualified workers wearing PPE.



Prohibited Approach Boundary

4

This area is so dangerous it is considered the same as making direct bodily contact with live parts. It should only be approached by qualified personnel wearing PPE and with an absolutely necessary reason for working so close to the equipment.

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Get to work

NEC- and NFPA-mandated labels help inform about the dangers of arc flash and requirements for maintenance and personnel, and should be looked at prior to opening the panel doors. You should also be sure the busbar is first de-energized; however, even if the equipment is de-energized, energy can still be stored in parts of the equipment and create an arc flash.



Watch the circuit

An arc flash is a type of short circuit in which damaging amounts of current are allowed to flow through a circuit. The circuit is completed through the air, causing it to break down and become conductive. This breakdown results in almost zero resistance to the electrical current, which allows the current to become stronger, causing an explosion.



Don’t slip up

Arc flash incidents can be caused by the accidental slip of a tool, or a loose part or your own hand touching live parts of the equipment. They can also be caused by insecure connections in the electrical equipment, improper installation or broken or moving parts, as well as dust, animals or bugs, corrosion, oil, grease or other impurities. Any of these factors can act as the catalyst a current needs to jump from one conductor to the next.



Blinded by the light

An arc flash is brighter than the sun, and can cause severe skin damage and blindness. Even if you’re wearing safety glasses, the brightness of the light can cause immediate, permanent blindness.

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Too hot

The sun is 9,000 degrees Fahrenheit however, an arc flash gets up to a whopping 35,000 degrees Fahrenheit. Even though an arc flash lasts for only a fraction of a second, it ionizes the air, generating heat so powerful it can cause fatal skin burns, the risk of which is greatly reduced by the use of PPE.



Cover your ears

An arc flash causes a very loud sound created by quickly-moving air, or a sound wave, that can reach 140 decibels at a distance of just two feet. Standard earplugs typically protect only up to 105 decibels, and you can go deaf from the intense arc flash sound.



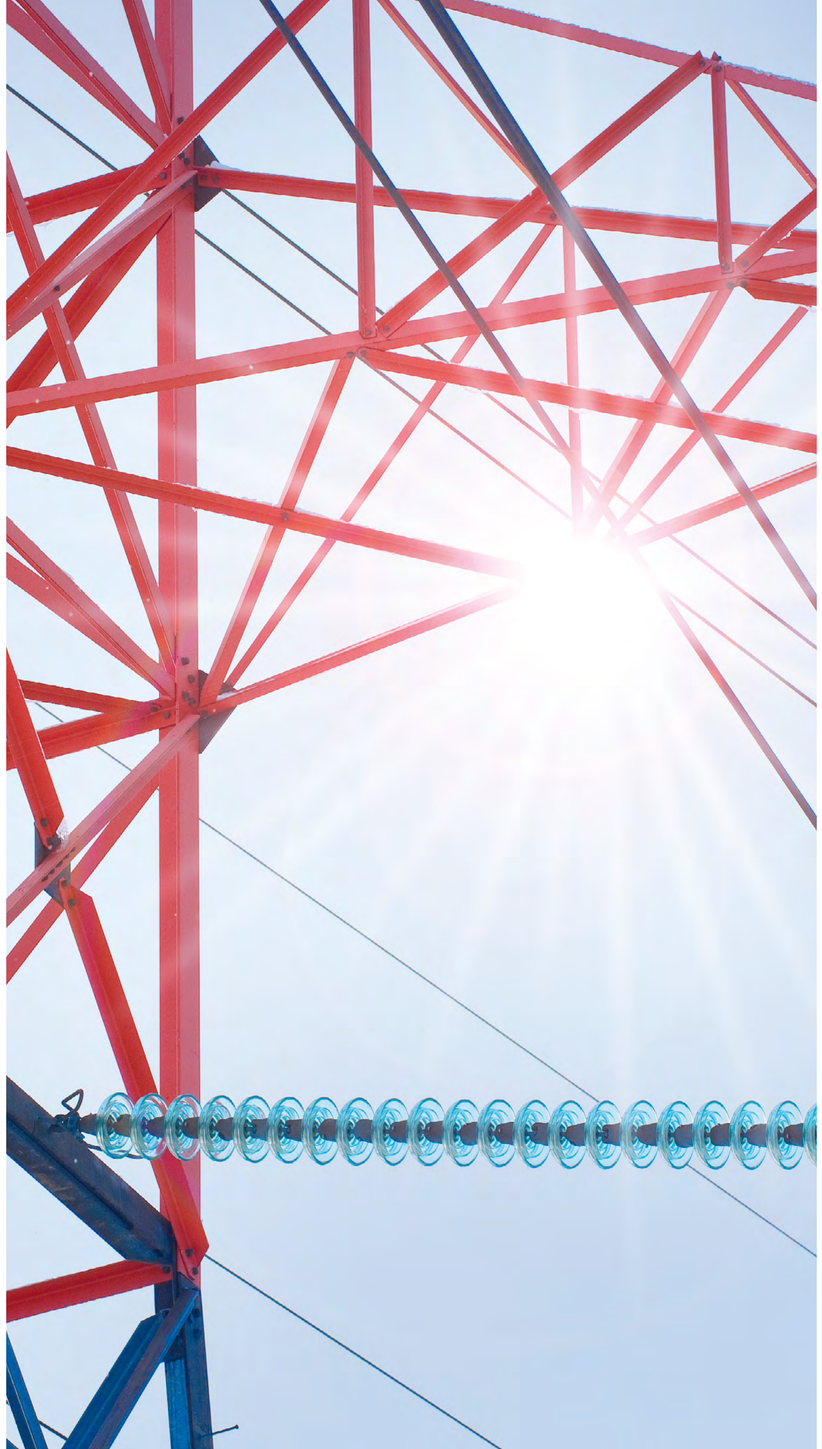
Hold on

Copper vaporizes from the heat generated by arc flash, creating a volume of gas that can be 67,000 times greater than its solid form. The explosion creates a wave of intense pressure than 700 miles per hour.

Additional Reading:

OSHA Safety Manual

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Understand the science

So what really happens anyways?

Arc flash can be caused by several factors:

- Accidental contact across conductors during maintenance or troubleshooting
- Component failures
- Use of underrated or improperly installed equipment
- Contamination or tracking over insulated surfaces
- Corroded cables, equipment or parts
- Lack of maintenance
- Presence of animals or insects

Arc flash can also be caused by compromising safety for system reliability.

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Load and Resistance

In a safely-completed circuit, a load is present to provide resistance to the flow of electricity, or the current. If the load is not present, the circuit is completed through the air. During arc flash incident, air breaks down and becomes conductive, losing its resistance and creating an arc.

Current

Electricity is able to travel easily through the air between the wires of cables inside the panel when voltage is high and resis-tance is low. This causes the current to increase tremendously leading to an explosion and other destructive forces.

Circuit Breaker

A circuit breaker is an electrical device that is designed to protect the wiring in an application. When the breaker senses a current above a certain threshold, it will open the circuit to prevent current flow.

Time is an important factor in arc flash events. The longer the circuit is closed, the higher the level of incident energy. Circuit breakers should be selected to open as fast as possible, while at the same time coordinated to avoid nuisance tripping.

Short circuit

An arc flash is a short circuit. When a temporary and unex-pected current, or fault, occurs, it causes a short circuit that allows damaging amounts of current flow through a circuit.

Voltage

Voltage is simply the “pressure” that moves the current along a conductor. It is an important factor in the severity of an arc flash event.

Additional Reading:
OSHA Safety Manual

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Arc Flash Prevention

Taking on today's electrical distribution challenges

Because arc flash is a big danger, engineers and equipment manufacturers are using a variety of approaches and technologies to help mitigate the conditions and potential hazards that can lead to arc flash.

- Making Your Circuit Breakers Selective
- Making Your System More Compliant
- Making Your System Design Preventive
- Making Your Procedures Safer

1 — Selectivity

2 — Compliance

3 — Prevention Through Design

4 — RELT

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Selectivity
Get selective

What is selectivity?

Selectivity refers to selectively-coordinated breakers, and is a technique where the circuit breaker closest to the fault trips first, thereby reducing the affected area of interruption. These new techniques use communications between intelligent circuit breakers. Modern system designs increasingly call for sensitive and fast-acting circuit breakers to be selective.

If protection isn't selective, short circuits can result in equipment outages, affecting much more of the facility than required. Selectivity can be compromised if, to achieve lower arc flash incident energy, the circuit breaker trip points are set too sensitively.

But doing so creates a dilemma: do you sacrifice safety for reliability, or vice versa, in order to achieve selectivity?

You Don't Have To Compromise!

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First: get smarter

Smart power distribution systems and breakers offering advanced communications and monitoring capabilities are now being deployed to control selectivity while providing higher performance, system reliability and better protections against arc flash incidents.

Modern trip units can now signal their responses to electrical events using embedded communications capabilities.

Second: start communicating

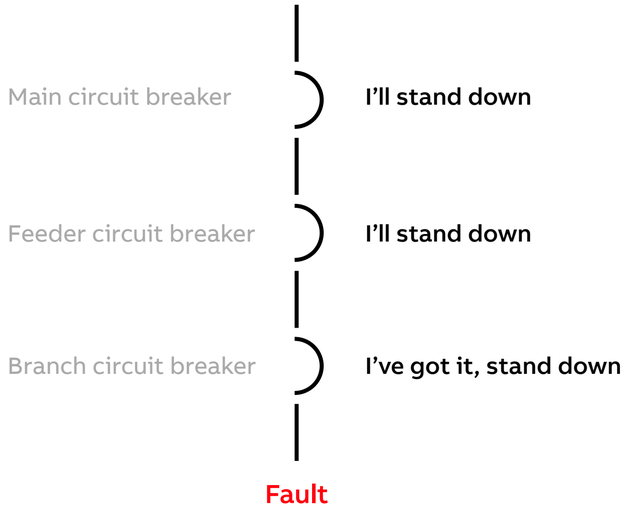
Two embedded communications capabilities we offer are instantaneous zone selective interlocking, or I-ZSI, and wave form recognition, or WFR.

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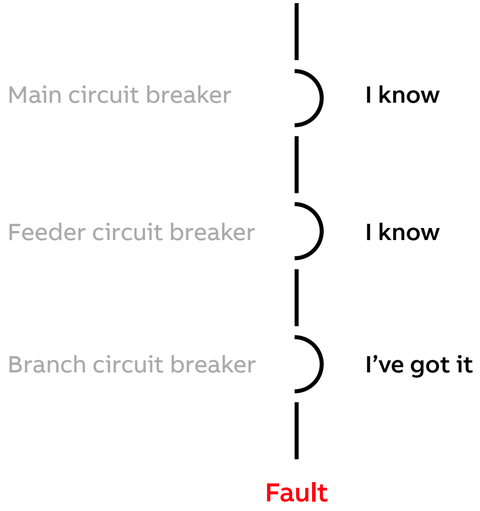
I-ZSI

Instantaneous Zone Selective Interlocking (I-ZSI) deploys multiple layers of large circuit breakers that operate as a system to protect against either small overloads of large faults. Each circuit breaker only operates when needed and acts as backup only when necessary. I-ZSI capability provides virtually instantaneous protection selectively, regardless of the size of a power system of the main circuit breaker.



WFR

Wave Form Recognition (WFR) is an algorithm that instantly allows a feeder (downstream circuit breaker above a panel or motor control center) that has current-limiting fuses or circuit breakers to be set at very sensitive levels while still providing selectivity. This technique provides a high level of virtually instantaneous protection when and where it's needed.



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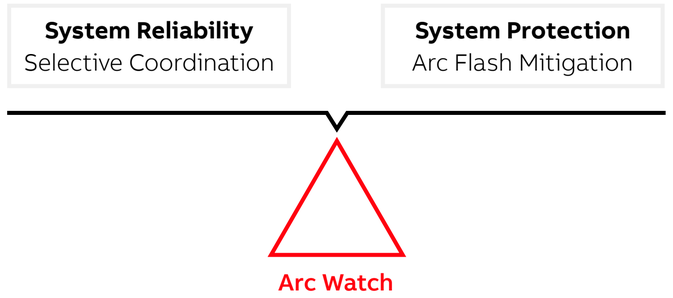
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Third: use a balanced solution

Our ArcWatch technology allows you to achieve system reliability through selective coordination through arc flash mitigation. We do this with current-limiting molded case circuit breakers, which are nested based on their energy-limiting let-through. These circuit breakers mechanically achieve selectivity by design. Combined with WFR and I-ZSI, you get a no-compromise solution.



Learn more about ArcWatch

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Compliance

How compliant is your equipment?

Codes and guidelines are the foundation for any arc flash protection plan. Arc flash mitigation starts in the electrical system design process and is guided throughout by a range of best practices, standards and regulations.

See how your equipment stacks up:

- Arc Flash Study
- Warning Labels
- PPE
- Arc Energy Reduction Standards

VIEW THE LIST

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Arc Flash study

Conducted to calculate potential arc flash incident energy and determine boundaries around the equipment that each carry varying degrees of risk.

You can read more about incident energy and arc flash boundary calculations in the IEEE Standard 1584-2002 and IEEE Standard 1584a-2004, Amendment 1 and IEEE Standard 1584b-2011 Amendment 2.



Warning labels

Applying detailed and durable arc flash hazard warning labels are an NEC requirement for field-marking potential arc flash hazards. These labels must include both arc flash hazard and shock hazard boundaries.



PPE

Adds another layer of protection for employees working within the arc flash boundary. Failure to wear the proper protective clothing and equipment puts you at serious risk of injury or death in the event of an arc flash.

You can learn more about PPE requirements:
NFPA 70E 130.5(b) and NFPA 70E Table H.3(b)
OSHA 1910.132(d)(1)

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Arc energy reduction standards

The NEC requires that circuit breakers be adjusted to 1200A or higher and must implement one of the four following methods in order to avoid additional calculation requirements:*

Zone selective interlocking technologies such as ABB's instantaneous zone-selective interlocking and wave form recognition.

Differential relaying, which detects differences exceeding a set pickup level, tripping all protective devices feeding a zone.

Energy-reducing active arc flash mitigation systems that contain and isolate the energy of an arc flash.

Energy-reducing maintenance switch, which limits the duration of the fault current by temporarily lowering the trip threshold of breaker.

How did you do?

The good news is there is circuit breaker line that can help. Systems designed with our circuit breakers can meet these requirements, helping you to remain fully compliant and achieve selectivity without sacrificing system reliability or arc flash protection.

Arc flash mitigation begins with system design.

SEE HOW

* For full details consult NEC 2017 240.87.

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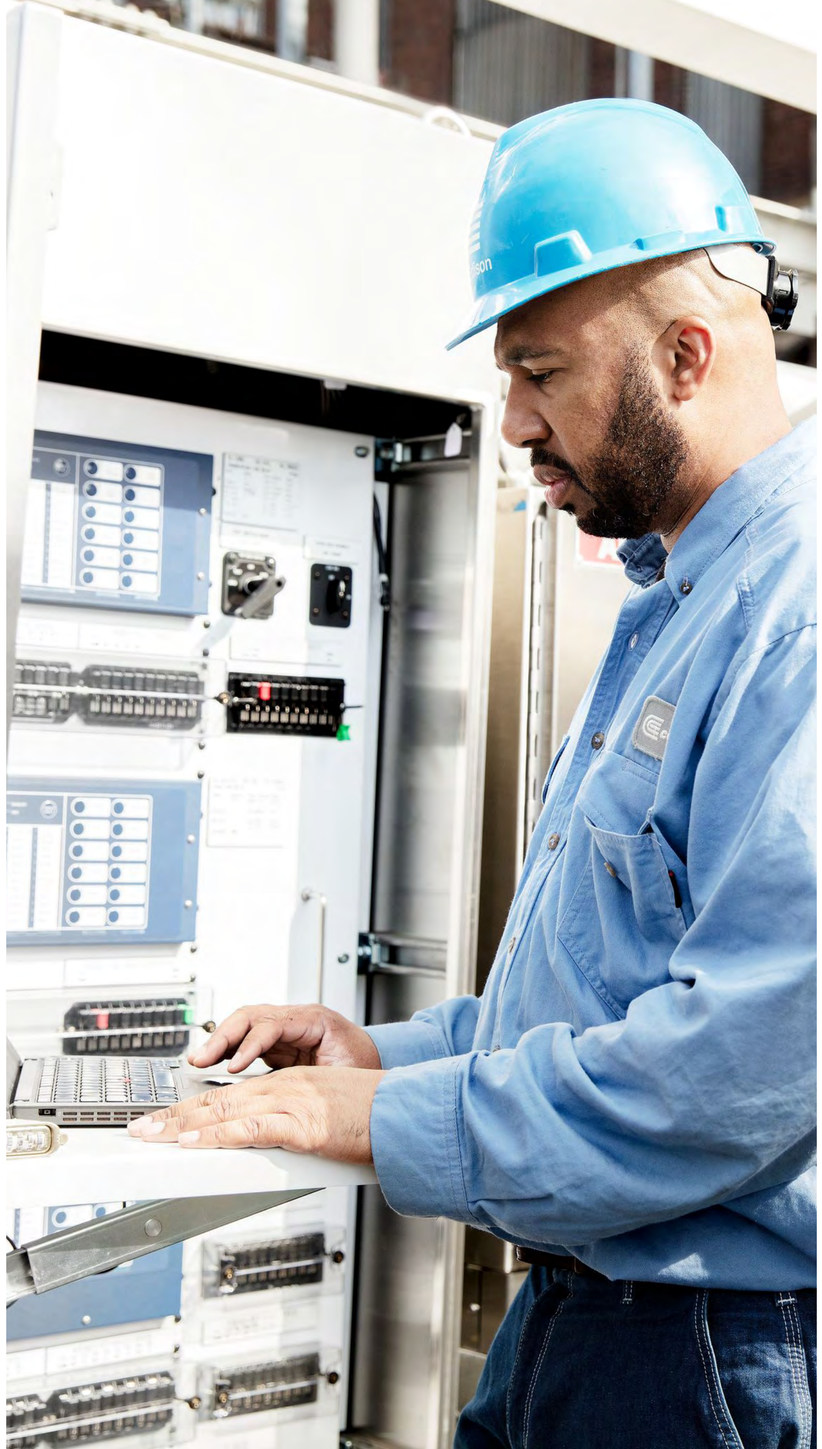
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Prevention Through Design
Building safer panels for your customers

Prevention Through Design helps reduce the risk of arc flash hazards, making electrical equipment safer for operators and electrical technicians. It applies to both the equipment design and the behavior or mindset changes necessary to keep personnel safe.

When you design your next system, employ these design considerations as part of arc flash mitigation.

SHOW ME

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01.

Keep workers outside of hazard zones by conducting an arc flash study that identifies protection boundaries, and implement arc flash warning labels that make those boundaries and PPE requirements clear.



02.

Use remote monitoring and control systems to conduct operations such as metering functions, opening or energizing breakers or reviewing a log of condition events. Human machine interface (HMI) displays and touch-screen controls allow many operations to be remote-controlled from tens or even hundreds of feet away from the main power equipment being served.



03.

Leverage remote racking systems to control the circuit breaker housing and work safely away from the racking operation. These remote racking units are portable and use a motor to rack the breaker into or out of the cubicle. The motor is controlled remotely with a hand-held control attached to rack low-voltage breakers in and out.



04.

Employ a reduced-energy maintenance switch, an approved* technology that lowers the energy and duration of an arc flash event. It is essentially a second instantaneous protection function that enables faster instantaneous trip protection. We call this technology Reduced Energy Let-Through, or RELT.

* Per 2017 National Electrical Code (NEC)

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05

Use smarter circuit breakers. Smart power distribution systems, which use a combination of sensors, communications-enabled circuit protection, software and remote monitoring and diagnostic capabilities, add new layers of safety to help mitigate arc flash.

Start making your workplace safer. We offer circuit protection and trip units embedded with these smart capabilities.

CHECK THEM OUT

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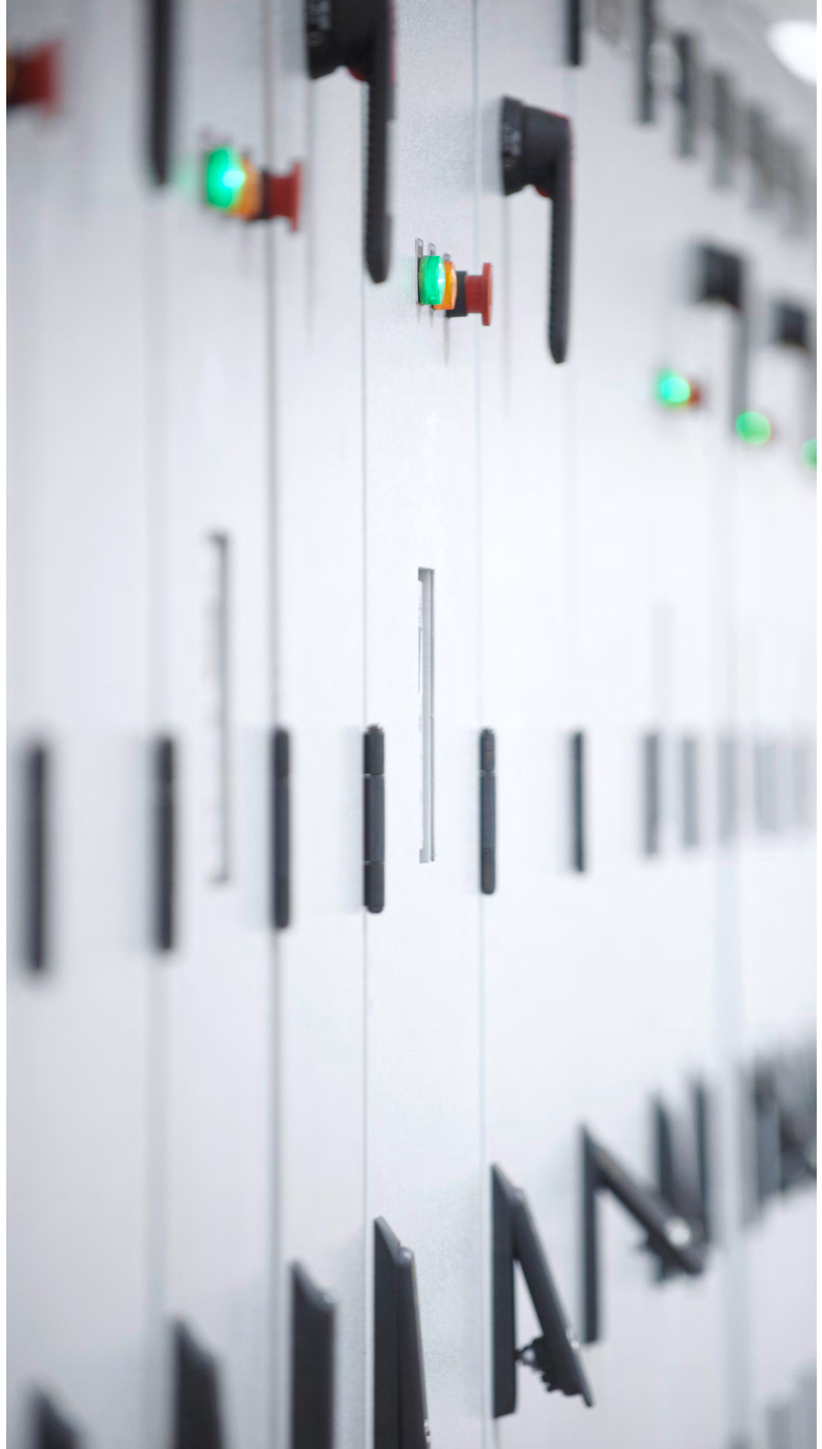
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RELT
Flip the switch

The energy-reducing maintenance switch is an approved* technology we refer to as Reduced Energy Let-Through, or RELT.

How does it work?

An energy-reducing maintenance switch creates a safety window, allowing operators to temporarily make the circuit protection more protective by changing the trip unit parameters when working on energized circuits. Before maintenance operations that involve higher arc flash risk, personnel can use a RELT switch to temporarily adjust the sensitivity of a trip device from 1.5 times up to 15 times the normal protection device rating. This adjustment effectively helps to control the duration, and severity, of an arc flash incident.

Learn more about the incorporation of the RELT switch into low- and medium-voltage power protection devices in the 2017 National Electric Code (NEC) 240.87 standard.

It’s as easy as 1, 2, 3!

* Per 2017 National Electrical Code (NEC)

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Step 1

Activate the RELT feature before working on equipment.

Step 2

Ensure you're getting positive feedback that the system is activated.

Step 3

Locate the activation and signal function on an equipment-mounted control or remotely with a switch located outside the arc flash boundary.



Download our whitepaper to learn more about RELT.

Download the whitepaper

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Arc Flash Safety Assessment

Are Your safety procedures good enough

Take this quick assessment to find out how your organization's safety procedures stack up.

1. How well do you understand arc flash risks?
   A. Very well
   B. Somewhat well
   C. Not very well

It is critical to fully understand the risks associated with arc flash so you can put the proper safety precautions in place before workers even begin maintenance on your electrical distribution equipment.

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2. Do you have a safety plan in place for dealing with an arc flash incident?
   A. Yes
   B. No
   C. I'm not sure

Once you understand the risks associated with arc flash, it is important to put together a safety program with a set of procedures to avoid both technical and operational hazards. Many companies, such as ABB, work with other companies to create comprehensive arc flash hazard plans, based on the guidelines of government and industry groups that define metrics for calculating potential arc flash incident energy levels and safe personnel boundary limits for workers. These standards also recommend both processes and technologies to help mitigate the risk or impact of an arc flash incident.

3. Do your workers wear PPE and follow recommended safety precautions, including following the arc flash hazard labels on equipment?
   A. Yes, all of the time
   B. Frequently or most of the time
   C. Sometimes but not always

Even when employing the best arc flash mitigation technology and rigorously following all safety procedures, the use of personal protective equipment (PPE) provides another critical layer of worker safety.

4. Yes, we employ advanced technologies that exceed
   A. Yes, we employ advanced technologies that exceed mandated arc flash safety requirements
   B. Yes, we employ technologies that at least meet mandated arc flash safety requirements
   C. I'm not sure of our current arc flash safety technologies

Employing direct arc flash mitigation technologies offers an important line of defense. Two core technologies, instantaneous zone-selective interlocking and wave form recognition, can be employed separately or together, in various combinations, to impede the potential for arc flash accidents. Other mitigation techniques, including use of a reduced-energy maintenance switch or arc flash containment systems, also provide added safety.

If you didn't answer "A" for all of the questions, we recommend that you revisit your arc flash mitigation strategies! You can speak to your ABB representative to start the process.

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There’s More Where That Came From

At ABB, we’re designing electrical distribution panels using arc flash mitigation technologies and design strategies that help keep maintenance personnel safe.

Are You Ready to Improve Your Arc Flash Protection?

CONTACT US

More tips like this at:

Power Better