

Arc-flash safety solutions



EATON

Powering Business Worldwide

Arc flash—the threat is real

An arc-flash event releases a tremendous amount of energy in the form of thermal heat, toxic fumes, pressure waves, blinding light, sound waves and explosions that can result in serious injury, including critical burns, collapsed lungs, loss of vision, ruptured eardrums, puncture wounds and even death.

According to the National Fire Protection Association (NFPA®), an arc flash occurs “when an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors.” Temperatures can reach 35,000 °F—three times hotter than the temperature of the sun! These excessive temperatures cause the air and metal in the path of the arc to expand and explode, creating an arc blast.

Throughout the world, arc flash threatens personnel safety, and companies face lost man-hours, lawsuits, fines, equipment damage, facility downtime and lost production.

So what arc-flash events really mean to you are problems. Safety problems. Legal problems. Financial problems. But there is a solution.

Total arc-flash solutions from the industry experts

Eaton’s power management solutions stress prevention, protection and preparation. Our products, engineering experience and industry know-how create a total arc-flash solution to meet your company’s needs. We offer a complete arc-flash hazard analysis focusing on:

Enhanced safety

Improve your facility’s overall arc-flash safety through training, labeling, analysis and products that reduce or eliminate exposure to dangerous situations. Meet or exceed the standards from NFPA 70E-2015 “Standard for Electrical Safety in the Workplace” and IEEE® 1584 “Guide for Performing Arc Flash Hazard Calculations.”

Operating cost efficiencies

Reduce or eliminate unplanned downtime, equipment damage, fines, lawsuits, injuries and fatalities through improved safety practices.

Best products, best services, best solutions

Eaton offers the industry’s widest range of arc-flash-related products and services. Our electrical services group comprises leading engineers who not only understand how to properly apply today’s safety standards, but many have been tapped for their expertise by committees who develop the codes that help protect what you value most.

Our commitment to help companies protect what they value most

Eaton understands that arc-flash safety is tremendously important to businesses striving to protect their most valuable assets—their people. That’s why we’ve made a \$500,000 contribution to the Institute of Electrical and Electronics Engineers (IEEE®) and the National Fire Protection Association (NFPA) Arc Flash Phenomena Collaborative Research Project. As a platinum-level sponsor of this important initiative, we will support efforts to improve electrical safety standards, predict the hazards associated with arcing faults and accompanying arc blasts, and provide safeguards for employees.



**Safety means...
knowing your hazard level**

Ensuring that your facility has the best possible arc-flash safety plan in place is vital to the safety of your employees and the continued success of your business. While current arc-flash safety standards are being enforced ever more strictly, they may not provide the specific

attention to detail required for a safe work environment, even under "worst case" conditions. The standards are open to interpretation, so it's up to you or your staff to draw conclusions from the general guidelines. There may be instances in which you think you've achieved compliance, when in fact, you haven't because you misinterpreted the standards.

Eaton has the experience and the expertise to help you understand the level of arc-flash hazard in your facility and to optimize your safety program accordingly.

An important first step to ensuring the safety of your workplace and employees is a high-level assessment of your company's readiness to deal

with arc-flash hazards using the checklist below. If you answer "no" or "not sure" to any of the questions, you need to address your arc-flash safety program immediately. Your business may be non-compliant with industry safety standards and at risk for an arc-flash incident.

A checklist for arc-flash safety:

	YES	NO	UNSURE
All persons who operate/maintain energized electrical equipment are trained for the voltage-class equipment that they operate/maintain.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All persons who operate/maintain energized electrical equipment have been trained on both shock and arc-flash hazards.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All persons who operate/maintain energized electrical equipment have access to the proper personal protective equipment (PPE) to protect them from both shock and arc-flash hazards.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
One-line diagram, including current protective device settings, exists, is legible and is accurate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All persons who operate the power system have easy access to the current one-line diagram.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Equipment is labeled correctly, and is in accordance with existing safe work practice codes and standards.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
De-energized procedures and equipment exist and are used.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Written safety procedures and energized work permitting processes exist and are followed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Equipment is grounded, and ground system is tested periodically.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Proper maintenance practices are followed, especially for fault protection equipment.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recent (less than five years old) relay/fuse coordination study exists, and relays are calibrated to the setting recommended.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Arc-flash analysis has been performed for this site (calculations, labeling and arc-flash boundaries).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Checklist adapted from IEEE Guide for Maintenance, Operation and Safety of Industrial and Commercial Power Systems (Yellow Book) Document Number: IEEE 902-1998

Eaton provides:

Electrical safety training for operators and maintenance personnel.

Arc-flash hazard training for operators and maintenance personnel.

Arc-flash hazard training focusing on selecting and using the proper PPE.

Development of one-line diagram of your facility.

Electrical safety training.

Arc-flash hazard training, labeling, protection boundaries, PPE.

Lockout, tagout, proper grounding; remote power racking to safely de-energize breaker.

Electrical safety training.

Grounding studies, electrical safety training.

Electrical safety training, Performance Based Maintenance (PBM), IR windows and Arcflash Reduction Maintenance System™ for safer maintenance.

Coordination and short-circuit studies.

Arc-flash hazard analysis.

Your System Today

Your Improved System

Superior protection with the right products and services

Eaton's power management solutions encompass the industry's broadest range of arc-flash-related products and services. From a comprehensive arc-flash hazard analysis to highly engineered products and expert services, Eaton has the experience and applications expertise to develop a total arc-flash solution for your facility.

This electrical room illustration shows how Eaton's products can be applied to mitigate arc-flash hazards. Please refer to pages 6 through 9 for a brief description of each product and to pages 10 and 11 for a hazard analysis and training overview.



To view an interactive version of this electrical room, visit www.arcflashsafetysolutions.com.

Low- and medium-voltage equipment to limit exposure of personnel to arc-flash hazards

	1 1200 A Bypass Isolation ATS	2 Arcflash Reduction Maintenance System	3 Arc-Resistant Medium Voltage Control	4 Arc-Resistant Switchgear	5 Bus Differential Schemes	6 Circuit Breaker Trip Units with Zone Selective Interlocking	7 Current-Limiting Reactors	8 DigiTrip™ Trip Unit with Arcflash Reduction Maintenance System	9 FlashGard™ Motor Control System	10 Feeder Protective Relay with Arcflash Reduction Maintenance System Settings	11 High-Impedance Transformers	12 High Resistance Grounding Systems
Limits frequency of arc-flash incidents	●		●	●					●			●
Reduces arc-flash event durations		●			●	●		●		●		
Reduces arc-fault currents ①							●				●	●

① Caution: Lowering the fault current may result in a longer clearing time by the upstream device. Please contact Eaton to ensure proper application.



- 13 Insulated Bus in Switchgear
- 14 Infrared (IR) Windows
- 15 Kirk® Key Interlock
- 16 Lighting Panelboards
- 17 Low-Voltage Switchgear with Arcflash Reduction Maintenance System
- 18 MCC Bucket and Safety Switch with Viewing Window
- 19 Online Infrared (IR) Monitoring
- 20 Partial Discharge System
- 21 Protective Devices with Current Limiting and High-Speed Operation
- 22 Remote Monitoring, Control and Diagnostics
- 23 Remote Power Racking
- 24 Secondary Fault Clearing Using Retrofit of Primary Breaker

●	●	●	●	●	●	●	●	●	●	●	●	Limits frequency of arc-flash incidents
				●							●	Reduces arc-flash event durations
		●						●				Reduces arc-fault currents

Broadest range of solutions...

1 1200 A bypass isolation ATS

The bypass isolation transfer switch capitalizes on Eaton's experience in designing and building low-voltage switchgear. Many features from our Magnum™ switchgear have been incorporated for improved safety and reduced arc-flash hazards, including dedicated wireway and safety barriers isolating personnel from line and load.

2 Arcflash Reduction Maintenance System

Available as a retrofit to a low-voltage power breaker, the Arcflash Reduction Maintenance System uses patented technology to reduce fault clearing time and lower the available arc-flash energy at the connected downstream devices. The system may be activated at the breaker or from a remote location. The result is a reduction of the incident energy, allowing for improved personnel safety while eliminating the need for higher levels of costly personal protective equipment (PPE).

3 Arc-resistant medium-voltage control

AMPGARD™ medium-voltage control affords the highest levels of safety and flexibility in the industry. The SL-400 vacuum contactor has the highest interrupting rating (8500 A), providing full coordination with the starter main fuses. The isolation switch is rated for 10,000 mechanical operations, offering reliability even when the switch is frequently operated. The unique features of arc-resistant AMPGARD ensure that the highest energy levels are directed to the rear of the structure and away from the operator.

4 Arc-resistant switchgear

In addition to providing maximum safety through circuit separation and isolation preventing access to live parts, Eaton's arc-resistant medium-voltage switchgear incorporates sealed joints, top-mounted pressure relief vents, reinforced hinges or latches, and "through-the-door racking," minimizing exposure to harmful gases and significantly reducing the risk of injury to facility personnel in the event of an arc-flash event.

5 Bus differential schemes

Bus differential schemes are coordinated zones of protection within your electrical system. When a fault is detected, tripping occurs instantaneously for faults only within that particular zone, leading to greater reliability throughout the facility, increased personnel safety, and elimination of intentional time delay. Eaton can engineer a system of bus differential schemes on new or retrofit equipment.

6 Circuit breaker trip units with zone selective interlocking

Zone selective interlocking deactivates the preset delay on the circuit breaker closest to the fault, which then trips with no intentional delay. This reduces the amount of time current flows and the amount of arc flash energy and stress (I^2t) the system encounters during fault conditions, resulting in improved personal protection and prolonged equipment life.

7 Current-limiting reactors

Current-limiting reactors connected in series are primarily used to reduce fault currents and to match the impedance of parallel feeders. For example, low-voltage motor control centers can be supplied with three single-phase reactors that limit available short-circuit current, providing a reduction in the available fault and arcing current at the equipment.

8 Digitrip trip unit with Arcflash Reduction Maintenance System

Eaton's Digitrip trip units for low- and medium-voltage applications feature an integral selector switch with five arc-flash reduction settings, enabling the operator to pre-select the maximum arc-flash reduction level possible to avoid nuisance tripping during maintenance operations. Testing has confirmed that the maximum protection setting can significantly reduce incident energy, resulting in reduced PPE requirements.

9 FlashGard enhanced motor control center

Eaton's motor control centers (MCCs) are built on "arc-free" designs intended to drastically lower the probability of the creation of an arc flash. The features of this new MCC include: three-position MCC bucket (connected, test and withdrawn), through-the-door racking mechanism and high short-circuit ratings.

10 Feeder protective relay with Arcflash Reduction Maintenance System settings

When properly applied to a power breaker, the FP-5000 feeder relay and a selector switch use control logic to automatically change the overcurrent settings to instantaneous to reduce fault clearing time and lower the available arc-flash energy at the connected downstream devices. The result is improved personnel safety while eliminating the need for higher levels of costly PPE.

11 High-impedance transformers

Eaton's transformers with increased impedance values drastically reduce the available arc-fault current. The lower arc-flash energy in a system generally translates into improved personnel safety.

12 High resistance grounding systems

Eaton's high resistance grounding system limits the magnitude of current during a ground fault, thus reducing arc-flash energy to increase personnel and equipment protection. Operators are alerted to faulted conditions and can easily locate the ground source via built-in fault tracing. Application of high resistance grounding systems eliminates the possibility of a line-to-ground fault condition, significantly increasing personnel safety.

...to improve safety in your industry



Petrochemical



Wind farms



Forest products



Utilities

Advanced arc-flash technology...

13 Insulated bus in switchgear

Insulated bus bar systems within switchgear reduce shock hazard in the event of accidental contact when an energized system is undergoing maintenance. Insulated bus is standard in all of Eaton's medium-voltage breaker assemblies. Contact Eaton regarding insulated bus in medium-voltage metal-enclosed switches and low-voltage breaker assemblies.

14 Infrared (IR) windows

IR windows in electrical equipment allow an operator to complete a thermal inspection of electrical switchgear without opening cabinets or doors. Using infrared thermography technology, the operator is able to safely and quickly assess potential problems in the equipment while the circuits are energized and under load.

15 Kirk key interlock

A Kirk® key interlock system ensures that a specific sequence of operations is followed to avoid human error. Eaton can engineer a specific configuration of interlocked breakers that can be energized only with a key. This eliminates excessive fault current that could result from unintentional paralleling of transformers and helps to keep personnel safe.

16 Lighting panelboards

Eaton's EZ Trim™ on lighting panelboards offers additional protection from faults and the resulting arc flash caused by loose trim hardware falling off onto live parts, when installed per the manufacturer's instructions. The reason—the EZ Trim has no loose hardware or screws.

17 Low-voltage switchgear with Arcflash Reduction Maintenance System

When an Eaton Magnum breaker equipped with the Arcflash Reduction Maintenance System is added to low-voltage switchgear feeding motor control centers or other equipment, maintenance becomes much safer. The protective device clearing time may be significantly reduced, resulting in lower incident energy and thus, reduced PPE requirements.

18 MCC bucket and safety switch with viewing window

Provides a positive visual confirmation that the circuit is de-energized, eliminating the requirement to open metal door and expose live parts.

19 Online infrared (IR) monitoring

For those locations where the incident energy levels are excessive and conventional arc-flash solutions are not practical, Eaton has an online infrared sensing system that allows monitoring without cover removal, therefore eliminating the need to ever open the cover when energized.

20 Partial discharge system

The InsulGard™ partial discharge system provides an early indication of insulation failure in switchgear, bus duct, power centers, generators, transformers and motors. Deteriorating insulation is the leading cause of electrical failure and results in partial discharge, or arcs, that typically occur within or between insulation materials. Early detection is key to a predictive maintenance program, and repairing the system prior to a full-fledged insulation failure can possibly avert an arc-flash explosion.

21 Protective devices with current-limiting and high-speed operation

Eaton's molded-case and power breakers with current-limiting and high-speed operation provide complete system protection against faults, including overloads, low-level short circuits and high-level short circuits. Due to their high interrupting capacity, the current-limiting devices will interrupt high arcs quickly, thus reducing arc flash in a system and increasing personnel protection.

22 Remote monitoring, control and diagnostics

Eaton's power management software enables an operator to remotely monitor, control and diagnose the power distribution system from across the room or across the world, but well outside of the arc-flash protection boundary. When maintenance is required, de-energize the switchgear with the software, and keep personnel away from a potentially dangerous situation.

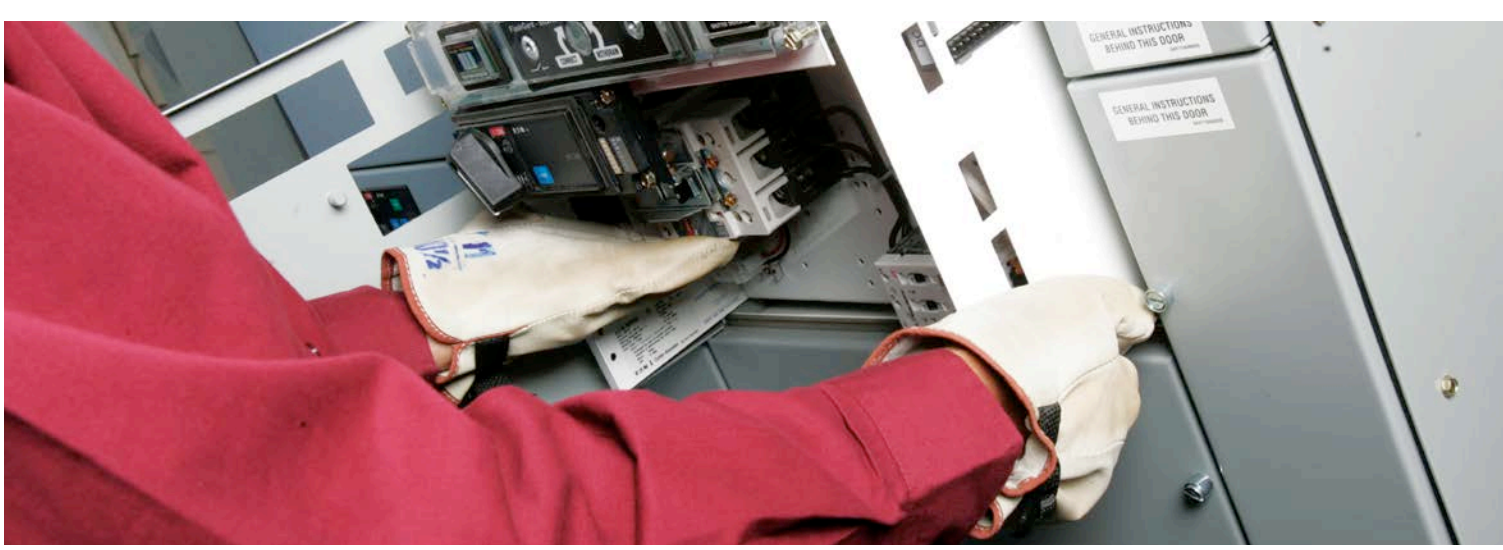
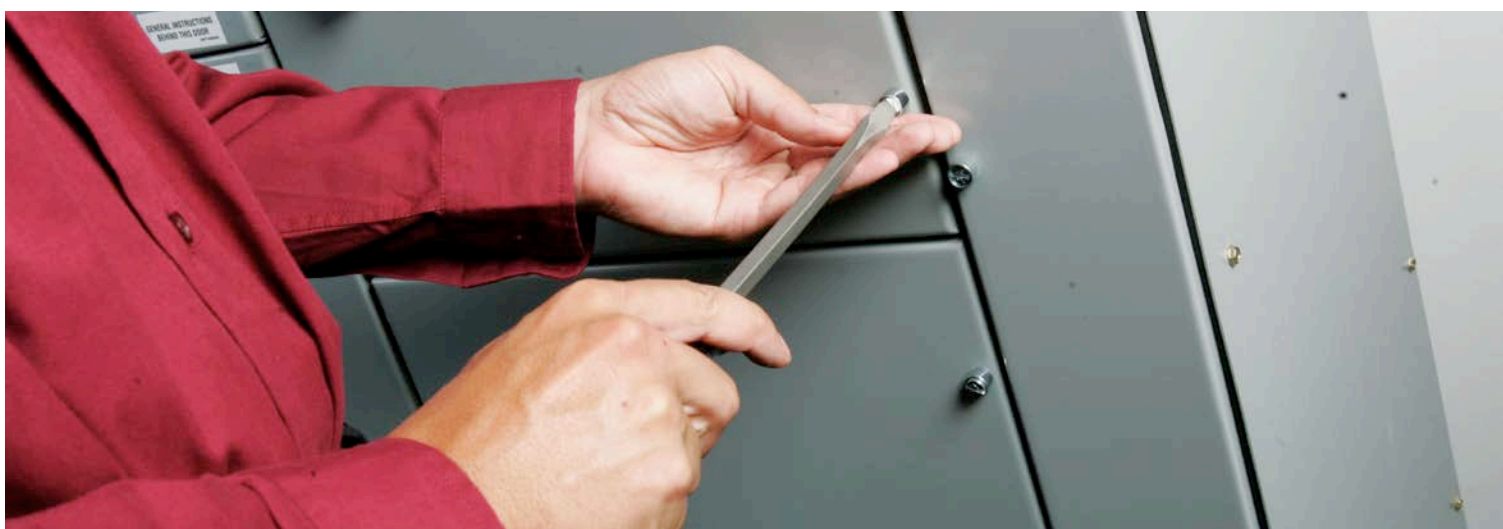
23 Remote power racking

Many arc-flash incidents occur when personnel insert or remove (rack) power breakers from low- or medium-voltage switchgear cubicles. Eaton's Remote Power Racking system (RPR-2) provides a means of remotely racking most breakers that use the rotation of a shaft for insertion or removal, enabling personnel to stand outside the arc-flash protection boundary.

24 Secondary fault clearing using retrofit of primary breaker

Excessively high arc-flash incident energies at the secondary of the transformer can be reduced by tripping a transformer primary protective device (circuit breaker). The tripping signal originates from current sensors mounted on the transformer secondary terminals. Eaton has retrofit solutions to replace or modify that primary device, even if it is a fuse, medium-voltage breakers (or low voltage as appropriate), which result in a system that provides superior arc-flash protection at the transformer secondary. This solution is especially useful for installations that do not use a secondary main (NEC® 6-disconnect rule).

...to enhance personal safety



A comprehensive arc-flash hazard analysis

An arc-flash hazard analysis is critical to the safety of plant personnel working on or near exposed energized electrical equipment. The analysis will quantify the release of thermal energy associated with potential arc-flash hazards and will describe safety recommendations such as establishing protection boundaries and specifying protective equipment for personnel.

Many offer this service, but few offer such extensive expertise backed by a full line of mitigating products and services as Eaton.

Eaton's highly qualified power systems engineers (PSE) have performed thousands of studies for all types of industries. Every PSE has access to a variety of analysis tools to best address the safety risks of your unique system. Our combined use of commercial and proprietary software uses IEEE and NFPA equations and methods for comprehensive and accurate calculations, including fault current momentary duty, device clearing time, arcing fault currents, duration of arc and incident energy. Eaton's PSEs draw on past experience, training and understanding to analyze the figures and develop recommendations, which are compiled in a written report. Upon request, the PSE will verbally present the findings in clear and easily understandable terms.

A comprehensive arc-flash hazard analysis includes the following services:

- Arc-flash system studies, calculations and consulting
- Arc-flash labeling
- Creation and/or verification of one-line electrical drawings
- Short-circuit and coordination studies
- Recommendations to help achieve a safer environment for personnel, which include:
 - Arc-flash boundaries
 - Safe working distances
 - Practical methods for reducing arc-flash hazards
 - Required protective flame-resistant clothing
 - Personal protective equipment (PPE)
 - Safe work practices

You can be certain that Eaton's extensive experience in arc-flash hazard analysis will provide the best solutions to protect what you value most.



An industry-leading arc-flash safety training program

A top-notch safety plan incorporates not only arc-flash hazard analysis recommendations, but also practical training for personnel who operate and maintain energized electrical equipment. Eaton offers both.

While some trainers simply recite information from published manuals, Eaton's trainers are the same electrical engineers who perform arc-flash hazard analyses and install, commission, troubleshoot and maintain electrical equipment every day. When you train with us, you're assured of getting the most current information, techniques and procedures available to keep your personnel safe and your processes running.

Education—the key to better arc-flash safety

Eaton's arc-flash safety training will show you how to determine Hazard Risk Category, incident energy value and flash protection boundary distances for the equipment in your facility. You'll learn to use that information in selecting electrical components designed to minimize arc-flash hazards, and how to choose personal protective equipment (PPE) according to the National Fire Protection Association's Standard 70E (NFPA 70E). And because we know that PPE can be bulky, be uncomfortable, limit dexterity and expose workers to heat exhaustion problems, we continually search for, and incorporate into our training, safe ways to minimize the use of PPE. Our training will reveal how a proper examination of your power distribution system can help you avoid "overdressing" for necessary operational and maintenance tasks.

We understand that a "one-size-fits-all" approach to training doesn't fit every situation, so in addition to our power systems training classes, we offer customized training specifically designed for your company's unique requirements. Furthermore, if it's not practical for your staff to train at one of Eaton's facilities, we can conduct the training at your site.

Here is a brief overview of Eaton's one-day "Understanding Arc Flash" training program.

- Existing and proposed standards
- Determining safe approach distance
- Methods for calculating prospective short-circuit current
- NFPA 70E methods for calculating flash protection boundary distance and incident energy value
- IEEE Standard 1584 methods for calculating flash protection boundary distance and incident energy value
- Determining hazard risk category
- Selecting protective clothing and PPE using incident energy exposure value and the PPE matrix
- ATPV values for common types of garments
- Practical methods for reducing arc-flash hazard

Eaton can award 0.8 CEUs for the successful completion of this training.

To learn more, contact Eaton's electrical training group at 723-779-5921 or EETraining@eaton.com.





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