EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Facility: DOE Complex

Best Practice Title: Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

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Brief Description of Best Practice: This best practice provides guidance/suggestions for designing electrical systems to reduce or eliminate personnel exposure to electrical hazards. The best practice contains five parts: (1) Practical safeguarding through compliance with NFPA 70 and 70E. (2) Installation and use of permanently mounted test devices. (3) Solutions for high incident energy at service disconnecting means. (4) Overcurrent protective device selection. (5) Quick Trips and other means to reduce personnel exposure to hazardous electrical energy.

Why the best practice is used: This best practice was developed to proactively address and mitigate risks associated with electrical hazards in facilities that include industrial, commercial, and research environments. Electrical incidents, involving shock and arc flash, pose significant risks to personnel safety, operational continuity, and equipment integrity. By establishing structured guidance on system design, this best practice aims to incorporate safety measures during the design phase that will reduce or eliminate the risk to personnel throughout the lifecycle of the electrical equipment rather than relying on less effective hierarchy of control methods such as administrative, awareness, and PPE.

What are the benefits of the best practice: Implementing this best practice offers a range of methods or means to enhance both safety and operational performance by reducing or eliminating personnel exposure to hazardous electrical energy.

What problems/issues were associated with the best practice: N/A (New best practice) How **the success of the Best Practice was measured:** N/A (New best practice)

Description of process experience using the Best Practice: N/A (New best practice)

Note 1: see Appendix B for definitions

EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Table of Contents

Part 1: Practical Safeguarding through compliance with NFPA 70 and 70E

Part 2: Installation and use of permanently mounted test devices

Part 3: Solutions for high incident energy at the service disconnecting means

Part 4: Overcurrent protective device selection

Part 5: Quick trips and other means to reduce personnel exposure to hazardous electrical energy.

Acronyms

AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
HPI	Human Performance Improvement
IEC	International Electrotechnical Commission
LSI	Long-Time delay, Short-Time delay, and Instantaneous trip
NEC	National Electrical Code
NRTL	Nationally Recognized Testing Laboratory (ex. UL, CSAus, ETL, etc.)
NFPA	National Fire Protection Association
PPE	Personal Protective Equipment
SECAD	Safeguarding Electrical Component Assembly Display

Introduction

Ensuring the safety of personnel who are likely to interact with hazardous electrical equipment, systems, components, or assemblies is essential and begins in the planning and design phase. Implementing safety in the planning and design phase should consider that the safety of personnel is important to maintain throughout the entire lifecycle of the electrical equipment from construction to installation, maintenance, and finally demolition of the equipment. Implementing safety by design in the planning, design, construction, and installation of electrical equipment is essential for personnel safety regardless of the size or complexity of the electrical system and the safety of personnel begins with National Fire Protection Association (NFPA) 70 National Electrical Code (NEC).

The NEC is a minimum standard, and compliance with this code is required by most local, state, and federal regulations. When electrical systems are not constructed and installed in accordance with the NEC and maintained in accordance with the manufacturer's instructions or industry consensus standards there is an increased risk to personnel from exposure to electrical

Note 1: see Appendix B for definitions

hazards. When the risk of exposure to personnel is due to a non-compliance with the NEC or due to the intentional removal of barriers to access hazardous electrical components then the requirements of NFPA 70E "The Standard for Electrical Safety in the Work Place" or other appropriate electrical hazard mitigation process must be implemented to mitigate the risk of personnel exposure to electrical hazards.

This best practice provides recommendations for the inclusion of safety in the design of electrical equipment including practical safeguarding per the NEC, reducing high incident-energy at the service disconnecting means, installing quick disconnecting means to reduce exposure to hazardous electrical energy, and use of LSI over current protective devices to reduce arc flash incident energy levels.

Part 1 Practical Safeguarding

Introduction

Compliance with the NFPA70 NEC ensures that electrical equipment and systems are installed and/or constructed in a manner that provides practical safeguarding of persons likely to interact with the electrical equipment. The NEC and NFPA 70E *Standard for Electrical Safety in the Workplace* require newly installed, constructed, or modified electrical equipment and systems to be inspected and approved by the Authority Having Jurisdiction (AHJ) prior to being placed into service. NFPA 70E relies on the NEC inspection and approval process to ensure that hazardous electrical energy is suitably insulated, isolated, or guarded. Whenever the requirements of the NEC are not met, and personnel are or can be exposed to hazardous electrical conductors or circuit parts, then the requirements of NFPA 70E are applied to ensure that electrical hazards are properly controlled or mitigated.

Scope

The information in this section was developed with respect to the NEC requirement for the practical safeguarding of electrical installations and assemblies to identify methods that can be employed in the planning and design phase of electrical equipment to further reduce or eliminate risk to personnel from exposure to hazardous electrical energy. This section is intended to provide guidance for the installation of electrical systems and assemblies that are subject to the NEC and as a result meet the NFPA 70E requirements for suitably insulating, isolating, and guarding of energized electrical conductors and circuit parts.

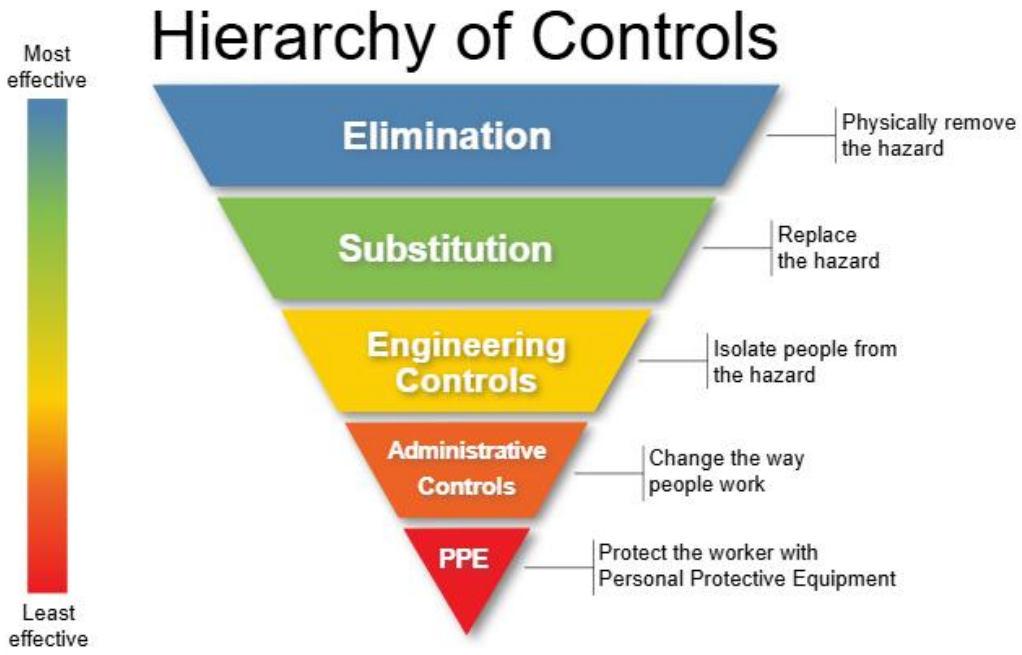
Consumer off-the-shelf (COTS) electrical equipment that is listed and labeled by a NRTL has already been designed and constructed with the safety of personnel in mind. NRTL listed equipment may therefore be approved by the AHJ without additional inspection and approval

Note 1: see Appendix B for definitions

provided the equipment has not or will not be modified from its original state. Electrical equipment that is not NRTL listed and labeled or approved equipment that is modified from its original state is required to be inspected and approved by the AHJ. [See EFCOG Best Practice 254]

Discussion

Electrical equipment that is installed, constructed, or assembled in accordance with the manufacturer's instructions and approved by the NFPA 70-AHJ has met the NEC's requirement for the practical safeguarding of persons. When electrical equipment is approved by the AHJ, it has been suitably insulated, isolated, or guarded in compliance with NFPA 70E. Electrical installations or assemblies subject to the NEC that are not NEC compliant with respect to the protection of personnel are consequently subject to NFPA 70E's hierarchy of controls.



The hierarchy of controls as applied to practical safeguarding begins with "elimination" of electrical hazards through equipment design such that it does not exist within the equipment. Elimination of an electrical hazard for the purposes of servicing or maintenance can be accomplished through the use of administrative controls and PPE to establish an electrically safe work condition in accordance with approved Lockout and Tagout procedures or exclusive control of a cord and plug [See 29 CFR 1910.147], "substitution" with a lesser hazard, "engineering controls" such as guards or covers to prevent access by unqualified personnel, "awareness" such as training, work practices, or signs warning of the hazard and *barricades* to

Note 1: see Appendix B for definitions

restrict access, “administrative controls” such as lockout tagout or procedures that identify safe work practices, and finally the use of “Personal Protective Equipment (PPE)” appropriate for the hazard.

Application

Compliance with the NEC regarding practical safeguarding ensures that unqualified personnel likely to interact with electrical equipment are not *exposed* to hazardous electrical energy. The installation, construction, or assembly of electrical equipment where hazardous energized electrical conductors and circuit parts are not *suitably insulated*, *isolated*, or *guarded* should be avoided.

Use of Finger-Safe Components in Electrical Installations and Assemblies [EFCOG BP # 269]

The term “finger-safe” refers to a level of ingress protection that guards against intrusion by objects roughly the size of an adult fingertip. Neither the NEC nor NFPA 70E recognize the term “Finger-safe”. The NEC refers to the practical safeguarding of persons and property from the hazards arising from the use of electricity, while NFPA 70E refers to energized electrical conductors and circuit parts being suitably insulated, isolated, or guarded, i.e., practical safeguarding.

Finger-safe is characterized as guarding of energized conductors or circuit parts sufficient to prevent inadvertent contact by the hand or finger. Finger-safe is only recognized as sufficient guarding for qualified personnel. **[EFCOG BP # 269]** NOTE: Covers or guards that are used to create a finger-safe condition should be adequately secured to prevent inadvertent removal.

The recommended minimum criteria for guarding against inadvertent contact by hand or finger is to meet or exceed the IP20 rating defined in ANSI/IEC 60529. IP20 provides protection against solid foreign objects 12.5mm (about ½ inch) in diameter or greater. Articulated test fingers are commercially available for testing devices not specifically designed to the IP20 standard.

The AHJ may specify an alternate standard such as found in the following references:

- NFPA 79, *Electrical Standard for Industrial Machinery* figure 6.2.3: Jointed Test Finger
- UL 498A, *Standard for Safety for Current Taps and Adapters* figure 11.1: articulated probe with web stop
- UL 61010-1 *Safety requirements for electrical equipment for measurement, control, and laboratory use* section 6.2: Determination of ACCESSIBLE parts Note: UL 61010-1 includes standardized specifications for defining a safe enclosure for lab measurement equipment.

Note 1: see Appendix B for definitions

EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Segregation of hazardous and non-hazardous components in equipment

For electrical equipment or systems that incorporate non-hazardous low-voltage controls or where access to make adjustments would reasonably be performed by a non-electrical worker, segregation of the hazardous and non-hazardous electrical components should be considered i.e., incorporating barriers/covers that provide suitable isolation/guarding that prevents access or exposure. A common example relevant to some designs is to segregate all components with non-hazardous voltages into an area within the electrical equipment with a secondary barrier or in a separate enclosure. Typically, end users will only bypass the barriers needed to safely access the equipment to perform their assigned task. Providing multiple compartments or multiple barriers is an effective means to restrict access to hazardous electrical components.

Where the local authority does not recognize the cord-and-plug exemption of 29 CFR 1910.147 as applicable to systems with more than one power cord, a strategy of multiple enclosed boundaries, each with a single power source and a low voltage output, may be possible. In this approach, the totality of the equipment is comprised of multiple electrical items pulled together, where each item has its own boundary for protection from hazardous electrical energy. In servicing such a system, it's often possible to only penetrate one barrier or boundary at a time.

Using Practical Safeguarding to mitigate Human Performance Indicators (HPI)

Time pressure or other HPI factors can cause personnel with basic or no electrical skills to bypass engineered barriers and enter electrical approach boundaries contrary to work control requirements and expose themselves to electrical hazards. The risk of improper actions can be mitigated by implementing designs that allow for easy access to non-hazardous components without the need to bypass guards that would expose them to hazardous electrical components. Design of electrical equipment should consider how the user will interface with the equipment and provide a means to interface with the equipment that is free from exposure to electrical hazards. The design may include such things as test points, switches, PLC's, indicators, meters, or other user interface devices on the exterior of the equipment that can be manipulated or viewed without accessing hazardous components.

Engineering/Installation Guidance

1. Unqualified workers should not be allowed within the limited approach boundary of finger-safe components unless supervised by a qualified person.
2. Only voltage-rated tools or instruments should be used within the restricted approach boundary of energized finger-safe components.
3. Electrical installations or assemblies should be verified finger-safe by the AHJ or their delegate during inspection for code compliance.

Note 1: see Appendix B for definitions

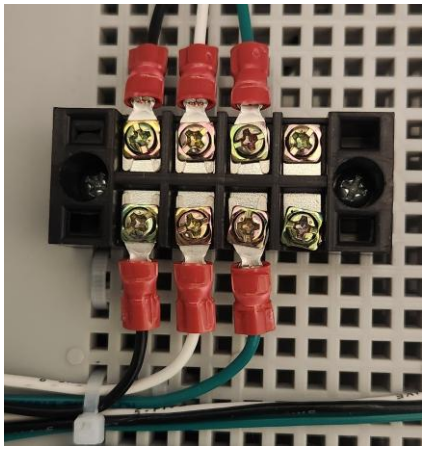
EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

The use of finger-safe components installed within enclosures is recommended for electrical assemblies and provides an additional layer of protection for qualified personnel. Unenclosed finger-safe components in an open environment do not provide sufficient protection for unqualified workers. Additional methods of protection may be needed, including attendance by a qualified person, the use of lockout tagout to control the source of energy, engineered barriers to prevent access or barricades erected that warn of the hazard and restrict access to the equipment.

Examples of Unacceptable and Acceptable Safeguarding Practices

EXAMPLE #1 Open unguarded terminal board - exposed energized circuit parts.



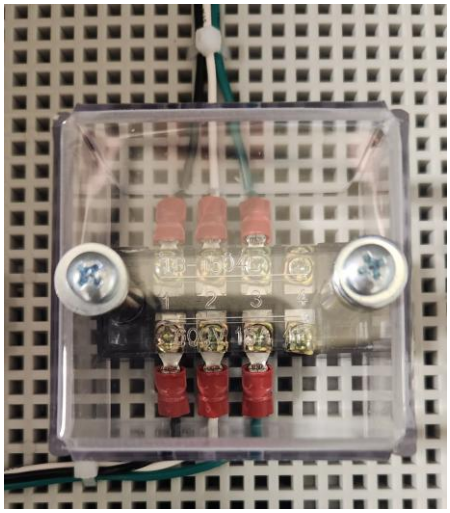
The use of open unguarded terminals outside of an enclosure does not comply with the requirements of NFPA 70 or NFPA 70E. This configuration may be acceptable when installed in an enclosure or with approval from the NFPA 70E – AHJ under limited or unique circumstances. Access to this configuration by unqualified persons must be controlled using appropriate methods.

Note 1: see Appendix B for definitions

EFCOG Best Practice - #276

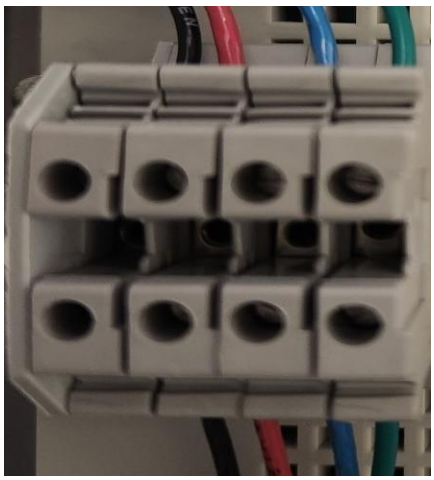
Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

EXAMPLE #1A Guarded, terminal board - No exposed energized circuit parts.



The use of engineering controls such as fabricated covers or barriers that prevent unqualified personnel from access to energized circuit parts is NEC compliant and meets NFPA 70E requirements for guarding.

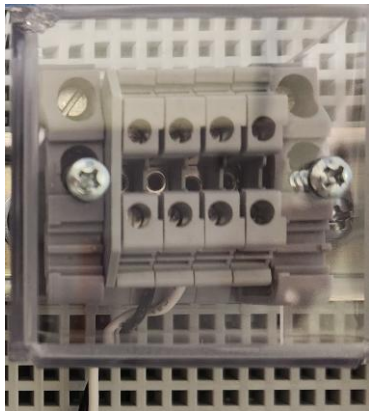
EXAMPLE #2 IP-20 rated "Finger Safe" terminals outside an enclosure.



The use of IP-20 rated "finger safe" terminals outside an enclosure does not meet NFPA 70 or 70E requirements. IP-20 rated terminals that are readily accessible are not recognized as being suitably guarded for the protection of unqualified personnel. IP-20 rated components are intended to be installed within an enclosure that prevents access by unqualified personnel. The NFPA 70E hierarchy of controls must be applied to prevent access by unqualified personnel.

Note 1: see Appendix B for definitions

EXAMPLE #2A Guarded IP-20 rated "Finger Safe" terminals.



The use of guarded IP-20 rated "Finger Safe" terminals inside or outside an enclosure is NFPA 70 and 70E compliant.

EXAMPLE #3 Improper wiring of IP-20 rated "Finger Safe" terminals.

Improper wiring of an IP-20 rated "Finger Safe" component defeats their IP rating, exposing personnel to electrical hazards.

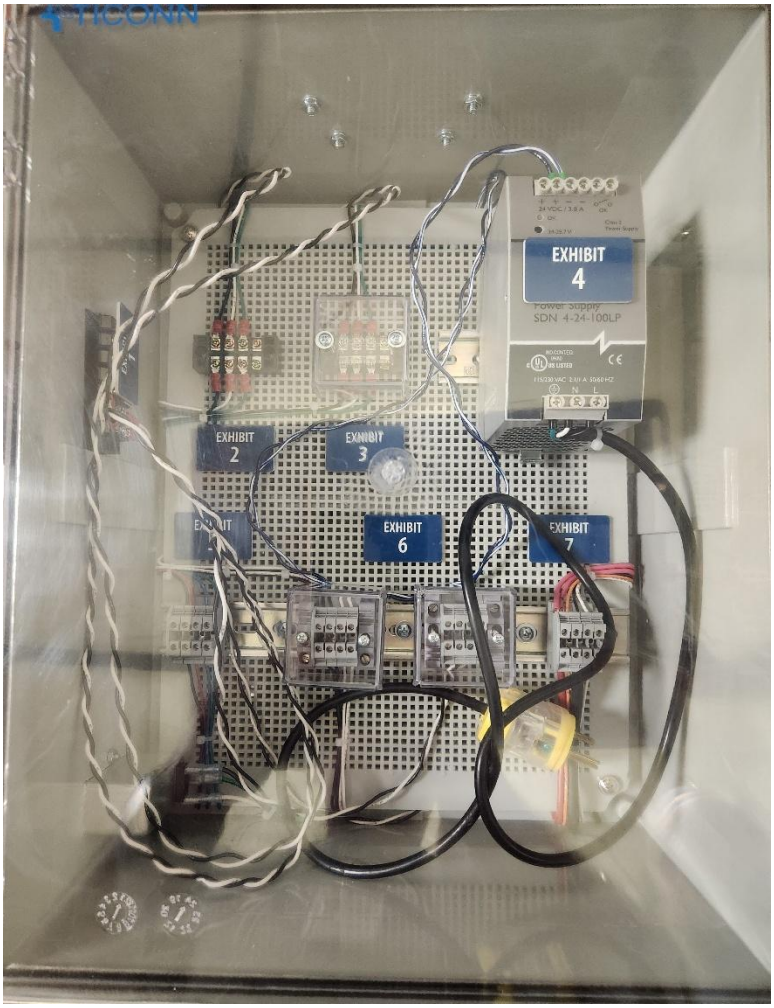
Note 1: see Appendix B for definitions

EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Safeguarding Electrical Component Assembly Display (SECAD)

Demonstration of NFPA 70 safeguarding techniques can be incorporated into a Safeguarding Electrical Component Assembly Display (SECAD). The SECAD with associated instructions can be used to illustrate proper and improper application of practical safeguarding for those who may be unfamiliar with NFPA 70 requirements.



***SECAD**

*The SECAD pictured was developed at Idaho National Laboratory (INL) as an instructional tool to illustrate proper and improper safeguarding techniques to research personnel who construct electrical assemblies for research projects. For information regarding the construction of a SECAD, please contact the INL AHJ.

Note 1: see Appendix B for definitions

Part 2 Installation and Use of Permanently Mounted Test Devices

The use of permanently mounted devices to test both absence and presence of voltage has increased in popularity over the last few years. There have been a lot of discussions regarding their most effective usage and when to implement a Voltage Test Station (VTS) versus an Absence of Voltage Tester (AVT). It is generally accepted that where possible, these devices should be installed to remove personnel from the hazard. An analysis of these devices can be found in **EFCOG Best Practice #268 "Installation and Use of Permanently Mounted Test Devices"**.

When modifying or upgrading electrical systems, EFCOG best practice #268 provides guidance on selection, installation, maintenance, configuration control, and use of permanently mounted test devices. An understanding of the best practice will provide practical information for those who seek to install them within their equipment/facility.

Part 3 Solutions for High Incident Energy at Service Disconnecting Means

Service disconnecting means often presents a significant hazard due to high incident energy levels, especially in large-scale or industrial electrical systems. Protecting workers and minimizing risks in these areas requires adopting advanced technologies and specialized safety practices. Below are key solutions designed to address high incident energy at service disconnecting means effectively.

Arc Resistant Electrical Equipment

Arc-resistant (Types 1, 2, 2B, 2C) electrical equipment significantly reduces or eliminates employee risk of injury by redirecting arc energy away from personnel operating the service disconnecting means. It is most effective during normal operation of the main device, ensuring that workers are not exposed to high arc flash energies. However, arc resistant equipment, depending on the type and the work activity, may not provide adequate protection for personnel working inside the equipment while it is energized and may need to be paired with additional protective measures to reduce the risk of injury to personnel to acceptable levels. To further enhance protection, Absence of Voltage Testers (AVTs) can be integrated into arc-resistant electrical equipment, enabling zero-energy verification before equipment access. It's worth noting that arc-resistant electrical equipment requires additional installation space, particularly above the equipment, due to specialized venting systems designed to manage arc

Note 1: see Appendix B for definitions

events safely. These devices are especially suitable for service disconnect locations with potentially high arc flash energies during switching operations.

Arc Blocking

Arc blocking technology provides targeted protection from line-side arc flash events at service disconnecting means. By using physical barriers to isolate line-side conductors completely, arc blocking ensures that personnel are not exposed to potentially hazardous sources of energy. These barriers are specifically designed to prevent arc sustainment, helping to contain potential arc flash events on the line side of the equipment. In addition to improving worker safety, this technology reduces equipment damage and downtime, enabling quicker recovery after an incident. Arc blocking is particularly effective for service disconnects operating at or below 2,500 Amps, making it a reliable solution for mitigating high incident energy at these locations.

Arc Quenching

Arc quenching is an advanced technology capable of significantly reducing incident energy levels on the load side of the service disconnecting means. When an arc event occurs, the technology redirects and dissipates the energy rapidly, significantly reducing the incident energy level. Arc quenching can also be combined with arc blocking technology to provide a comprehensive solution, protecting both the line and load sides of the disconnecting means. Current technology supports fault currents up to 100 kA and can incorporate multiple light sensors for coverage of downstream equipment. This makes arc quenching an ideal choice for systems where high incident energy poses a severe risk.

Arc Detection Relaying

Arc detection relaying is an emerging technology that enhances protection at service disconnecting locations by identifying arc flash events in real time. These systems typically use sensors to detect sudden energy spikes or variations in light intensity that signal an arc condition. While still under development, arc detection relaying has the potential to complement other protective measures, such as arc blocking and arc quenching, providing faster response times to high-energy events.

Administrative Controls

Administrative controls play a vital role in reducing risks at service disconnecting means, regardless of the technical solutions employed. Maintaining increased working distances between personnel and energized equipment helps limit exposure to high incident energy. Workers should also follow established safety procedures, including lockout/tagout (LOTO), zero-energy verification, and adherence to PPE requirements. Regular training ensures employees are familiar with hazards and understand how to operate advanced arc flash

Note 1: see Appendix B for definitions

mitigation systems. These administrative practices provide an additional layer of protection and help ensure compliance with industry standards such as NFPA 70E.

Addressing high incident energy at service disconnecting means, requires a robust combination of advanced technologies and administrative controls. Solutions such as arc-resistant electrical equipment, arc blocking, arc quenching, and arc detection relaying offer targeted protection against arc flash risks, while administrative controls promote safe work practices and behaviors. By integrating these measures, facilities can effectively mitigate high incident energy hazards, protect personnel, and ensure safe, reliable operation of service disconnecting means.

Part 4 Overcurrent Protective Device Selection

Choosing the correct overcurrent protective device is essential to ensure proper trip time, as this directly impacts the ability to reduce the severity of arc flash incidents and protect workers from electrical hazards. Protective devices must be carefully selected to respond quickly to fault conditions, isolating dangerous currents before they escalate into harmful or catastrophic events, while still allowing for normal operation of equipment. Proper trip timing also ensures selective coordination within the system, so only the faulted circuit is de-energized, minimizing system disruptions while maintaining safety. Inadequate or improperly configured devices may allow fault currents to persist for longer than necessary, increasing incident energy levels and the risk to personnel and equipment. Therefore, selecting protective devices with precise trip time settings is crucial for balancing safety, reliability, and operational efficiency in electrical systems.

The reduction of arc flash incident energy (AFIE) can be achieved by lowering the current threshold at which the protective device trips or by reducing the time delay before the device activates. However, this approach can be challenging for some equipment such as motors or transformers, as they produce high inrush currents during start up that may cause nuisance tripping. To address this issue, an LSI circuit breaker can be utilized, allowing for precise adjustment of the trip settings to "carve the curve" around the inrush current while still maintaining effective protection against fault conditions. This ensures safe and reliable system operation while minimizing the risk of unnecessary interruptions.

LSI circuit breakers are advanced protective devices designed to respond to different types of overcurrent scenarios. These circuit breakers provide customizable protection settings tailored to specific system requirements:

1. Long-Time Protection (L): Protects against sustained overload conditions and is adjustable to avoid nuisance tripping.

Note 1: see Appendix B for definitions

2. Short-Time Protection (S): Protects against moderate overcurrent conditions over short durations and can be coordinated across devices to limit unnecessary trips.
3. Instantaneous Protection (I): Provides immediate trip response for extreme overcurrent or short-circuit conditions without delay.

By combining these features, LSI circuit breakers offer precise control over trip characteristics in low and medium-voltage systems, significantly reducing the likelihood and severity of arc flash incidents by limiting fault currents and isolating dangerous conditions quickly.

LSI circuit breakers protect workers by minimizing arc flash energy and ensuring rapid isolation of faulted circuits. Their instantaneous protection mechanism quickly disconnects the affected circuit, significantly reducing the energy released during an arc flash event and lowering the risk of catastrophic incidents. By offering adjustable short-time settings, these breakers enable selective coordination between upstream and downstream devices, ensuring that only the faulted circuit is interrupted. This functionality enhances overall safety while reducing unnecessary system disruptions. Additionally, LSI circuit breakers provide customizable settings that allow engineers to optimize protection levels based on system requirements, balancing safety, and operational reliability to maintain system efficiency. Their capability to isolate faults promptly reduces incident energy at exposure points, creating safer conditions for workers performing energized work on hazardous electrical equipment.

An added layer of safety can be achieved by utilizing a separate circuit breaker enclosure to supply panelboards that are fed from transformers. This design isolates the arc flash incident energy (AFIE) that would typically be present on the line side of the main circuit breaker within a separate enclosure. As a result, any work performed on circuits within the panelboard is limited to the load-side AFIE of the separately enclosed circuit breaker, significantly reducing the potential risk to personnel and enhancing safety during maintenance or operations of the affected panelboard.

Part 5: Quick Trips and Other Means to Reduce Personnel Exposure to Hazardous Electrical Energy

The use of arc flash reduction devices is not a new practice in the electrical industry. These devices have been implemented for many years and provide an added degree of protection for personnel who use and maintain electrical equipment. These devices offer numerous benefits, but also present certain challenges. A thorough understanding of these devices can identify scenarios where they can help reduce personnel exposure to hazardous electrical energy.

Note 1: see Appendix B for definitions

EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Energy-reducing Maintenance Switching (Quick Trips)

Quick trip switches are devices that are typically installed on the face of electrical equipment and are designed to reduce the amount of arcing current that is available downstream of a protective device. These switches typically consist of a rotary knob and a light (often blue). Switching to the maintenance mode activates a setting in the associated relay that will manipulate the instantaneous settings of the protective device to allow a shorter trip time. When in maintenance mode, the protective relay can significantly reduce the incident energy of an arc flash incident.

There are many differing maintenance mode switches found on the market today. Even though these devices come with different naming conventions, they all essentially provide the same protections. The following are some of the naming conventions that are used in industry:

- Energy-Reduction Maintenance Switch (ERMS)
- Arc flash Reduction Mode System (ARMS)
- Reduced Energy Let-Through (RELT)
- Quick Trips

Advantages of using Quick Trips:

1. Reduction of arc flash energy up to 10x the normal value.
2. Reduces the calorie rating of arc flash PPE when working on energized equipment.
3. Allows for quick change to relay setting rather than relay programming for maintenance.
4. Can be installed with a lockable cover for both configuration and LOTO control.
5. Temporarily reduces incident energy levels for energized work.

Disadvantages of using Quick Trips:

1. Reduction only applies to the downstream equipment protected by the relay.
2. Potential to cause nuisance tripping.
3. Only designed to be used during maintenance of systems, not for full time use.

Note 1: see Appendix B for definitions

EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Summary of using quick trips

When considering the use of maintenance switches, consider how they will be used. These devices are a great addition to allowing safer work on equipment when installed and paired correctly with a properly programmed relay.

Zone-selective interlocking (ZSI):

There is a constant struggle to achieve a balance between circuit breaker selective coordination and arc flash reduction. Selective coordination of circuit breakers can result in higher incident energy levels in downstream equipment. Alternatively, lowering the settings for reduction of arc flash incident energy levels can cause nuisance tripping and undesirable downtime of critical equipment. ZSI uses protective relaying to create “zones”. When a fault occurs, each ZSI enabled breaker sends a delay signal to the upstream circuit breakers. When a circuit breaker receives this signal, it intentionally delays tripping for a pre-determined length of time, allowing the downstream device to clear the fault. This allows the circuit breaker closest to the fault to clear the fault using the lowest settings possible without sacrificing coordination.

Advantages of using ZSI

1. Improved coordination – The closest circuit breaker will clear the fault, minimizing widespread outages.
2. Faster clearing times for all fault locations – the closest circuit breaker will not receive a delay signal and operate quicker.
3. Arc-flash mitigation – Fast trip times yield lower incident energy.
4. Reduced equipment damage/stress - shorter fault durations lead to lower thermal and mechanical stress or damage.

Disadvantages of using ZSI

1. Added system complexity – Requires interlock signaling between devices, increasing design and installation effort.
2. Commissioning and testing burden – Logic, signal paths, failure modes, and trip timing must be verified and maintained.
3. Significant failure mode impacts – Broken delay signals and misconfigured logic can cause circuit breakers to trip unnecessarily, or cause delays that eliminate the benefits.

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EFCOG Best Practice - #276

Designing Systems to Reduce or Eliminate Exposure to Electrical Hazards

Conclusion

The safety of personnel who interact with energized electrical equipment starts in the planning and design of electrical equipment and systems and should consider the entire Lifecyle of the electrical equipment from installation to demolition. Reducing or eliminating personnel exposure to hazardous electrical energy can be accomplished by utilizing the technologies and methods discussed in this best practice and implementing new technologies as they become available.

REFERENCES

- **NFPA 70 - 2023** *National Electrical Code*
- **NFPA 70E - 2024** *Standard for Electrical Safety in the Workplace*
- **ANSI/IEC-60529 - 2013** *Degrees of Protection Provided by Enclosures* (IP Code)
- **NFPA 79 - 2021** *Electrical Standard for Industrial Machinery*
- **UL-61010-1 – 2012 Third Ed. 93** *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use; Part 1: General Requirements*
- **OSHA Nationally Recognized Testing Laboratories:** https://www.osha.gov/nationally-recognized-testing-laboratory-program/current-list-of-nrtls
- **EFCOG Best Practice # 268** "Installation and Use of Permanently Mounted Test Devices"
- **EFCOG Best Practice # 269** "Use of Finger-Safe Components in Electrical Installations"
- **EFCOG Best Practice # 254** "Non-NRTL Utilization Equipment Inspection Process"

Note 1: see Appendix B for definitions

Appendix B - DEFINITIONS:

Approved - Acceptable to the authority having jurisdiction. (NFPA 70 – 2023 Article 100)

Barricade – A physical obstruction such as tapes, cones, or A-frame wood or metal structures intended to provide a warning and to limit access. [NFPA 70E – 2024 Article 100]

Barrier – A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts to prevent unauthorized access to the work area. [NFPA 70E – 2024 Article 100]

Exposed (as applied to energized electrical conductors or circuit parts). – Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors and circuit parts that are not *suitably guarded*, *isolated*, or *insulated*. [NFPA 70E – 2024 Article 100]

Guarded – Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, *barriers*, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger. [NFPA 70 - 2023 Article 100]

Insulated – Separated from other conducting surfaces by dielectric (including air space) offering high resistance to the passage of current to ground. [NFPA 70E – 2024 Article 100]

Isolated (as applied to location) – Not readily accessible to persons unless special means for access are used. [NFPA 70E – 2024 Article 100]

Qualified - One who has skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. (NFPA 70 – 2023 Article 100)

Suitably (as applied to insulation, isolation, or guarding) – Determined by an electrical AHJ, electrical Subject Matter Expert (SME), or electrical engineer to be adequate for the practical safeguarding of persons likely to interact with the electrical conductors or circuit parts.

Note 1: see Appendix B for definitions