ELECTRICAL SAFETY GUIDE

HELPING EMPLOYERS PROTECT WORKERS FROM ARC FLASH AND OTHER ELECTRICAL HAZARDS

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WHY AN EFFECTIVE SAFETY PROGRAM IS ESSENTIAL

The Hazards are Real

Electrical Shocks

National Safety Council statistics show that electrical injuries occur in U.S. industries with alarming frequency:

- 30,000 non-fatal electrical shock accidents occur each year
- 1,000 fatalities due to electrocution occur each year

According to the U.S. Bureau of Labor Statistics, nearly half of all work-related electrocutions occur during routine construction, maintenance, cleaning, inspection, or painting activities at industrial facilities, prompting Occupational Safety and Health Administration (OSHA) to identify electrocutions as one of the "Construction Focus Four" hazards.

Although electrical shock accidents are frequent and electrocutions are the fourth leading cause of industrial fatalities, few are aware of how little current is required to cause severe injury or death. In this regard, the current required to light a 7 1/2 W, 120 V lamp is enough to cause a fatality – if it passes across a person's chest.

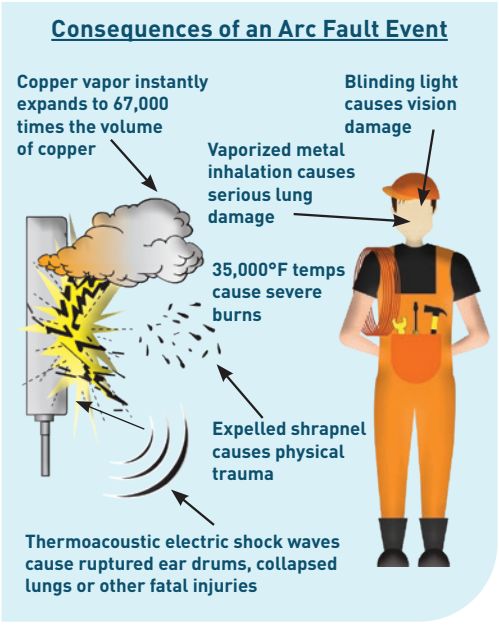
Arc Flash and Arc Blasts

Arc flash and arc blasts that occur when short circuit currents flow through the air are violent and deadly events.

- Temperatures shoot up dramatically, reach up to 35,000° Fahrenheit, and instantly vaporize surrounding components.
- Ionized gases, molten metal from vaporized conductors and shrapnel from damaged equipment explode through the air under enormous pressure.

Anyone or anything in the path of an arc flash or arc blast is likely to be severely injured or damaged.

Statistics from the National Institute for Occupational Safety and Health (NIOSH) indicate that five to ten arc flash explosions occur in electrical equipment every day in the United States. According to the NFPA, these accidents send more than 2,000 workers to burn centers with severe injuries each year.



Safety is Your Responsibility and It's the Law

As an official act of Congress, the Occupational Safety and Health Act of 1970 is the law. Section 5(a) mandates that each employer shall:

1. Furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious harm to his employees.
2. Comply with occupational safety and health standards promulgated under the act.

One of the key OSHA regulations that employers must comply with is 29 CFR 1910 'Occupational Safety & Health Standards.' These standards establish the legal obligation requiring employers to proactively assess workplace hazards and take appropriate actions to advise and protect their employees from the hazards.

In situations where electrical injury occurs, OSHA uses compliance with **NFPA 70E** as a key test to determine appropriate precaution guideline conformity. If negligence is determined, the employer may be subject to substantial fines and management personnel may be held criminally liable.

29 CFR 1910 – Occupational Safety & Health Standards

Key Electrical Safety Requirements

General requirements. – 1910.132

1910.132(d)(1) The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall:

1910.132(d)(1)(i)–(iii) Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment; Communicate selection decisions to each affected employee; and, Select PPE that properly fits each affected employee.

1910.132(f)(1) The employer shall provide training to each employee who is required by this section to use PPE.

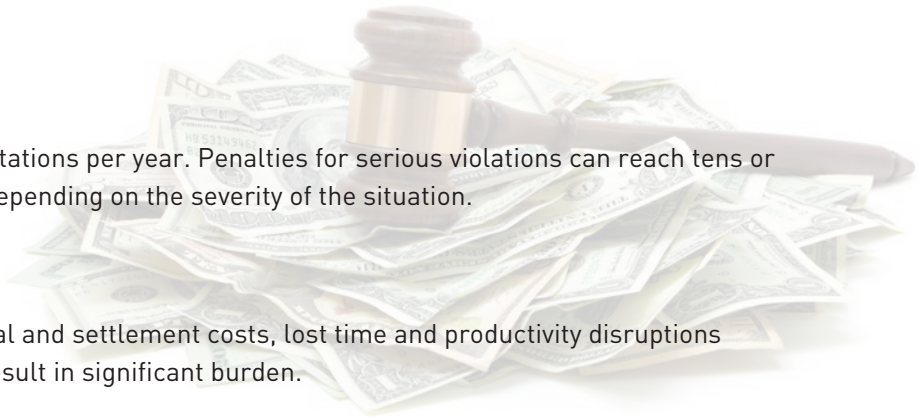
Safeguards for personnel protection. – 1910.335

1910.335(a)(1)(i) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

The Costs of Electrical Accidents can be Enormous

Injury Costs

When serious electrical accidents occur, the cost to a business often exceeds $1 million and the cost to the injured person is immeasurable.



OSHA Citations

On average, OSHA issues 40,000 safety citations per year. Penalties for serious violations can reach tens or even hundreds of thousands of dollars, depending on the severity of the situation.

Lawsuits

In addition to the financial impacts of legal and settlement costs, lost time and productivity disruptions caused by personal injury lawsuits can result in significant burden.

NFPA 70E®

Visit *NFPA.org* to purchase a complete copy of the NFPA 70E Standard

National Electric Code Section 110.16 Arc Flash Hazard Warning FPN No. 1:

NFPA 70E-2024, Standard for Electrical Safety in the Workplace, provides guidance; such as, determining the severity of potential exposure, planning safe work practices, arc flash labeling, and selecting personal protective equipment.

NFPA 70E is a registered trademark of the National Fire Protection Association, Quincy, MA 02169

As the standard for electrical safety in the workplace, NFPA 70E addresses the safety-related work practices, maintenance requirements, and administrative controls necessary to protect employees from electrical energy hazards. It serves several important purposes:

- It is the primary resource and guide for employers to determine compliance with OSHA's electrical safety regulations.
- It is referenced by OSHA and the courts, in workplace injury investigations, to assess whether the involved employers took reasonable and appropriate precautions to protect their employees.

If injury occurs, failure to comply with NFPA 70E may prove very costly.

Key Elements of the Standard

While the NFPA 70E standard was developed in the U.S., it is largely adopted in Canada's CSA Z462 'Workplace Electrical Safety' standard and is also increasingly recognized and used in Mexico. So, the key elements summarized below will generally apply in all three countries. *Consult the standards for complete details.*

Article 110 – General Requirements for Electrical Safety-Related Work Practices

Electrical Safety Program

The OSHA CFR 1910.333 Standard is quite clear about employer's responsibilities: Section (a) states that "safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards."

Article 110 of the NFPA 70E standard provides helpful guidance on how these and other associated legal requirements in the OSHA Standard can be met.

The Standard for Electrical Safety in the Workplace

Electrically Safe Work Condition:

First Priority: Hazard Elimination

Hazard elimination is specifically identified as the first priority in the implementation of safety-related work practices, and accordingly is the first method listed in the Hierarchy of Risk Control Methods to be employed:

(1) Elimination (2) Substitution (3) Engineering Controls (4) Awareness (5) Administrative Controls (6) PPE

It is important to note that the use of PPE is indicated as the least effective risk control method. If a hazard can be eliminated, it should be eliminated; there is no risk of injury if hazards do not exist.

110.2(B) Compliance

The OSHA CFR 1910.333 Standard also requires, in section (a)(1), that "live parts (above 50 V) to which an employee may be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations."

Thus, an employer's Electrical Safety-Related Work Practices must include the determination of when it is necessary to establish an **Electrically Safe Work Condition** by disconnecting and isolating the circuit parts to be worked on from the energized circuit.

Energized electrical conductors and circuit parts operating at 50 V or more, are required to be placed into an electrically safe work condition before work can begin, if:

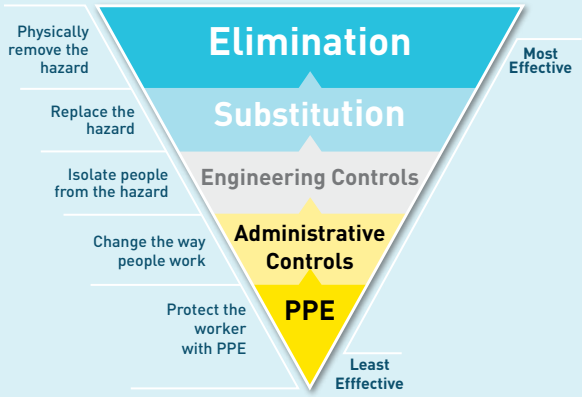
1. The activity is not a permitted normal operation of energized equipment
2. The employee is within the limited approach boundary
3. There is an increased likelihood of injury from an exposure to arc flash hazards

Exception: Normal Operation

Normal operation of energized electric equipment shall be permitted provided the equipment is properly installed, maintained, and rated for the available fault current, with no evidence of impending failure; and is being used for its intended function in accordance with the manufacturer's instructions, labeling and listings, and with any doors or covers closed and secured. Normal operation refers to using the equipment, not working on it.

NFPA 70E Standard for Electrical Safety in the Workplace

HIERARCHY OF RISK CONTROL METHODS



National Institute for Occupational Safety and Health (NIOSH)

NFPA 70E®

CSA Z462
Workplace Electrical Safety

CSA Z462 is a Workplace Electrical Safety standard in Canada. It is based on NFPA 70E and has been harmonized with Parts I, II and III of the Canadian Electrical Code.

Visit *csagroup.org/store* to purchase a complete copy of CSA Z462.

Justification for Energized Work

Only after all opportunities to establish an electrically safe work condition have been exhausted should the decision be made to work on, or near, energized electrical conductors and circuit parts. Work on energized parts at 50 V or more should only be performed if the employer considers the capacity of the source and any overcurrent protection can demonstrate that de-energizing will introduce additional hazards, or is not feasible due to equipment design or operational limitations.

Electrical Safety Program

Another key work practice requirement is the maintenance of a documented electrical safety program to direct employee activities in a manner appropriate for the different voltage, energy level, and circuit conditions that may be encountered. The program must address inspections, maintenance, employee awareness and self-discipline, electrical safety principles, emergency response plans, and procedures, risk assessment and control, job planning, communication, and scope changes, incident investigations, electrically safe work condition policy, lockout/tagout, audits, and documentation.

Training Requirements

Employees who may be exposed to electrical hazards must be specifically trained to understand the hazards associated with electrical energy, as well as the safety-related work practices and procedures required to provide protection from them. The level of training an employee receives determines the tasks he/she is qualified to perform.

Only **'Qualified Persons'** with appropriate training may perform work on or near exposed and energized electrical conductors or circuit parts. The training requirements include:

- Recognizing and assessing potential hazards and risk control methods
- Distinguishing energized from non-energized parts and determining the voltage
- Understanding the relationship between the hazard and potential injury
- Determining approach and flash protection boundaries
- Selecting appropriate personal protective equipment and tools
- Specific work practices and procedures to be followed
- Lockout/tagout procedures
- Emergency procedures for assisting victims of electrical incidents

The Standard for Electrical Safety in the Workplace

Article 120 – Establishing an Electrically Safe Work Condition

The most effective way to prevent electrical injury is to eliminate the hazards by establishing an electrically safe work condition. To do so, workers must identify and disconnect all possible sources of electrical energy and prevent its reappearance through effective lockout/tagout procedures.

This article of the standard focuses heavily on lockout/tagout principles, equipment, and procedures. It defines the following eight-step procedure for establishing and verifying an electrically safe work condition.

Process for Establishing and Verifying an Electrically Safe Work Condition

Establishing and verifying an electrically safe work condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

1. **Determine all possible sources of electrical supply to the specific equipment.** Check applicable up-to-date drawings, diagrams, and identification tags.
2. **After properly interrupting the load current, open the disconnecting device(s) for each source.**
3. Wherever possible, **visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn** to the test or fully disconnected position.
4. **Release stored electrical energy.**
5. **Block or relieve stored nonelectrical energy** in devices to the extent the circuit parts cannot be unintentionally energized by such devices.
6. **Apply lockout/tagout devices** in accordance with a documented and established procedure.
7. **Use an adequately rated portable test instrument to test each phase conductor or circuit part at each point of work to test for the absence of voltage.** Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source. (Refer to NFPA 70E 2024 Article 120.6 for exceptions)
8. **Where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them.** Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with guidelines in NFPA 70E 2024 Article 120.6.

Lockout/tagout is quick and easy since all MELTRIC® Switch-Rated devices have integral locking provisions.

- A user simply needs to provide a lock to perform lockout/tagout on **MELTRIC** plugs.
- Simple lockout provisions are also available on **MELTRIC** receptacles.
- Easily lock the plug and receptacle together to prevent unauthorized disconnection.

NFPA 70E®

Connection and disconnection of a MELTRIC® Switch-Rated plug and receptacle is a NFPA 70E defined 'Normal Operation.'

Arc Flash PPE Required: No

NFPA 70E – Section 130.2 Energized Electrical Work Permit

(A) When Required. When work is performed as permitted in accordance with 110.2(B), an energized electrical work permit shall be required and documented when 1) work is performed within the restricted approach boundary; and 2) the employee interacts with the equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

Article 130 – Work Involving Electrical Hazards

When electrical conductors and circuits equal to and greater than 50 V cannot be placed into an electrically safe work condition, and work is performed as permitted in accordance with NFPA 70E Section 110.2(B), the following requirements must be met:

- Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
- An energized electrical work permit shall be completed as required by NFPA 70E 2024 Article 130.2.
- An electric shock risk assessment shall be performed as required by NFPA 70E 2024 Article 130.4.

Work Permit

When non-routine work must be performed on energized parts or within the restricted approach boundary, a detailed work permit must be prepared before the work can begin. The work permit must document the following elements and be approved/signed by a responsible owner, manager, or safety officer:

- The location and description of the circuit and equipment to be worked on
- A description of the work to be performed
- Justification for performing the work in an energized condition
- A description of the safe work practices to be employed
- Results of the electric shock risk assessment to include voltage exposed, limited approach boundary, and personal and other protective equipment
- Results of the arc flash risk assessment to determine the incident energy at the working distance or arc flash PPE category, personal protective equipment required for worker safety, and the arc flash protection boundary
- Restricted access of unqualified persons from the work area
- Evidence that the job briefing has been completed
- Needs energized work approval signatures by authorized or responsible management, safety officer, or owner

The Standard for Electrical Safety in the Workplace

Electric Shock Risk Assessment and Approach Boundaries

An electric shock risk assessment shall be performed to identify electric shock hazards, estimate the likelihood and severity of injury or damage, and determine the associated required protective measures, including PPE. Because personnel will approach energized electrical conductors or other live circuit parts, limited and restricted approach boundaries must be determined in order to identify safe approach distances and the precautions required to minimize the possibility of electric shock. These boundaries are determined by consulting tables 130.4(E)(a) and (b) in the standard based on voltage and conductor type.

Arc Flash Risk Assessment

An arc flash risk assessment shall also be performed by a qualified person to identify arc flash hazards, estimate the likelihood and severity of injury or damage, and to determine if additional protective measures, including PPE, are required. As a part of this assessment, arc flash protection boundaries must be determined based on the incident energy, and will be the distance at which the incident energy equals 1.2 cal/cm^2. The distances for common equipment and voltage levels are provided by table 130.7(C)(15)(a) and (b) in the standard. Others must be determined by specific calculation.

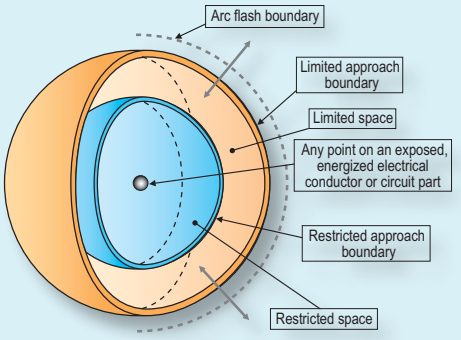
Personal and Other Protective Equipment

Employees working in areas where electrical hazards are present must be qualified to perform the work. They must be provided with, and use, protective equipment designed and constructed for the specific part of the body to be protected and for the work to be performed. PPE requirements can be determined from tables in the standard, based either on the calculated incident energy level, or on the PPE category assigned to the type and electrical energy characteristics of the equipment being worked on.

Section 130.7(C)(15) provides details on selection of appropriate arc rated PPE. Four categories of increasingly protective PPE are defined based on the minimum level of incident energy they provide protection against. The PPE category required can be determined by calculation of the incident energy level or by consulting the table identifying PPE categories for common equipment and voltage levels.

Limits of Approach

Before work can begin near exposed energized parts, approach and flash protection boundaries must be determined.



Arc flash boundary – when an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm^2 (5 J/cm^2).
Note: Second degree burn on unprotected skin is likely to occur at an exposure of 1.2cal/cm^2 (5J/cm^2) for one second.

Limited approach boundary – an approach limit at a distance from an exposed energized electrical conductor or circuit part within which an electric shock hazard exists.

Restricted approach boundary – an approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock due to electrical arc-over combined with inadvertent movement.

NFPA 70E is a registered trademark of the National Fire Protection Association, Quincy, MA 02169

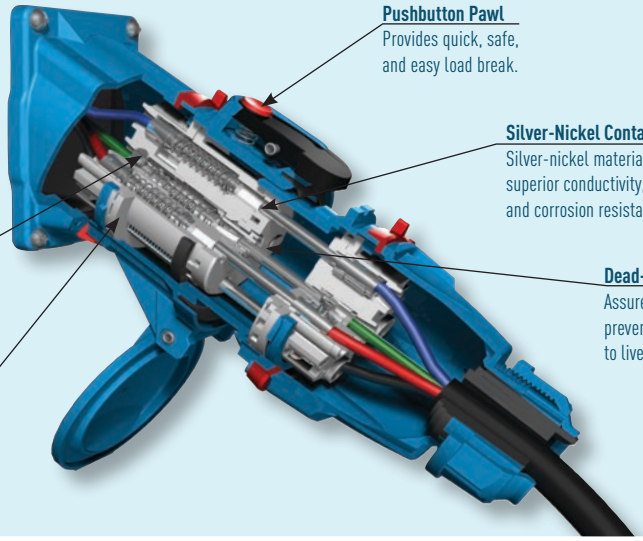
ENSURE SAFETY
with MELTRIC's Switch-Rated Plugs and Receptacles featuring DECONTACTOR™ Technology

Provide the Safety of a Switch with Every Plug and Receptacle

MELTRIC's Switch-Rated plugs and receptacles combine the safety and functionality of a disconnect switch with the convenience of a plug and receptacle. They allow users to safely make and break connections under full load and provide significant protection in overload and short circuit conditions. They are UL and CSA rated for:

- Branch circuit disconnect switching, up to 200 A
- Motor circuit disconnect switching, up to 100 hp
- Short circuit closing and withstand, up to 100 kA in circuits protected with RK1 current limiting fuses

DECONTACTOR™ Technology



WORK SAFETY

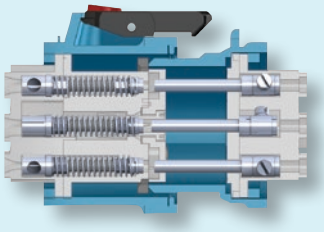
Prevent Unintended Exposure to Live Parts and Arcing

MELTRIC's Switch-Rated plugs and receptacles provide the safety and security of true dead-front construction.

- Load making and breaking is isolated in enclosed arc chambers.
- A safety shutter automatically closes and blocks access to the live contacts before the plug can be removed.

These features ensure that the plug contacts are de-energized before the plug is removed and they prevent unintended access to live parts and exposure to arcing during product operation.

Dead-Front



Enclosed Arc Chambers

Provide Consistently Reliable Connections

MELTRIC Switch-Rated plugs and receptacles use DECONTACTOR™ technology similar to motor starters.

- Spring-loaded butt-style contacts ensure that optimal contact force is always maintained.
- Solid silver-nickel contact material resists wear, withstands arcing and corrosion, and maintains superior electrical performance.
- Spring-driven operating mechanisms ensure a quick and positive load-break and eject the plug to the OFF position.

MELTRIC Switch-Rated plugs and receptacles allow welders and other equipment to be safely connected and disconnected, even in overload conditions.

SIMPLIFY NFPA 70E COMPLIANCE

with MELTRIC's Switch-Rated Plugs and Receptacles featuring DECONTACTOR™ Technology

MELTRIC's Switch-Rated plugs and receptacles simplify compliance with NFPA 70E by eliminating the possibility of exposure to energized parts and arcing when making and breaking the electrical connections required to changeout motors and other equipment. This avoids the need to take many of the special precautions required to ensure that workers are aware of and protected from the electric shock and arc flash hazards that exist whenever work is performed on or around energized circuit components.


Integral provisions make lockout/tagout simple.

Switch Ratings Simplify De-energization

With push button load-breaking, UL and CSA switch ratings for applications up to 200 A and short circuit closing and withstand ratings up to 100 kA (in circuits protected with RK1 current limiting fuses), switch-rated plugs and receptacles provide a safe, simple, and convenient means of disconnecting the load. There is no need for the interlocks and auxiliary disconnects required with standard plugs and receptacles.

Dead-Front Construction Ensures a Safe Work Condition

DECONTACTOR™ technology ensures that load making and breaking is isolated in enclosed arc chambers and that a safety shutter closes over the live receptacle contacts before the plug can be removed. This prevents user exposure to live parts and arcing, and ensures that a safe work condition is maintained. There is no need to perform a hazard analysis, obtain work permits, use cumbersome PPE, or take the other precautions required when working on or near live parts.

Plug Removal Verifies De-energization

Removing the plug from the receptacle provides visual verification of contact separation and de-energization. This avoids the need for the voltage testing required with many other disconnect switches that often involves energized electrical work and associated safety precautions.

Switch-Rated plugs and receptacles enable quick motor changeouts.

Specialized Personnel may not be Required on Site

Because there is no electrical work to be performed and no concern about access to live parts when making and breaking connections with switch-rated plugs and receptacles, mechanics can quickly changeout motors with pre-wired replacements.

No Hazard/No PPE Required

Making and breaking electrical connections with MELTRIC's Switch-Rated plugs and receptacles meet NFPA 70E's 'Normal Operation' definition, so no special personal protective equipment is required. There is no need to 'suit-up' with cumbersome PPE.

Motor Changeout Process Comparison

MELTRIC Switch-Rated Plugs & Receptacles

Mechanics can quickly and safely make and break electrical connections, without special PPE.

1. Switch receptacle to 'off' position
2. Remove plug from receptacle
3. Apply lockout/tagout
4. Remove old/install new motor
5. Remove lockout/tagout
6. Insert plug into receptacle

- **Changeout downtime is reduced by up to 50%.**
- **Equipment and installation costs are reduced** by eliminating the need for interlocks and safety switches.
- **Maintenance efficiency is improved** by allowing mechanics to perform changeouts. **Pre-wiring can be done at a convenient time** in the electrical shop helping to ensure proper motor rotation.

Typical Disconnect Switch

After operating the disconnect switch, a workerstill needs to verify de-energization. Exposure to live parts is inevitable, so PPE is required.

1. Switch disconnect to 'off' position
2. Apply lockout/tagout
3. Perform electric shock/arc flash risk assessment
4. Obtain permit for energized electrical work
5. Suit up with appropriate PPE
6. Remove the disconnect switch cover
7. Voltage test to verify de-energization
8. Disconnect motor from hard-wiring
9. Remove old/install new motor
10. Connect new motor to hard wiring
11. Remove lockout/tagout
12. Turn disconnect to the 'ON' position
13. Remove and store PPE

ISSUES

MELTRIC receptacles can be added to existing disconnects to avoid PPE requirements for voltage testing.

ELIMINATE THE HAZARDS
of Standard Plugs & Receptacles

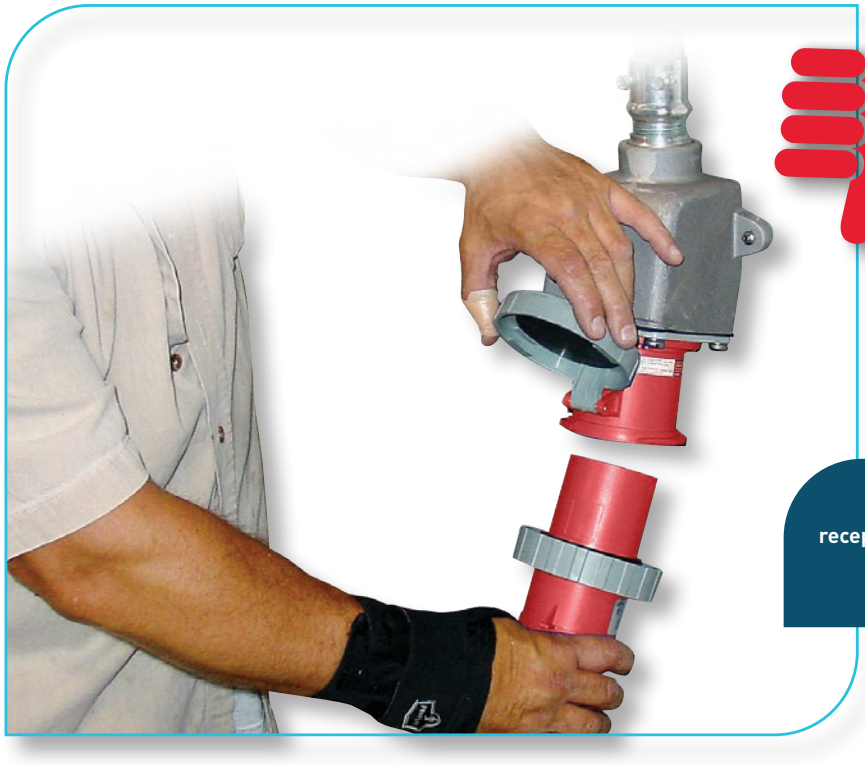
Switch-Rated Plugs and Receptacle

MELTRIC DS and DSN series Switch-Rated plugs and receptacles are designed and rated to function as a switch. Users can safely make and break connections, even in overload conditions.

- Silver-nickel contacts resist wear and maintain superior conductivity even in wet and corrosive environments.
- Silver-nickel butt-style contacts withstand arcing and resist welding, allowing them to close into and withstand short circuit currents as high as 100 kA.
- Enclosed arc chambers and dead-front construction prevent exposure to arcing and eliminate unintended access to live parts.

Switch-Rated plugs and receptacles, from MELTRIC, provide a secure and foolproof means of ensuring user safety without the need for interlocks and safety switches required with other types of plugs and receptacles. At no time is a user exposed to live contacts while connecting or disconnecting.

Standard Plugs & Receptacles



Most traditional plugs and receptacles should never be connected or disconnected under load.

Standard pin and sleeve and twist type plugs and receptacles are not intended to be disconnected or connected under load. Doing so can be very hazardous.

- The electrical properties of their brass contacts degrade significantly from oxidation and wear occuring with normal use.
- Because brass cannot withstand arcing, the contacts may vaporize and cause an arc flash if connected or disconnected in overload conditions.
- Live front designs expose users to live parts and also to the arcing or arc blasts that may result from their use in adverse conditions.

Because nothing prevents standard pin and sleeve and twist type plugs and receptacles from being connected and disconnected under load in many applications, users are often exposed to these hazards. When interlocks are provided, their function is often defeated by the use of extension cords.

Make and Break Electrical Connections
Simply, Safely and in Compliance with NFPA 70E®

Use MELTRIC Switch-Rated Plugs and Receptacles

DSN

- 20 – 150 A, 600 VAC
- .75 – 75 hp
- Compact and lightweight
- Type 4X, IP66/IP67 and IP69/IP69K
- Configurable with up to 6 auxiliary contacts
- Fiberglass reinforced thermoplastic poly casings resist electric shock, chemicals, and UV rays

DS

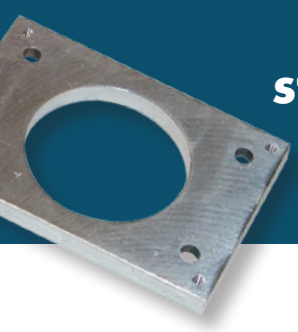
- 20 – 200 A, 600 VAC
- .75 – 100 hp
- Type 3R or 4X
- Larger wiring capacity, rugged durability
- Configurable with up to 6 auxiliary contacts
- Available in fiberglass reinforced thermoplastic poly or zinc alloy casings – both materials resist electric shock, chemicals, and UV rays

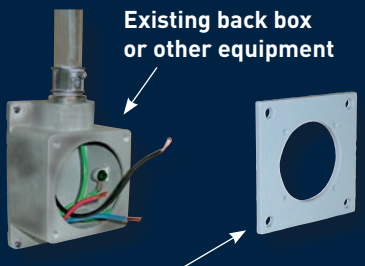
Ratings

- **UL and CSA Listed:**
  - UL 1682
  - UL 2682
  - CSA C22.2 No. 182.1
- **UL and CSA Switch-Rated per UL 2682 and Listed for:**
  - Motor Circuit Disconnect Switching
  - Branch Circuit Disconnect Switching
- **Short Circuit Rated**
  - Up to 100 kA closing and withstand with RK1 current limiting fuses

** Testing was performed with RK1 current limiting fuses sized at 400% of the highest full load motor ampacity associated with the devices hp ratings. Visit **meltric.com** to confirm ratings.*

Easily update existing equipment with standard MELTRIC adapter plates





Plug into SAFETY and RELIABILITY with **MELTRIC®**

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