ELECTRICAL SAFETY-BY DESIGN

BENEFITS BEYOND COMPLIANCE

GRACE PESDs®

Electrical safety is personal and it starts with YOU. Whether you are a maintenance or electrical worker on the front line, or responsible for design and management, you have a unique role and responsibility in protecting yourself and the people around you from devastating hazards of electrical energy.

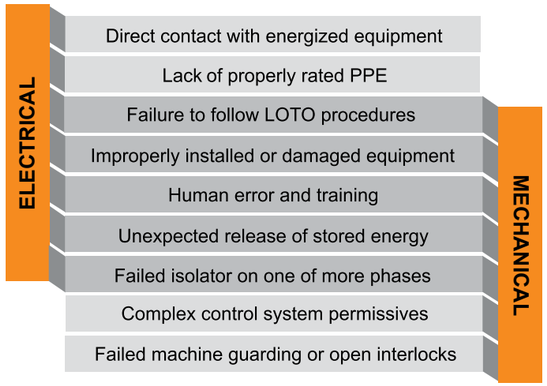
WHY REDUCE LOCKOUT/TAGOUT (LOTO) RISKS IN YOUR FACILITY?

Two of the top ten most cited OSHA violations are related to the control of hazardous energy, and use of electrical work practices. These are covered under the OSHA regulations:

- **CFR 1910.147** covers the servicing and maintenance of machines and equipment in which the unexpected energization or startup of the machines or equipment, or release of stored energy, could harm personnel.
- **CFR 1910.333** covers the safety-related work practices to prevent electrical shock or other resulting injuries from direct or indirect electrical contact when work is performed around the electrical equipment and circuits.

Failure to perform proper mechanical or electrical LOTO can lead to electrocution, electrical shock, arc-flash and other hazards. In addition to huge penalties, these hazards often result in lost time wages, compensation claims, permanent disability and fatalities.

Most common reasons workers are **affected** by **hazardous energy**



The U.S. Department of Labor from 2011 to 2015 reported an average of 150 fatalities per year in the United States due to “exposure to electricity” and more than 50,000 are injured for disregarding LOTO protocols. The Bureau of Labor Statistics also reported an average of 2370 non-fatal electrical injuries a year due to electrical shock and electrical burns in the last decade. Grace’s Permanent Electrical Safety Devices (PESDs) seek to prevent these hazards through Safety-by-Design, substantially reducing the risk and enhancing the productivity in mechanical and electrical LOTO procedures.

R-3W2 Voltage Indicator PESD

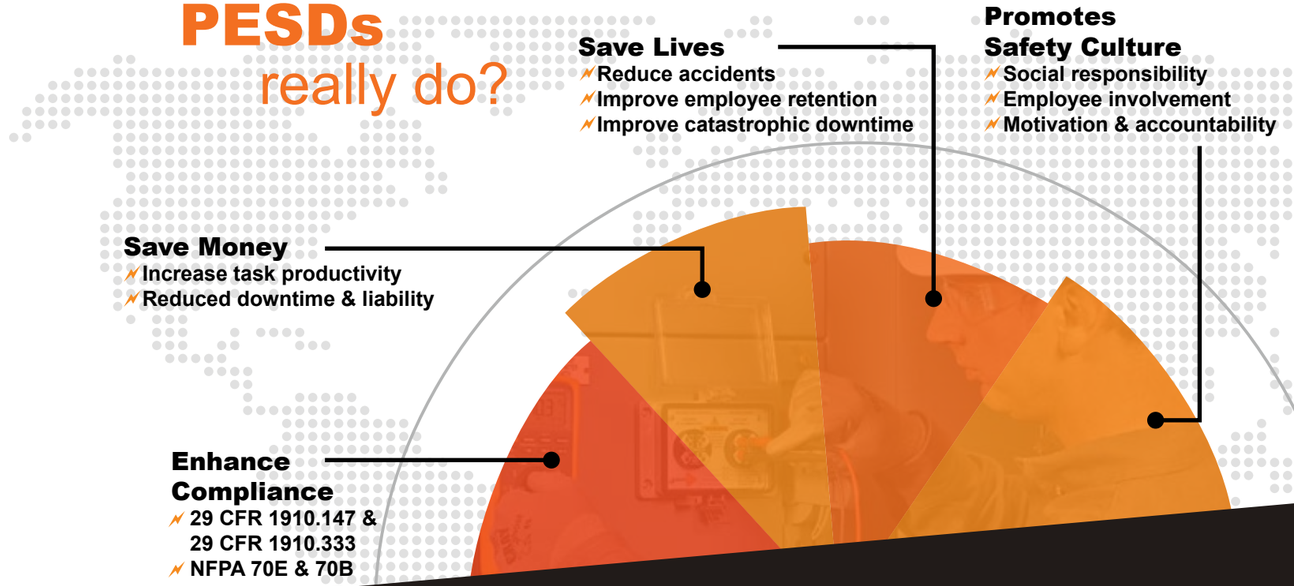
PESDs also assist facility personnel by providing alternative preventive measures for the tasks that are integral and repetitive to the production process.

HOW THE SAFETY-BY-DESIGN PHILOSOPHY HELPS IN REDUCING RISKS

Permanent Electrical Safety Devices (PESDs) work to confront common LOTO procedural and implementation issues, user error, compliance and productivity by engineering innovative safety solutions that mitigate or eliminate various task risks. When properly incorporated into a facility’s LOTO procedure, thru-door voltage indicators, Safe-Test Points™, voltage portals, and combination units inherently reduce risk by providing a safer and more productive method of performing verification of hazardous energy isolation, thereby enhancing compliance with NFPA 70E and OSHA energy isolation principles.

Safe Test-Point™ PESD

What do **PESDs** really do?



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GOING BEYOND THE TRY-TEST

Qualified maintenance personnel performing mechanical LOTO are tasked with isolating electrical energy. As part of the verification of deenergized condition, OSHA requires a person to operate the equipment controls, also known as Try-Test, to ensure the equipment cannot be restarted. There are several significant risks associated with solely relying on the Try-Test.

Risks associated with Try-Test:

- Isolating wrong controls
- Accidental restart of the equipment
- Getting caught in the equipment
- Contact with live source of energy at the machine level
- Citations for not following 1910.147 procedures

Safety conscious and forward thinking companies understood these risks early on and started to require electricians to perform Absence of Voltage Testing (AVT) for mechanical LOTO. With the advent of NFPA 70E and research on Arc Flash, companies began to realize through job hazard analysis that this task while reducing the hazards of the energized condition of the equipment on the other hand greatly increased the workers' exposure to electricity in performing the test itself.

Additionally, the involvement of an electrician in a simple mechanical LOTO further hampered productivity. An externally-mounted voltage indicator provides a means to verify the voltage presence inside an electrical panel safely from the outside in addition to the OSHA required Try-Test. Without a voltage indicator, a mechanic performing mechanical LOTO would be required to work in tandem with an electrician using a voltmeter to physically verify voltage inside an electrical panel. In this case, the electrician is exposed to voltage. With the combination of the Try-Test and thru-door voltage indicators, the mechanic can solely verify deenergized condition without any voltage exposure.

HOW TO ENHANCE COMPLIANCE AND FOSTER A SAFETY CULTURE?

Electrical safety goes beyond legislation and compliance. An environment that is highly productive and efficient is a culture where employees are secure, safe and cared for.

According to the U.S. Department of Labor, a safe and healthy workplace not only protects workers from injury and illness, it can also lower injury/illness costs, reduce absenteeism and turnover, increase productivity and quality, and raise employee morale. In other words, safety is not just a good practice, it is good for business.

How do **PESDs** fit into **Electrical Safety?**

A sound electrical safety program should constitute all aspects of risk control hierarchy in eliminating, substituting, engineering controls, awareness, administrative controls, and Personal Protective Equipment (PPE). While it is important to understand the fault currents, arc flash labels, type of PPE, and other incident energy calculation tools; nothing comes close to avoiding one's exposure to the incident itself.

When it comes to electrical safety, what is important to you?

Risk Control Hierarchy

Sample Job Hazard Analysis

Rating Scale: 1-5, Probability rating of 1 is unlikely and 5 is Highly probable and Exposure rating of 1 is less than 1x per month and 5 is exposed at all times.

As the exposure to incident energy is reduced with PESDs, the risk score and the injury risk costs are significantly reduced by 60 - 75% based on the single or multiple PESDs used in the below task scenarios.

Task Scenario	Task Owner	Assumed Task Steps	Risks Involved	Exposure	Severity	Probability	Assumed Risk with Admin Controls	Reduced Risk with PESDs & Admin Controls	PESD	Risks Mitigated with PESDs
Maintenance tech, operator and a qualified electrician needs to verify release of stored energy, and establish an electrically safe work condition to perform major maintenance on a machine press - **Mechanical & Electrical LOTO and site specific switching procedures.**	Qualified Electrician, Task Qualified Maintenance Tech and Machine Operator	• Throw the main disconnect switch to “OFF” position or open the main disconnect switch • Verify the release of stored energy • Release or lock any hydraulic systems on the machine and apply tags • Don arc-rated PPE as mentioned in the arc flash label • Create a limited approach and restricted approach boundaries • Erect barricade zones • Perform Three Point Test (Live-Dead-Live Test) using an adequately rated portable test instrument • Lockout and attach tags to the main feeder line • Perform the repair	• Possible Shock/and Arc-flash Hazard • Accidental release of stored energy • Accidental contact with the live source of energy • Wrong feeder shut down • Back feed from other sources • Accidental drop of tools and objects on live conductors inside the cabinet • Lack of properly rated PPE	Exposure **3** x Severity **5** x Probability **4** = Assumed Risk **60** **Utilize two PESDs and reduce risk by 75% = Reduced Risk to 15** **3** Less than 1x shift	**5** Major Permanent Im-pairment or death and caught by equipment	**4** Probable	**60** $387,982	**15** $96,750	Voltage Test Station installed in the MCC and Flex-Mount Voltage Indicator Installed on the disconnect switch at the machine	**Voltage Test Station (VTS) enables qualified electrician to visually verify:** • Perform Three Point Test (Live-Dead-Live) for absence of voltage from outside the door. • Voltage presence • Release of stored electrical energy • Backfeed from other sources **Flex-Mount Voltage indicators enables operator to visually verify:** • Release of stored electrical energy • Hazardous voltage presence at the disconnect switch • The stuck blade condition of the disconnect switch
Verifying and creating an electrically safe work condition to perform a maintenance task on a MCC – **Electrical LOTO and site specific switching procedures.**	Qualified Electrician	• Don arc-rated PPE as mentioned in the arc flash label • Throw the main feeder to “OFF” position or open the main disconnect switch • Create a limited approach and restricted approach boundaries • Erect barricade zones • Perform Three Point Test (Live-Dead-Live Test) using an adequately rated portable test instrument • Lockout and attach a tag to the energy isolation device • Perform the repair	• Possible Shock/and Arc-flash Hazard • Accidental contact with the live source of energy • Wrong feeder shut down • Back feed from other sources • Accidental drop of tools and objects on live conductors inside the cabinet • Lack of properly rated PPE	Exposure **4** x Severity **5** x Probability **3** = Assumed Risk **60** **Utilize the Voltage Test Station PESD and reduce risk by 75% = Reduced Risk to 15** **4** More than 1x shift	**5** Major Permanent Impairment or death	**3** Possible	**60** $350,000	**15** $87,500	Voltage Test Station installed in the Motor Control Center (MCC)	**Voltage Test Station enables qualified electrician to visually verify:** • Voltage presence • Release of stored electrical energy • Backfeed from other sources • Perform three point test (live-dead-live) for absence of voltage from outside the door. • Verify zero voltage from outside the panel.
Minor servicing and adjustments to the machine - **Routine Maintenance**	Task Qualified Machine Operator	Operator has to throw the the disconnect switch to “OFF” position and follow the machine specific instructions to perform minor service	• Sudden release of energy • Mechanical failure of the disconnect switch (Stuck blade)	Exposure **4** x Severity **3** x Probability **4** = Assumed Risk **48** **Utilize two PESDs and reduce risk by 75% = Reduced Risk to 15** **4** More than 1x shift	**3** Lost time, Full Recovery, and some permanent impairment	**4** Probable	**48** $59,292	**12** $14,823	Voltage Indicator and Voltage Portal installed in the machine control cabinet	**Voltage indicator enables operator to visually verify:** • Release of stored electrical energy • Hazardous voltage presence at the disconnect • Verifies the stuck blade condition • Backfeed from another source **Voltage Portal & NCVD Pen:** • User can perform the absence of voltage test with NCVD pen in all three phases • Provides additional risk reduction by going beyond visual indication.
Removing a stuck part from a machine on a production line - **Task integral to production process**	Task Qualified Machine Operator	Operator has to throw the disconnect switch to “OFF” position and follow the machine specific instructions to remove the part.	• Unexpected release of stored energy • Mechanical failure of the disconnect switch (Stuck blade)	Exposure **4** x Severity **3** x Probability **4** = Assumed Risk **48** **Utilize one PESD and reduce risk by 60% = Reduced Risk to 19** **4** More than 1x shift	**3** Lost time, Full Recovery, and some permanent impairment	**4** Probable	**48** $77,995	**19** $31,198	Voltage indicator installed in the machine control cabinet or on the disconnect switch	**Voltage indicator enables operator to visually verify:** • Release of stored electrical energy • Hazardous voltage presence at the disconnect • Verifies the stuck blade condition

Cost of Injury source: Injury Facts 2017, Bureau of Labor Statistics and OSHA sites. Please note the above job hazard analysis, assumed task steps and risk reduction numbers are for calculation purposes only. Please consult your factory’s EHS, safety and reliability departments and safety procedures to determine your unique job hazards and associated risks.

OSHA's Office of Regulatory Analysis states-

For every $1 invested in safety and health programs, **companies can expect a return of $4 - $6**

PESDs enhance compliance with NFPA 70E and OSHA energy isolation principles. The result is increased productivity and decreased risk through our Safety-by-Design efforts.

GRACE VOLTAGE INDICATOR PESDs

Voltage indicators are PESDs that visually represent presence of voltage with flashing or non-flashing, redundant LED lights. Typically hardwired to the load side of disconnect, voltage indicators illuminate whenever hazardous voltage or stored energy is present in any individual phase.

R-3F2

GRACE VOLTAGE PORTAL PESDs

The voltage portals offered by Grace minimize arc flash risks and maximize electrical safety by providing maintenance personnel a no-touch portal to energy on the outside of grounded electrical enclosures. These Voltage Portals detect voltage presence from outside the cabinet through the use of a Non-Contact Voltage Detector (NCVD) pen without the risk of being exposed to arc flash or shock hazards.

R-1A
NCVD Pen sold separately

GRACE SAFE TEST-POINT™ PESD

Safe-Test Point™ allows qualified personnel to perform absence of voltage tests safely from outside an electrical cabinet. The device reduces the risk of arc flash and shock hazard to the OSHA shock hazard threshold.

GRACE COMBINATION PESDs

Combination units take our tried and true voltage indicator and portal PESDs and place them both within a single protective housing or couple them together with our custom labels. The best example of our combination PESDs is the Voltage Test Station (VTS). Using the VTS test points, qualified personnel can measure AC/DC voltages both phase to phase or phase to ground while task qualified personnel can visually verify energy isolation in addition to the Try-Test when electrical work is not part of the required task. With the VTS, maintenance and inspections can be quickly and accurately performed.

A Combination PESD featuring Safe-Test Point™ and R-3W Voltage Indicator

HOW GRACE PESDs FIT INTO YOUR LOTO PROCEDURES?

Grace PESDs engineer out the risk associated with routine maintenance tasks allowing it to be safely conducted from outside of the electrical cabinet, inherently reducing the risk of arc flash and shock hazards significantly. When properly incorporated into a facility's electrical and mechanical LOTO safety procedures, PESDs enhance compliance with NFPA 70E and OSHA energy isolation principles.

The **LOTO Procedure**

1. Notify affected employees that machine or equipment will be shut down and locked out
2. Shut down the machinery or equipment
3. Isolate energy sources with energy-isolating devices

Incorporate Grace PESDs for decreased risk

4. Lock out energy-isolating devices with assigned locks
5. Release or restrain stored or residual energy

Incorporate Grace PESDs for increased productivity.

6. Test machinery to make sure it can't start up

The Department of Labor reported from 2011 to 2015

"...More than 50,000 are injured for disregarding Lockout/Tagout protocols..."

HOW PESDs FIT INTO NFPA 70E STANDARDS

PESDs greatly assist users with an easier and safer method of performing mechanical & electrical lockout/tagout. Allows users to productively perform the steps outlined in **NFPA 70E 2018 standards, Article 120.5** in establishing and verifying an electrically safe work condition.

120.5 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.

PESDs when installed by a qualified electrician and documented in the drawings, helps to identify all the possible sources of electrical supply to specific equipment. For example: connected to the line side/load-side of the source.

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 fully disconnected position.

PESDs connected to the load side of the disconnect switch verifies the voltage presence at the Energy Isolation device in the event of phase loss, back feed or stuck blade condition.

4) Release stored electrical energy.

PESDs verify the release of stored electrical energy or dissipation of energy when connected to capacitive loads. Voltage Indicators continue to illuminate when voltage is present automatically without switching meter settings.

5) Release or block stored mechanical energy.

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 to verify it is deenergized. 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 a known voltage source.

CAT rated PESDs with the combination of high impedance protected test points enables the users to perform the three-point test or absence of voltage test from outside the cabinet in normal operating condition with equipment doors closed and secured per Article 130.2 (4).

8) Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following: on any known voltage source.

WHY SHOULD YOU GO BEYOND COMPLIANCE WITH GRACE PESDs?

Voltage is the common denominator in an electrical accident or an arc flash; no voltage means no accident/arc flash. At Grace, our mission has always been to ensure that every electrical worker returns home safely to their family and loved ones. With electrical safety meshed in our DNA and programmed in our brains, we are always striving for ways to improve the workplace electrical safety standards by developing innovative products and solutions that minimize the risk of electrical exposure. PESDs are a result of a constant zeal to find simple, innovative and practical ways of developing electrically safer work conditions that reduce accidents, improve productivity, enhance compliance as well as foster a safety culture.

At Grace, **electrical safety** is not just our business; it's our **mission**.
Choose **PESDs** and decide to **go beyond compliance.**

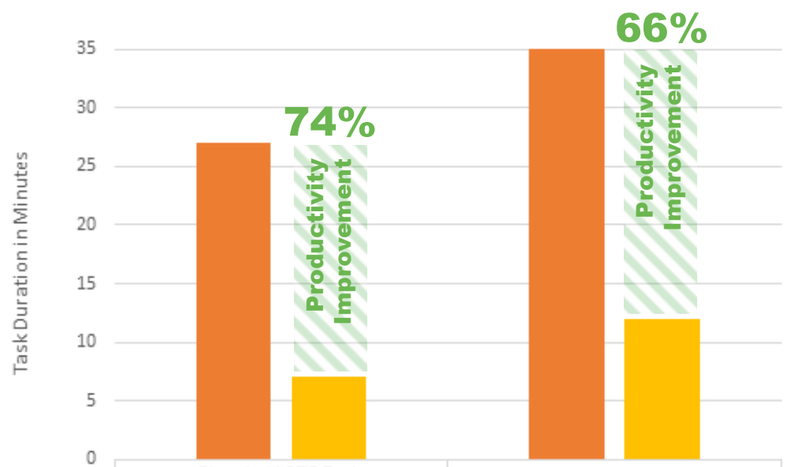
HOW CAN YOU SAVE MONEY AND IMPROVE PRODUCTIVITY?

The cost of injury prevention is far less than the cost of an injury. Workplace injuries cost companies in lost time, increased insurance premiums, OSHA citations, penalties and other workers' compensation to name a few. Electrical safety demands a precise answer to the question of voltage absence.

The cost of non-compliance:

- OSHA Citations
- Production losses
- Wages for work not performed
- Increased workers' compensation insurance costs
- Damage to equipment or machinery
- Hiring and/or training new employees
- Decline in product quality and worker morale
- High turnover and lost work time

Productivity Improvement with PESDs

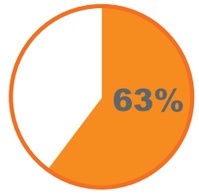


	Electrical LOTO Task Verifying and creating an electrically safe work condition	Mechanical LOTO Task
Normal Task duration(in Mins)	27	35
Task duration with PESD (in Mins)	7	12

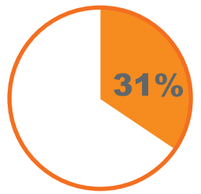
PESDs AND ELECTRICAL SAFETY- THE BOTTOM LINE

Based on a recent electrical safety survey conducted with PESD users, the results found PESDs reduced electrical LOTO tasks an average of 20 minutes and reduced mechanical LOTO tasks by an average of 23 minutes. The following charts illustrate additional findings and data from that study:

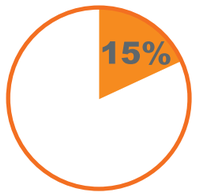
Users have identified failed or faulty isolators with PESDS



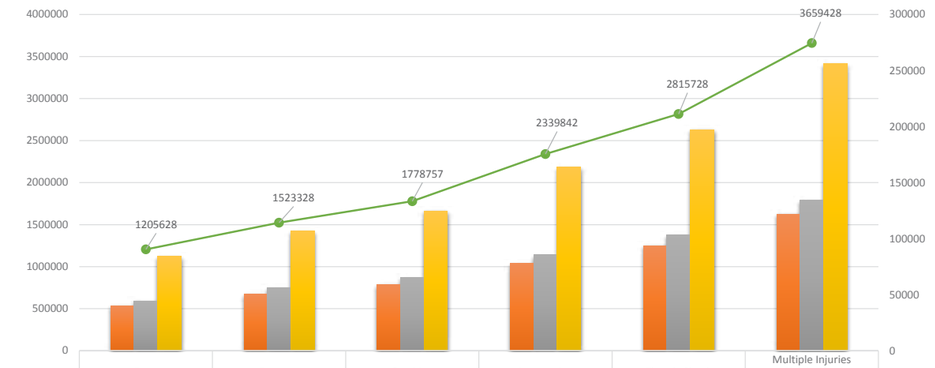
Users have fewer accidents with PESDS



Users have seen a reduction in near misses using PESDS



Estimated Cost of Occupational Injuries & Additional Revenue Needed to Offset Costs



	Burn	Fracture	Crushing	Amputation	Electric Shock	Multiple Injuries (Physical and Psychological)
Direct Cost	$ 40188	$ 50778	$ 59292	$ 77995	$ 93858	$ 121981
Indirect Cost	$ 44206	$ 55855	$ 65221	$ 85794	$ 103243	$ 134179
Total Cost	$ 84394	$ 106633	$ 124513	$ 163789	$ 197101	$ 256160
Additional Sale Required to Offset accident cost	$ 1205628	$ 1523328	$ 1778757	$ 2339842	$ 2815728	$ 3659428

Direct Cost | Indirect Cost | Total Cost | Additional Sale Required to Offset accident cost

Note: Indirect cost ratio of 1.1 and profit margin of 7% is considered in the above calculation.

FOR MORE INFORMATION VISIT PESD.COM OR CALL 1.800.280.9517

GRACE PESDs® Safety Solutions

All of these are tools that allow for maintenance and inspections to be safely conducted from outside of the electrical cabinet, inherently reduce the risk of arc flash and shock hazard significantly.

	INDIVIDUAL PESDs			MULTI-PESDs (COMBO UNITS)			MEDIUM VOLTAGE INDICATOR
Type of Energy Verification	Voltage Indicators	Voltage Portals	Safe-Test Point	Voltage Indicator & Voltage Portal Label Combo Units	Voltage Indicator & Safe-Test Point Label Combo Units	Voltage Test Station (VTS) Environmentally Protected	Medium Voltage Indicator
Part Number	 R-3W Series  R-3F2  R-3D2	 R-1A  R-T3  R-3K	 R-3MT	 R-T3W2-LCF  R-T3W-LCH	 R-3WMT	 P-S10S21-M3RX	 R-1VL003
Voltage Presence	YES	YES with NCVD Pen	YES with meter	YES	YES	YES	YES
Phase Loss		NO					
Stored Energy Dissipation							NO
Voltage Absence	NO			NO	YES with meter	YES with meter	
Primary Task	Mechanical Lockout/Tagout	Mechanical Lockout/ Tagout	Electrical Lockout/ Tagout	Enhanced Mechanical Lockout/Tagout	Enhanced Electrcial Lockout/Tagout		Visual Indication
Type of Worker	Machine Operator, Task Qualified Worker	Machine Operator, Task Qualified Worker	Qualified Electrician, Electrical Engineer	Machine Operator, Task Qualified Worker	Qualified Electrician, Electrical Engineer		Qualified Electrician, Electrical Engineer

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Warning: Verify an electrical conductor has been de-energized using an adequately rated test instrument before working on it. Follow appropriate Energy Control (Lockout/Tagout) procedures as per OSHA Subpart S.

c UL us LISTED RoHS CE CAT III & IV

Certifications may vary by product. Refer to the individual product datasheet for additional details.

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SS-PESD-EB-EN 1801