



# Switchgear Safety LLC

## Arc Flash Mitigation Through Remote Operation

Switchgear Safety LLC provides customers with the most advanced offering of electrical safety equipment on the market. See how our innovative lineup of product solutions can help you better protect your personnel, equipment, and bottom line.

# Presentation Overview

- **About Switchgear Safety LLC (5 slides)**
  - About, at a glance, mission, qualifications, & customers
- **Arc Flash Basic Information (10 slides)**
  - Basic information, causes, dangers, standards, & mitigation
- **How Switchgear Safety Can Help (20 slides)**
  - Market overview, product solutions, benefits, & conclusion
- **Case Studies (5 slides)**
  - Brookhaven National Laboratory & Gulf States Electric arc flash accidents
- **Closing (3 slides)**

# About Switchgear Safety LLC

- Founded in 2018 by David Walterscheid and currently based in Ponder, TX
- Created with a new vision for product design, operation, & sales methods
- Focused on becoming a market leader with innovative & competitive products
- Committed to reinventing the marketplace by challenging the status quo
- Dedicated to doing things right to fully support our customers & partners



**SWITCHGEAR  
SAFETY**  
ELECTRICAL SAFETY SOLUTIONS

- 
- ➔ REMOTE RACKING
  - ➔ REMOTE SWITCHING
  - ➔ LOCK-OUT/TAG-OUT
  - ➔ CUSTOM SOLUTIONS

# Our Company At A Glance

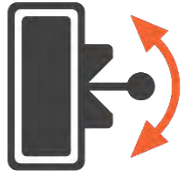
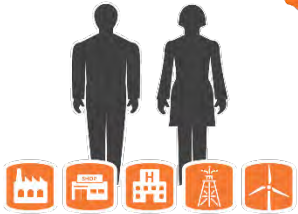
**OVER  
800  
APPLICATIONS  
IDENTIFIED**



**COMPATIBLE  
WITH ALL  
MAJOR  
MANUFACTURERS**



Our Customers



Litigation



Lost productivity



Property damage



Penalties

**BENEFITS OF REMOTE OPERATION**



IMPROVE SAFETY



MINIMIZE DOWNTIME



REDUCE COSTS





# Our Mission Statement

**“ At Switchgear Safety LLC our mission is to design and manufacture the industry’s highest quality electrical safety products – focusing on remote operation and lock-out/tag-out solutions – and to work together with our customers to create a custom and well rounded solution to ensure that all of their specific safety needs are met. ”**

# Our Qualifications

- 10+ years in electric safety industry, 5+ years as executive of remote operation focused company
- Contributed to numerous patents & trademarks in the field of remote operation and electrical safety
- Written multiple whitepapers and articles on remote operation and equipment life extension
- Oversaw development of 300+ unique remote operation devices installed in facilities worldwide
- Electrical safety products have won awards from industry publications and trade organizations



# Our Markets & Locations Served

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- **Markets served**
  - Established: Steel, aluminum, wood, pulp & paper
  - Emerging: Wind, solar, nuclear
- **Locations served**
  - Global: Oil and gas/petrochemical, datacenters, mining, minerals, cement
  - Regional: Traditional utilities, machine builders/OEMs, government
  - Local: Water/wastewater treatment, institutional, commercial, government



# Arc Flash Basic Information

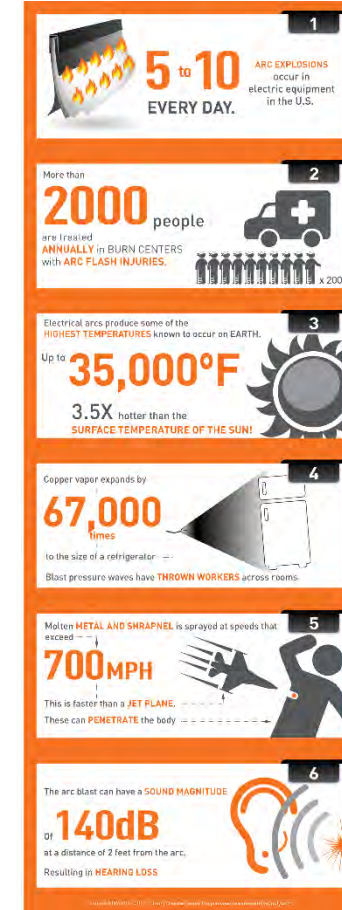
- Dangerous condition associated with release of energy caused by electric arc
- Insulation gap or isolation between conductors cannot withstand potential
- Heat, light, pressure, & sound energy can cause injury or equipment damage
- Severity based on proximity (in), duration (s), and available energy (kA)
- Flash protection boundary defines minimal safe distance during operation





# Arc Flash By The Numbers

- Up to 10 arc flash incidents/day in USA, resulting in 2,000/year treated at burn centers
- Temperatures up to 35,000°F, or 3.5 times the surface of the sun
- Superheated air rapidly expands, causing pressure blast up to 500 psi travelling 6,000 ft/s
- Vaporized metals expand rapidly (Copper 67,000x), ejecting shrapnel up to 700 mph
- Explosion causes hearing damage from due to magnitudes up to 140 dB



# Arc Flash Incident Energy

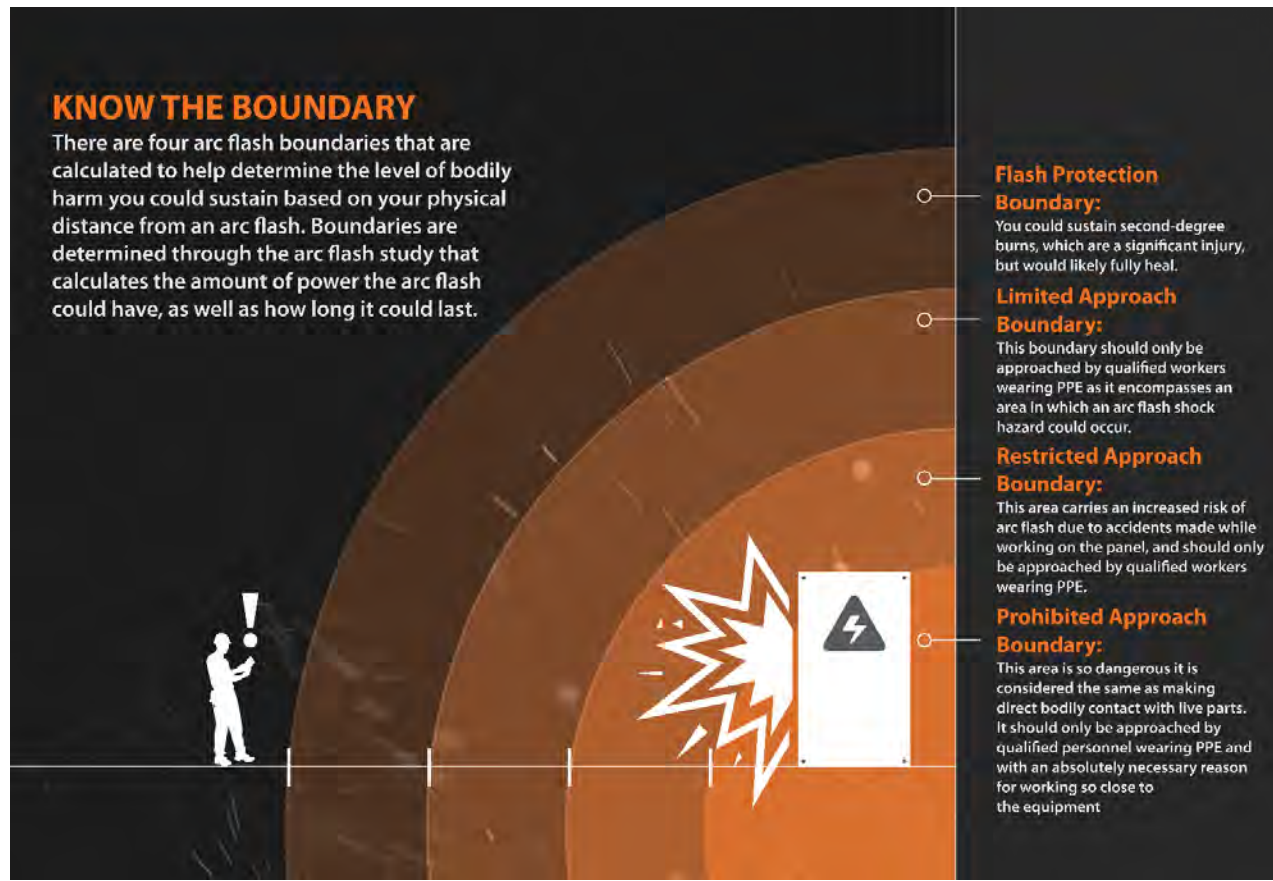
- Energy measured in  $\text{cal/cm}^2$ , referred to as incident energy ( $E_i$ )
- $E_i$  calculated at a working distance from the source (Commonly 18")
- $E_i > 1.2 \text{ cal/cm}^2/\text{s}$  results in 2<sup>nd</sup> degree burn at calculated distance
- Analysis required when working at or near potential source
- Regulations require PPE rating  $> E_i$  at specified working distance



# Arc Flash Protection Boundary

## Four boundary levels:

- Flash protection boundary (Outer)
- Limited approach boundary
- Restricted approach boundary
- Prohibited approach boundary (Inner)



# Arc Flash Industry Standards

- **Three standards organizations establish practices for prevention of arc flash incidents in the USA:**
  - NFPA: NFPA 70 – National Electrical Code (NEC) & NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces
  - OSHA: 29 - Code of Federal Regulations (CFR) Part 1910, Subpart S: Standards for work practices
  - IEEE: C2 – National Electric Safety Code (NESC); 1584 – Guide to Performing Arc Flash Hazard Calculations





# NFPA 70E Hazard Risk Category Table

- Many companies use tables for PPE selection to save money and avoid arc flash study
- Tables may only be used if the available fault current & clearing times are known
- Tables assume maximum amp-cycle value, & if these limits are not met a study is required
- Arc flash study results & HRC tables assume OCPD will clear fault within published TCC
- A failed or slow OCPD will result in higher  $E_b$  than suggested PPE based on study or tables





**Table 130.7(C)(15)(A)(ii) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems**

Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated >240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-V class (277 V through 600 V, nominal) equipment Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA B2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant switchgear Type 1 or 2 [for clearing times of <0.5 sec (30 cycles) with a fault current rating of 100 kA or greater, or the arc-resistance of the equipment is not known]	N/A (doors closed)	N/A (doors closed)

**Table 130.7(C)(15)(B) Arc-Flash Hazard PPE Categories for Direct Current (dc) Systems**

Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources 100 V < Voltage < 250 V Parameters: Voltage: 250 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current < 4 kA	1	900 mm (3 ft)
4 kA < short-circuit current < 7 kA	2	1.2 m (4 ft)
7 kA < short-circuit current < 15 kA	3	1.8 m (6 ft)
Storage batteries, dc switchboards, and other dc supply sources 250 V < Voltage < 600 V Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current < 1.5 kA	1	900 mm (3 ft)
1.5 kA < short-circuit current < 3 kA	2	1.2 m (4 ft)
3 kA < short-circuit current < 7 kA	3	1.8 m (6 ft)
7 kA < short-circuit current < 10 kA	4	2.4 m (8 ft)

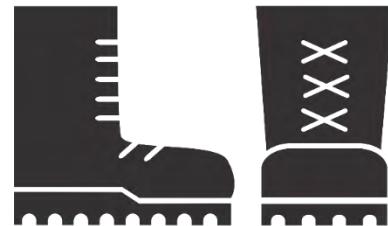
# NFPA 70E Hazard Risk Category PPE

PPE CATEGORY <b>1</b>	PPE CATEGORY <b>2</b>	PPE CATEGORY <b>3</b>	PPE CATEGORY <b>4</b>
<p>Minimum Arc Rating of <b>4 cal/cm<sup>2</sup></b></p> <p><b>Arc Rated Clothing:</b></p> <ul style="list-style-type: none"> <li>• AR long-sleeve shirt and pants, or AR coverall</li> <li>• AR face shield, or AR flash suit hood</li> <li>• AR jacket, parka, rainwear, or hard hat liner (as needed)</li> </ul> <p><b>Protective Equipment:</b></p> <ul style="list-style-type: none"> <li>• Hard hat</li> <li>• Safety glasses or safety goggles</li> <li>• Hearing protection (with inserts)</li> <li>• Heavy-duty leather gloves</li> <li>• Leather footwear (as needed)</li> </ul> 	<p>Minimum Arc Rating of <b>8 cal/cm<sup>2</sup></b></p> <p><b>Arc Rated Clothing:</b></p> <ul style="list-style-type: none"> <li>• AR long-sleeve shirt and pants, or AR coverall</li> <li>• AR flash suit hood, or AR face shield and AR balaclava</li> <li>• AR jacket, parka, rainwear, or hard hat liner (as needed)</li> </ul> <p><b>Protective Equipment:</b></p> <ul style="list-style-type: none"> <li>• Hard hat</li> <li>• Safety glasses or safety goggles</li> <li>• Hearing protection (with inserts)</li> <li>• Heavy-duty leather gloves</li> <li>• Leather footwear</li> </ul> 	<p>Minimum Arc Rating of <b>25 cal/cm<sup>2</sup></b></p> <p><b>Arc Rated Clothing:</b></p> <ul style="list-style-type: none"> <li>• As required: AR long-sleeve shirt, AR pants, AR coverall, AR flash suit jacket, and/or AR flash suit pants</li> <li>• AR flash suit hood</li> <li>• AR gloves</li> <li>• AR jacket, parka, rainwear, or hard hat liner (as needed)</li> </ul> <p><b>Protective Equipment:</b></p> <ul style="list-style-type: none"> <li>• Hard hat</li> <li>• Safety glasses or safety goggles</li> <li>• Hearing protection (with inserts)</li> <li>• Leather footwear (as needed)</li> </ul> 	<p>Minimum Arc Rating of <b>40 cal/cm<sup>2</sup></b></p> <p><b>Arc Rated Clothing:</b></p> <ul style="list-style-type: none"> <li>• As required: AR long-sleeve shirt, AR pants, AR coverall, AR flash suit jacket, and/or AR flash suit pants</li> <li>• AR flash suit hood</li> <li>• AR gloves</li> <li>• AR jacket, parka, rainwear, or hard hat liner (as needed)</li> </ul> <p><b>Protective Equipment:</b></p> <ul style="list-style-type: none"> <li>• Hard hat</li> <li>• Safety glasses or safety goggles</li> <li>• Hearing protection (with inserts)</li> <li>• Leather footwear (as needed)</li> </ul> 

\*HRC levels previously ranged from 0 to 4. Level 0 meant the worker was outside the arc flash boundary and no arc flash PPE was required. The new PPE Categories have eliminated level 0. However, non-melting clothing is required for tasks not included in PPE Categories 1 to 4.\*

# PPE Information & Limitations

- Properly rated, all-inclusive PPE is expensive to purchase & maintain to requirements
- High level PPE not recommended for exposure above 50cal/cm<sup>2</sup> due to arc blast pressures
- The higher the level of protection of PPE, the more mobility, dexterity, and vision is reduced
- Cumbersome PPE contributes to increased operator fatigue and decreased productivity



# Arc Flash Mitigation Approach

Two basic methods to mitigate arc flash:

- **Modify work practices**
  - First step to increase worker safety
  - Includes training personnel, labelling equipment, wearing PPE, working on de-energized gear, or limiting work within boundary
- **Modify equipment or system**
  - May be necessary to attain desired level of safety
  - Includes reducing total amp-cycles of the arcing fault, reducing fault current, reducing clearing times, installing prevention/reduction systems, or upgrading equipment

**Remote operation lies at the intersection**





# Arc Flash Mitigation Challenges

- Reducing fault current may increase OCPD clearing time and may increase the hazard
- Preferred method for electrical work is to de-energize equipment, but switching off equipment considered an arc flash hazard
- NFPA 70E tables for PPE selection can only be used if the available fault current and clearing times are known
- Bottom line - there is no possible way to completely avoid arc flash hazards



# How Switchgear Safety Can Help

- **How to limit personnel exposure to arc flash during live bus racking even if:**
  - There is a mechanical equipment failure
  - There is an electrical equipment failure
  - Rules and regulations are not followed
  - Personnel is not wearing the proper PPE
  - Everything is done correctly
- **Use of remote operation equipment will not prevent an arc flash, but it will save personnel from its effects if one occurs**
- **Increased operator distance is the safest option to guarantee personnel safety**



# Benefits Of Remote Operation



## IMPROVE SAFETY

- Racking and switching operations can be performed from up to 300 feet away
- Reduces or eliminates the requirement for full body arc flash hazard PPE
- Eliminates all potentially hazardous contact with gear during operation



## MINIMIZE DOWNTIME

- Quick installation and removal from equipment increases productivity
- On board diagnostics identify issues before they become a problem
- Quantify condition of mechanisms to determine ideal maintenance schedule



## REDUCE COSTS

- Prolong service life of aging electrical equipment through increased safety
- Reduced maintenance and operational workforce requirements
- No required downtime for added equipment and modifications

# Remote Operation Industry Shortcomings

- **Until Switchgear Safety, only 3 non-OEM manufacturers to choose from**
  - All are affiliated or owned by larger companies with other interests beyond remote operation
- **OEM offerings generally lacking in applications and features**
  - Do not dedicate same effort to remote operating products as they do with others
- **Most major systems and associated controls designed 10+ years ago**
  - Limited by the technology of a decade ago, with little competitive incentive to update





# Remote Operation Industry Shortcomings

- **Training, additional applications, or unlocking existing features costs extra**
  - “Unlocking” additional features may be a simple software change that requires factory technician
- **Many require modifications and/or additional components at added cost**
  - Added costs due to additional parts for every application as well as downtime to install
- **Switchgear or breaker modifications may not adhere to IEEE C37.59**
  - Standard for Requirements for Conversion of Power Switchgear Equipment

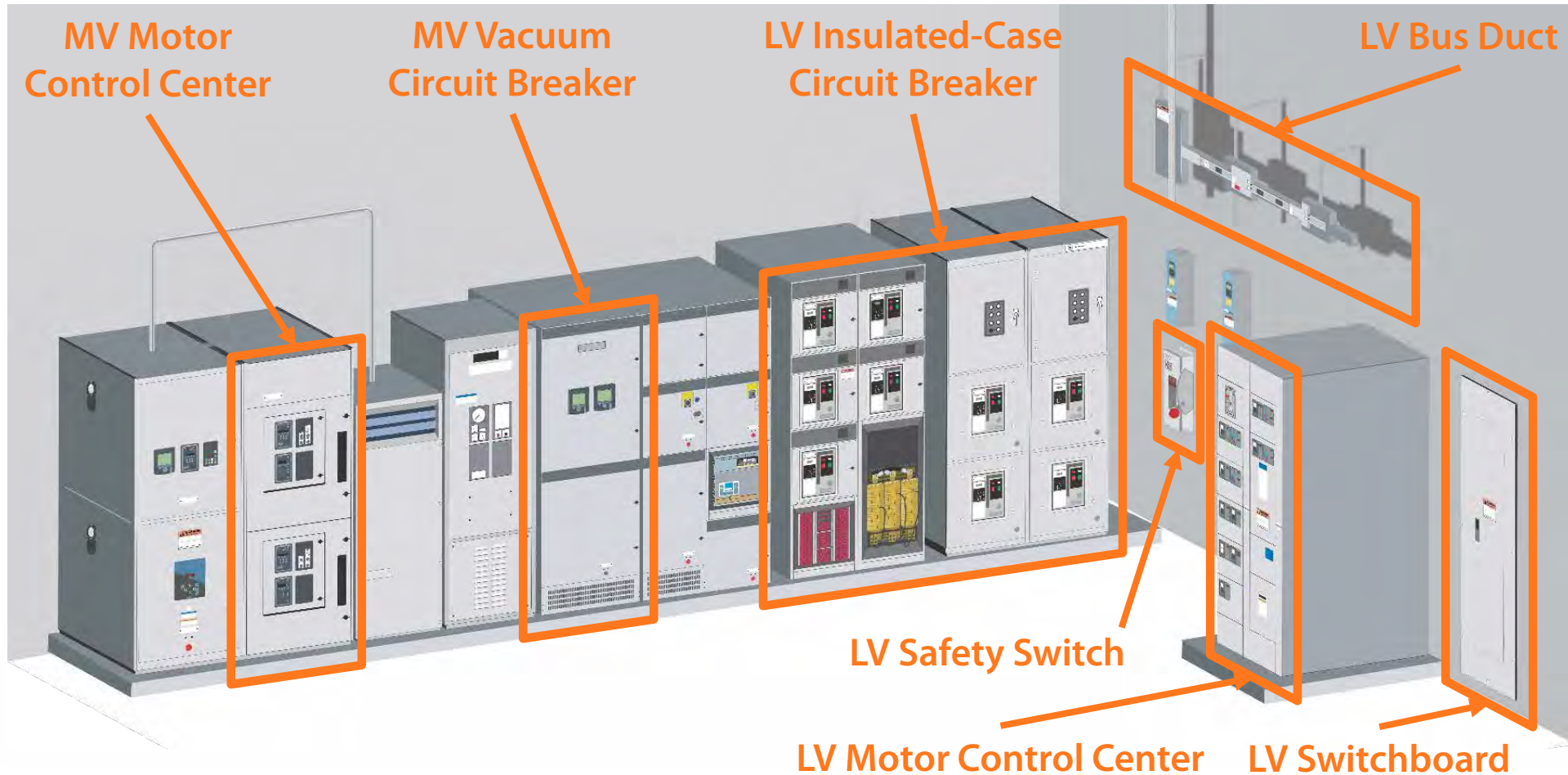


# 2018 Updates To ANSI/IEEE C37.59

- Remote operating devices, no matter their form, cannot alter/prevent the manual operation of the equipment as designed
- Construction and performance of the remote operation device shall be in accordance with applicable standards
- If switchgear is modified in any way (Holes drilled, bracket mounted) it must be re-certified according to industry standards



# What Can Be Remotely Operated

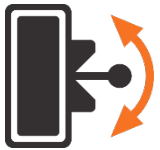


# Switchgear Safety Offerings



## Remote Racking Solutions

- Allow personnel to safely install or remove low and medium voltage circuit breakers from a safe distance outside the arc flash boundary.



## Remote Switching Solutions

- Allows technicians to remotely charge, close, and/or open circuit breakers, switches, and more from a safe distance outside the arc flash boundary.



## Lock-out/Tag-out Solutions

- Temporary magnetic Lock-out/Tag-Out (LOTO) solutions custom designed for customers' unique electrical and non-electrical equipment.



## Custom Safety Solutions

- Need something not listed here? We are always looking for new ways to help our partners achieve the highest levels of safety possible.



# Remote Racking Solutions

- Racking is the act of physically installing or removing a breaker from main power bus
- Remote racking allows user to perform operation from outside arc flash boundary
- Compatible with low & medium voltage breakers with rotary or extractor mechanism
- Can most often be accomplished with little to no modifications to the breaker or gear
- Eliminates all manual contact between equipment and user during operation

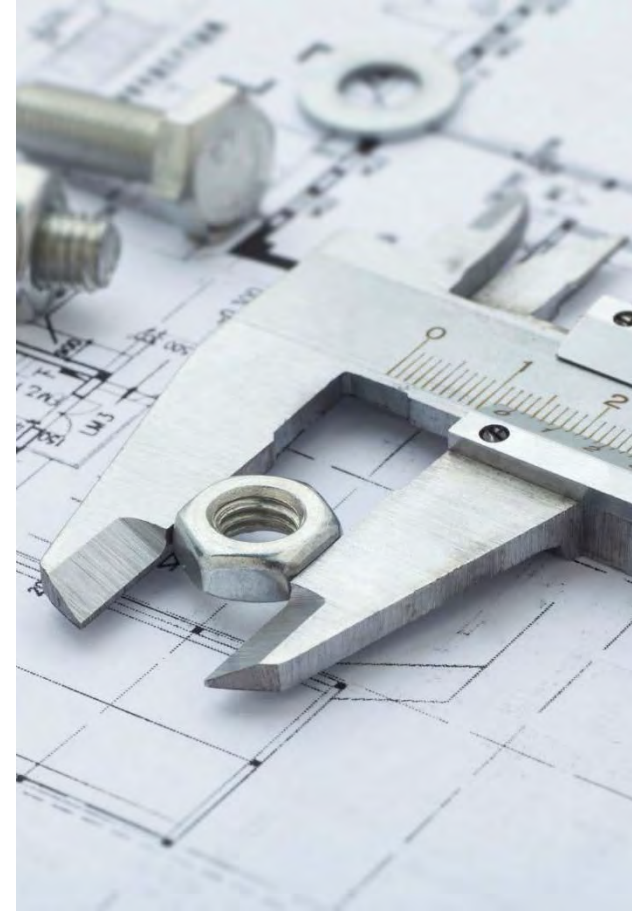


# UniRack™ Universal Remote Racking

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- Self-contained upright racking unit with onboard control and power systems
- Allows users to monitor & record all aspects of the racking operation
- Almost 200 applications identified for low and medium voltage circuit breakers
- Variety of user specified options to custom tailor the system to your facility's needs

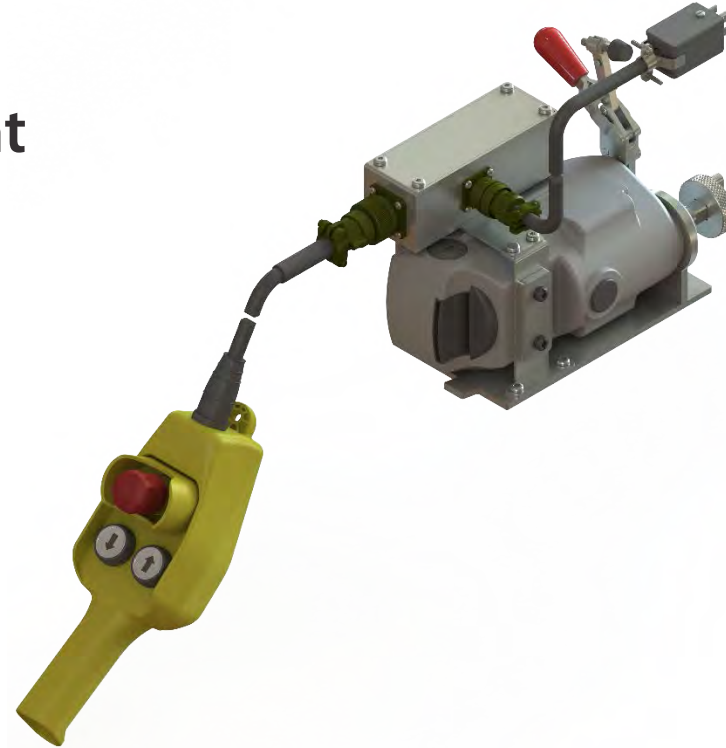
\*Currently available for pre-order with estimated availability 1/1/21



# RoboRack™ Remote Racking

- Application specific racking units are designed for a single type of equipment
- Powered and controlled via the Universal Remote Controller
- Mounts to the breaker or switchgear with little to no modification required
- Over 90 applications available for low and medium voltage circuit breakers

\*Many models currently available with more being added regularly



# Remote Switching Solutions

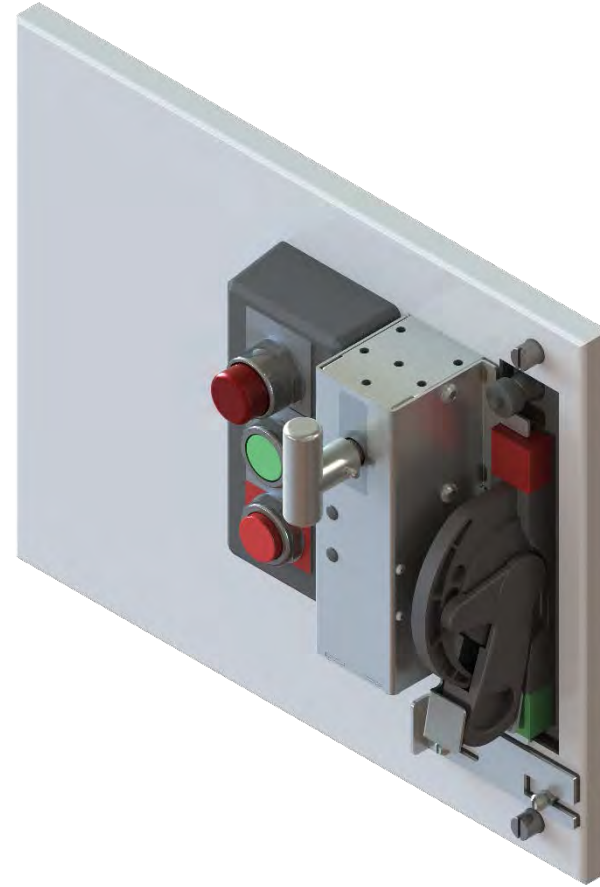
- Switching is the act of changing the state of live electrical equipment (ON or OFF)
- Remote switching allows user to perform operation from outside arc flash boundary
- Compatible with many types of low & medium voltage electrical equipment
- Can most often be accomplished with little to no modifications to the breaker or gear
- Eliminates all manual contact between equipment and user during operation



# SafeSwitch™ Remote Switching

- Allows users to charge, close, and/or open different types of electrical equipment
- Compatible with circuit breakers, motor control centers, load switches, control switches or pushbuttons, and more
- Powered and controlled via the Universal Remote Controller
- Over 750 applications for remote switching identified and available for quote

\*Many models currently available with more being added regularly





# Flexitrol™ Universal Remote Controller

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- One single operator for all application specific products
- AC/DC power system for use with or without AC available
- Operation via large touchscreen or tactile pushbuttons
- Streamlined user interface for quick & simple operation
- Housed in a rugged case with added storage for accessories



# Lock-out/Tag-out Solutions

- Lock-out/Tag-out (LOTO) is a procedure required by OSHA
- Regulated by Title 29 Code of Federal Regulations (CFR) Part 1910.147
- Machinery isolated, locked, & tagged until it can be repaired
- Prevents hazardous energy from release while machinery is serviced



# LOTO Pro™ Lock-out/Tag-out Devices

- Patent pending design utilizes switchable magnets to attach to equipment
- No modifications to electrical equipment or enclosure required
- Designs can be customized for many types and styles of equipment, not just electrical
- Breaker control switch and pilot device model available now, & more coming soon
- OH&S magazine's 2019 Electrical Safety category Product Of The Year winner



# LOTO Pro™ - Breaker Control Switch

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- Compatible with all types and styles of breaker control switches
- Electrically lockout control of potentially dangerous equipment
- Installation and use still allows for use of remote operating equipment
- Simple to setup with zero required modifications to switch or panel
- Quick to install & remove from electrical equipment with only a turn of the handle



# LOTO Pro™ - Pilot Device

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- Compatible with most types and styles of pilot devices (Push buttons, switches, etc.)
- Includes provisions for up to three LOTO devices (Padlocks, hasps, etc.)
- Over 100 lbf holding force on electrical panel when magnet engaged
- Zinc plated steel assembly and hardware for strength and corrosion resistance
- Proudly designed, manufactured, and assembled in the United States





# Custom Solutions

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- **Closed door racking conversions**
  - Cell and breaker additions, as well as a minor front panel modifications to facilitate door closed racking
- **Extraction to rotary racking conversions**
  - Retrofit existing extraction style breakers and/or switchgear with newer rotary racking mechanisms
- **Built-in racking conversions**
  - Design, manufacture, and install on-board hardware, motor, controls, and power for built-in racking
- **Monitoring and testing equipment**
  - Breaker location and state monitoring equipment to aid in remote racking and remote switching



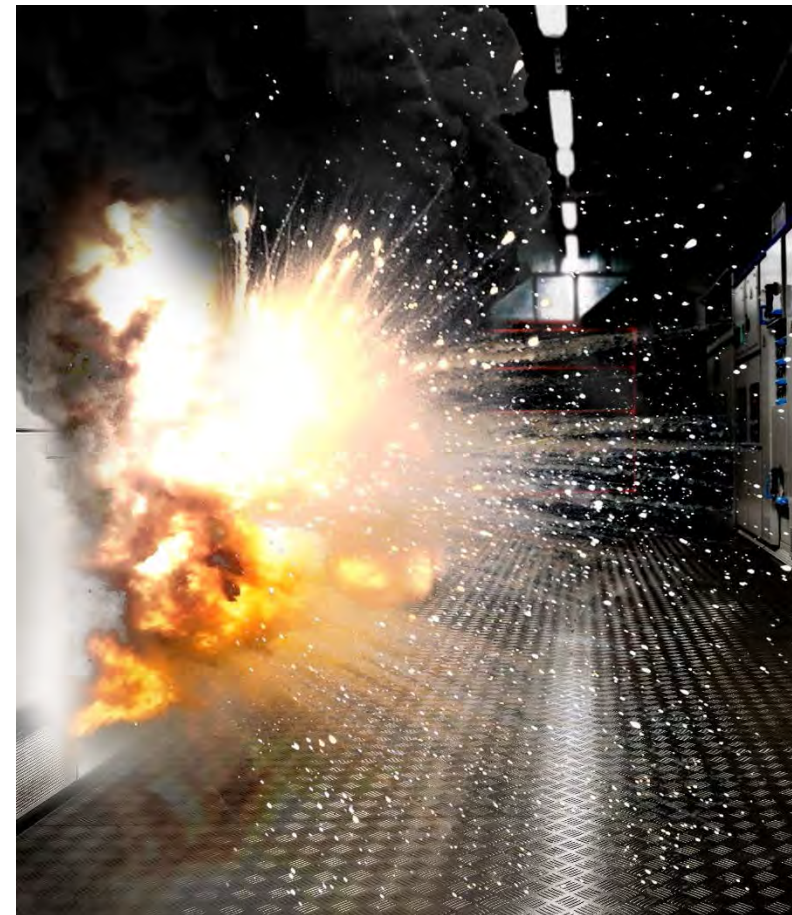
# Why Partner With Switchgear Safety?

- Only truly independent manufacturer of remote operation solutions
- Most up-to-date systems available, all developed within the past year
- We listen to our customers to develop systems that work they way they want
- Small operation with low overhead means our prices cannot be beat
- Unmatched attention to detail with all aspects of products and business



# Case Studies

- The following two case studies detail real life arc flash incidents
- The first deals with an arc flash during a racking operation
- The second deals with an arc flash during a racking operation
- Each incident could have been avoided with remote operation
- Each facility now employs remote operation for arc flash mitigation



# Case Study 1 – Gulf States Electric Utilities

- **Date:** January 5, 1993
- **Location:** Gulf States Electric Utilities  
Sabine Power Station – Bridge City, TX
- **Equipment:** Toshiba 5kV air circuit breaker retrofitted for FPE DST-2
- **Incident:** Arc flash occurred during removal while trying to troubleshoot close issue
- **Casualties:** Operator in arc flash suit and nearby supervisory killed, three employees around corner injured (Two very severely)



\*Actual DST-2 breaker, not retrofit\*



# Case Study 1 – Gulf States Electric Utilities

- **Details:** Breaker would not close, next shift began to remove breaker, jam cleared during removal, causing arc flash
- **Cause:** Retrofit breaker from adjacent switchboard not compatible with switchboard it was racked into
- **Factors:** Time-pressure, vague guidance, miscommunication, & negligence
- **Solution:** Switchgear Safety UniRack™ UNR001-A01A with remote racking tooling for FPE DST-2 breakers





# Case Study 2 – Brookhaven National Lab

- **Date:** April 14, 2006
- **Location:** Brookhaven National Laboratory
- **Equipment:** GE 400A fusible disconnect switch in 1200A panelboard section
- **Incident:** Arc flash occurred internal to panelboard, cover was closed and remained closed, paper near panel ignited
- **Casualties:** 1<sup>st</sup> & 2<sup>nd</sup> degree burns to forearms, hands, & face and corneal contusion to eyes (Full recovery was made)



# Case Study 2 – Brookhaven National Lab

- **Details:** Engineer attempting to diagnose startup issues operated disconnect switch
- **Cause:** Over-voltage state (High resistance leakage to ground) coupled with switch failure (Cracks, broken & missing pieces)
- **Factors:** Time-pressure, high workload, overconfidence, vague guidance, non-normal conditions, & multitasking
- **Solution:** Switchgear Safety SafeSwitch™ SFS076-B01A remote switching device and FLX001-A01A universal controller



# Closing

- It is usually a series of events that lead to the failure of a system or process - people make mistakes, equipment fails
- You can't always prevent an accident, but you can safeguard against the worst case scenario if one occurs
- There are many approaches to arc flash mitigation, but remote operation is the only one to guarantee personnel safety
- Remote operation safety equipment by Switchgear Safety is *The Smart Solution*



# Questions

**Thank you for your time today!**

**If you have any questions we will be happy to answer them now.**





# Contact Information

- Visit our brand new website:  
[www.SwitchgearSafety.com](http://www.SwitchgearSafety.com)
- Call to discuss your facility's safety needs and concerns: (888) SG SAFETY
- Sign up for our email list to learn about new products & industry news
- See videos of our latest and best selling items on our YouTube Channel.
- Follow us on Social Media for updates on new products, events, and news.



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