

Arc Flash Energy Reduction – Part 1 – *Distance is Your Friend!*

Arc Flash Energy is dependent upon several variables. IEEE Guide 1584-2002 and NFPA 70E have equations that you can use to calculate the arc flash energy and arc flash boundary. The arc flash energy calculations are based upon several variables. Some of these variables that impact the arc flash energy are listed in order of importance:

1. **Working Distance** (Distance from the Arc to the Torso)
2. **Bolted Arc Three Phase Fault Current** (Typically 80 to 100% of three phase bolted fault current)
3. Upstream Protective Device **Opening (tripping) Time**.
4. **Voltage**
5. **Bus Bar Spacing** (Gap)

In a typical distribution system, there are only a few variables that an employee can change without an extreme amount of effort. The bolted fault current is fixed. It usually cannot be changed or reduced. The bolted fault current is based upon the utility available fault current, the utility step down transformer kVA and impedance. Motor, generator, cable sizes and cable lengths are all fixed. These are sized during the design process and based upon the National Electric Code rules and standards. Once installed, these items cannot be readily changed.

The voltage and bus bar spacing also cannot be adjusted. The bus bar spacing is based upon UL and NEMA standards. Once the equipment is manufactured, changing the bus spacing is not an option.

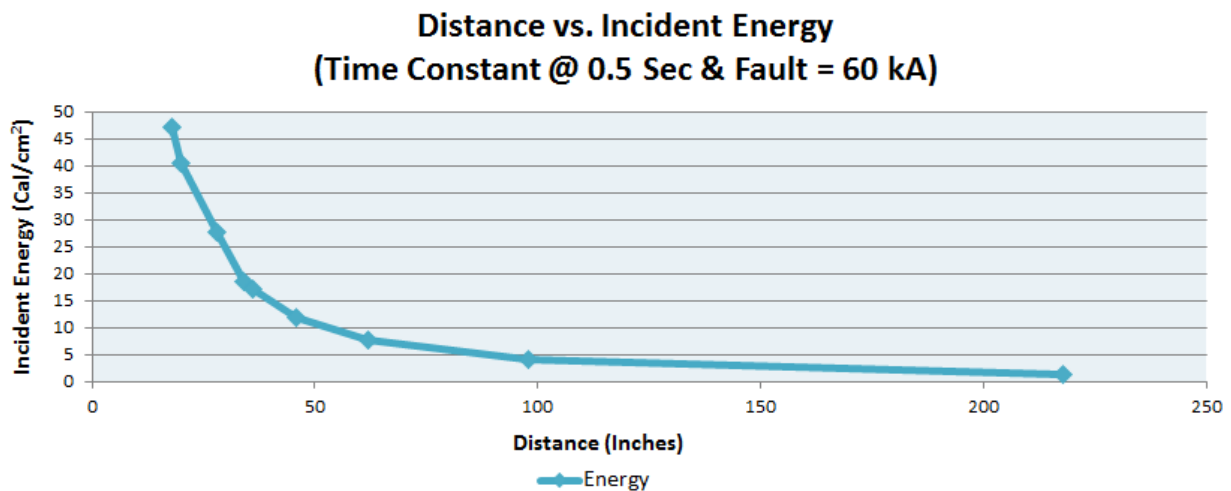
The remaining two items that significantly impact the arc flash energy calculations are Working Distance and Protective Device Opening Times. Part 1 of this series investigates the impact of Working Distance. Part 2 of this series of articles will deal with protective device Opening/Tripping Time.

Working Distance

The working distance is the distance between the worker's torso and the arc. The goal is to reduce the energy that a person would receive in this area of the body. If this area of the body is protected, then the chance of survival increases substantially. This part of the body can be protected by increasing the distance or by wearing the appropriate level of PPE based upon the amount of energy that is available.

The working distance is the easiest item that a worker can control when working on electrical equipment. The graph below shows the arc flash energy level versus working distance at 480 Volts. The available fault current is fixed at 60,000 Amperes and Tripping Time fixed at 0.5 seconds. It should be noted that at the normal working distance of 18 inches (average arm length of a human.), the arc flash energy is 48 Cal/cm² (calories per centimeter squared). If the worker steps back to a working distance of 48 inches, the arc flash energy drops to 12 Cal/cm².

This is a significant reduction. Increasing the working distance further will continue to lower the arc flash energy level. At 240 Inches (20 feet), the arc flash energy drops below the 1.2 Cal/cm² which would not require Arc Rated PPE. (Note: PowerStudies, Inc. highly recommends wearing a minimum of 8 Cal/cm² arc rated PPE when working or operating on any electrical equipment.)



The working distance can be increased by using different working methods and tools. Some of these methods are:

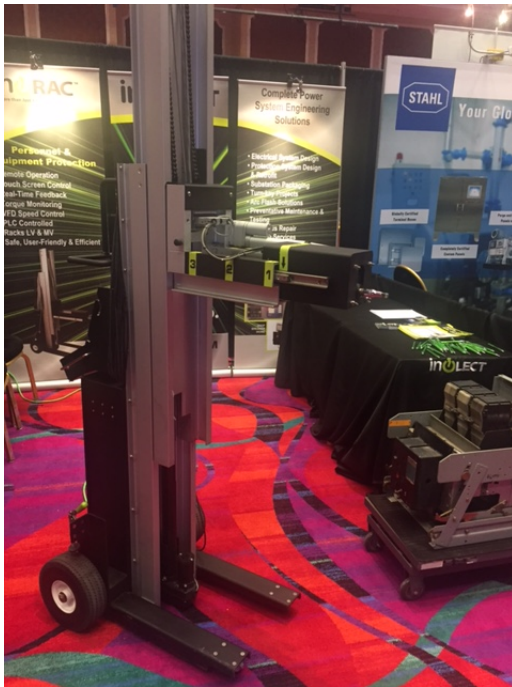
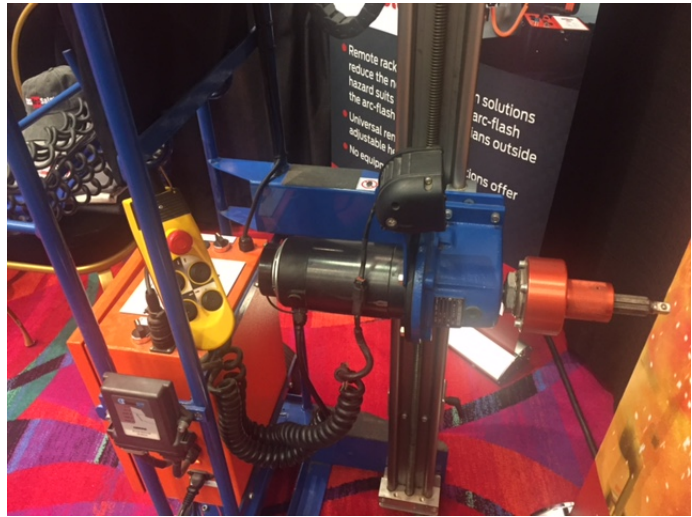
- Hot Sticks to operate equipment or measure voltage
- Remote Racking Devices
- Control Switch Remote Devices
- Rope and Pulley Systems to operate Manual Breakers.



Hot Sticks have been used in the utility industries for over a hundred years. Using hot sticks in the low voltage world is acceptable as long as there is enough space in the electrical room. The minimum length of a hot stick is 4 feet. Using hot sticks increases the distance between the energized part and the worker.

Racking out low voltage or high voltage circuit breakers is a very hazardous task and sometimes must be performed with the door open. Using a remote racking device can greatly increase the working distance and also will allow the worker to be off to the side of the cubicle.

These remote racking devices have a motorized device that attaches to the door or cubical and couples to the socket where the manual racking tool would be inserted. The remote racking devices all have a control unit that is cord connected with a 15 foot or more control cable. The operator can then stand to the left or right side of the cubicle and remotely insert or remove breakers. There are also now remote racking devices for removing or inserting buckets into Motor Control Centers. Below are some various types of remote racking devices.



Switchgear Remote Racking Devices



Motor Control Center Bucket Racking Device

Although well maintained electrical equipment is very reliable, it can sometimes fail. Sometimes these breakers, disconnect switches, or motor starters fail and an arc flash event is started. If this equipment can be operated with distance between the equipment and the operator, then it will be much safer. However, some equipment is manually operated. There are several types of portable (attachable) remote operating devices. Again, the operator will have a 15 to 20 foot control cable and remote control operator unit. Below are a few different types.



Panel Control Switch Remote Operator



Power Circuit Breaker Remote Operator Device

Another way to remotely operate manually operated switches and circuit breakers; this can be performed using a system of [pulleys and rope](#). Pulleys are strategically located above and below the switch. Rope is then attached to the handle which enables the operator to get distance between the operator and equipment. Below is a picture showing how to manually operate a medium voltage switch.



Manual Operation of a Medium Voltage Switch with Rope and Pulleys

Remember, *Distance is your friend* when it comes to the electrical arc flash hazard. Increasing the working distance lowers the arc flash energy exposure. Distance can be controlled by many different devices and even rope and pulleys. Before you operate that electrical equipment, stop and think about ways to operate it remotely or at a greater distance. This could save your life!