

# Retrofit for Safety

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The topic of arc flash and incident energy associated with electrical distribution equipment is at the forefront of most electrical designers' minds when planning a new electrical installation. The industry is becoming increasingly aware of the dangers associated with arc flash and the safety concerns of the technicians performing daily tasks on the equipment. While planning equipment and protection schemes to minimize incident energy is a priority for new installations, there are innumerable existing installations that have hazards which present a danger to the electricians at the site. This paper is written with respect to electrical equipment installed applied in large commercial facilities. However, the same techniques can be used in any type of electrical installation. The purpose of this paper is to provide ideas on how to design solutions to remove the electrician from within the arc flash boundary for performing routine tasks in existing installations.

There are many fine articles written on the topic of arc flash, the heat energy it produces, and the calculation of the possible available arc flash energy for the purpose of selecting appropriate personal protection equipment required for a specific task. The intent of this paper is not to deal in detail with that aspect. Rather this is written to assist the reader in dealing with the situation after the studies have been done and the labels have been attached to the equipment. References to NFPA 70E-2012 (Standard for Electrical Safety in the Workplace) will be made in this paper and readers should familiarize themselves with this document to fully understand the issues.

Recently, a situation facing many building owners is the reluctance, or in some cases, refusal of electricians they hire to perform basic tasks such as opening and closing a protective device in a switchboard while the board is energized. In years past, the electrician would either perform their task on energized equipment or simply open the device to de-energize the equipment. Now that the industry is becoming more educated in arc flash safety, the electricians are looking and thinking about the task and are reluctant to perform work on energized equipment when there is another option. The case presented next is common among large commercial office buildings. A new tenant moves into the building and a new busway plug-in feeder breaker or fused switch is required to be installed on their level for their additional loads. In years past, the electrician (which we will name Bob) would simply stab the busway plug into the energized busway and not question his decision. However, today Bob wants to de-energize the busway before inserting the new busway plug, which he considers to be a wise decision. To de-energize the busway riser, Bob goes to the main switchboard at the lower level of the building to turn off the device feeding the busway riser. Bob then notices an arc flash label attached to the equipment indicating "Extreme Danger, No PPE suitable." Bob is now in a quandary as to what to do. Bob notifies the building engineer of his predicament and the building owner tells Bob that just opening and closing the breaker or fused switch does not warrant a hazard and the hazard only exists when Bob is actually working on live equipment. The building owner references some articles that he has saved to support his position.

Bob, however, is not so easily swayed. He breaks out his copy of NFPA 70E-2012 and quickly goes to the task table 130.7(C)(15)(a) and notices that the table lists the task of “CB or fused switch operation with enclosure doors closed” has a hazard risk category of 0 which matches what the building owner has told him. Yet Bob is still uncomfortable because he is looking at the door over the breaker in the switchboard and notices all of the ventilation openings in it. Bob thinks to himself that the door has so many vents, that it would not matter whether the door was open or closed should an arc occur within this switchboard and the vents would allow the arc energy to pass outward with little effect. He then re-reads his copy of NFPA 70E and notices that for 600V class switchgear or switchboards, the Hazard Risk table is only applicable for equipment with a maximum of 35kA of short circuit current available. Bob also reads in the text of 130.7(C)(15) that it requires an incident energy analysis when the maximum listed short-circuit currents of the table are exceeded. Bob has a decision to make, in either risking his safety by performing the task the building owner is paying him to do or to tell the building owner that he will not do what is required without a shutdown from the utility. Bob decided not to operate the device but he also chose to work with the owner to find a solution.

The equipment Bob was dealing with had high levels of fault current in excess of 120kA. The equipment looked well maintained but it was also over 30 years old. Instead of turning off the device serving the bus riser, he looked at operating the main device. The same scenario existed and Bob still could not de-energize his bus riser unless he arranged for the utility to shut it down from their side. Bob got the shutdown, installed the busway plug and then worked up a plan to prevent this costly and time consuming scenario from happening again. Knowing that the risk is vastly diminished when outside the arc flash boundary of this equipment, Bob decided the best solution was to install remote operators on the device to remove him or other electricians from the hazardous area.

Working with a local consulting firm hired by building owner, they devised a plan to add shunt trips and remote close solenoids to the devices in the main switchboard. The OEM vendor for the equipment was consulted who informed them that the fused switch could accommodate a shunt trip, but not a remote close solenoid. The OEM vendor also informed them that the breaker they wished to modify had not been manufactured for many years and all of the accessories they needed were no longer available. The consultant then assumed that the only option was to completely replace the equipment. But the OEM vendor then advised them about a retrofit program they had initiated that was perfect for this scenario.

After verifying all of the required fault current ratings, the fused switches and the older insulated case circuit breakers were replaced with new electrically operated insulated case breakers. Remote control stations were mounted at locations outside of the arc flash boundary so that Bob and future electricians could open and close these devices in a safer manner.

The reader should be aware that although the retrofit described above sounds simple, it involves careful planning and competent technicians to perform the retrofit. In addition to the mechanical aspect of mounting a new device to the primary and secondary runbacks for the breaker within the cubicle and retrofitting a new enclosure door, control power also has to be provided for the electrical operation of the devices. This can be done with a control power transformer (CPT) within the switchboard or it can be provided from an external source. A question which is often raised when

determining control power sources is whether the source needs to be continuous (dc or ups backed) or if a CPT in the equipment is sufficient. In a situation involving low voltage switchgear or switchboards, the source of control power is typically adequate as long as the CPT is connected ahead of the device being controlled. If power to the facility is lost, the devices can still be opened manually. There is no arc flash hazard present in this case since the equipment is not energized.

Another solution to mitigate arc flash for consideration by the consultant and owner is a maintenance safety feature available on the trip unit of new circuit breakers. These features are turned on when where faster arcflash current isolation time is needed that cannot be provided by the settings determined for a selective protective system. Such features (referred by some suppliers as Reduced Energy Let Thru mode or "RELT") offers an additional instantaneous setting which can reduce arc flash incident energy when properly set and enabled. While RELT is a great feature and can offer benefits to the user, a hazard analysis must be done to determine if lowering the settings will offer the reduced incident energy necessary to bring the level below 12 cal/cm<sup>2</sup>. The incident energy level of 12cal/cm<sup>2</sup> is the level where the recommendations for PPE listed in NFPA 70E-2012, Annex H, Table H.3(b) change from basic PPE to PPE requiring arc-rated clothing, face shield, balaclava and parka. In some cases where the available short circuit current is high, the reduction in settings will not reduce the incident energy below the 12cal/cm<sup>2</sup> level and the RELT switch could provide a false sense of safety to the operator.

The breaker retrofit work within the switchboard does require a shutdown and, depending on the type of retrofit being performed, the shutdown might be lengthy. This might dictate that the retrofit work occur over a holiday weekend. Outages for breaker retrofit work may involve less time in low voltage switchgear which is a fairly structured design and have draw-out mounted breakers. Most OEM vendors of switchgear either offer the original breaker styles for many years or offer retrofit breakers that have been predesigned for a straightforward installation within the switchgear with minimal modification to the breaker cubicle, if any. However commercial office buildings tend to use switchboards as the standard over switchgear.

The wide variations in switchboard designs over the years can make the retrofit of devices more difficult. There have been many different overcurrent devices utilized and different mounting arrangements. For the more popular devices installed by an OEM, solutions may have been designed to make the process easier. There are situations where the breaker retrofit work involves a new design and in some cases there is no option available. If the desired retrofit involves existing molded case breakers or group mounted fusible switches, there might not be an electrically operated device available that can fit in the existing physical space.

The other work related to the retrofit project is the construction and installation of the remote control panel. There is a lot of flexibility in design of this panel that is up to the discretion of the designer or owner, but there are numerous factors to consider. Providing an enable switch to make the operation of the new breaker a two-step process is a good idea that helps eliminate inadvertent operation. This enable switch can be a simple momentary contact switch which would not allow operation of the open and close buttons unless it is held in or it could be a keyed switch so that the building owner has control over the operation of the breakers. An indicator of the breaker position status is also a good idea and might be necessary if the actual breaker is not within site of the operating station.

Status indication is simple to implement by providing auxiliary contacts within the breaker and indicating lights in the operating station. Long life LED indicating lights are recommended for the status indication.

The shutdown time of a retrofit is also a great time to perform the safety related maintenance requirements addressed in NFPA 70E chapter 2. General maintenance such as cleaning and re-torquing the bussing within the equipment should be performed during the retrofit shutdown. This can generally be done simultaneously with the actual retrofit work. Many owners also take this time to update the electrical meters within the equipment. Most of the older equipment utilizes analog voltage and current meters that are typically mounted in ANSI standard 4" round cutouts in the equipment doors. Multi-function meters are available that can mount into these same 4" cutouts without any additional mounting modifications required. In most cases, the existing current transformers (CTs) for current measurement and voltage transformers (VTs) for voltage measurement can be reused. Typically, the only additional work needed is to provide a control power source for the meter. The building owner can then advance from simple voltage and current monitoring to more advanced power, demand, power factor and harmonic measurements. The meters designed to fit within these existing cutouts are also typically available with optional Modbus RTU, Ethernet or Bacnet communication capabilities.

In conclusion, there is no substitute for safety. No electrician or technician should be urged to work on energized equipment when it is not absolutely necessary. Retrofitting older manually operated Insulated case breakers or fused switches within a switchboard or retrofitting a manually operated low voltage power circuit breaker in switchgear with new electrically operated devices is a viable option toward creating a safer workplace. A remotely controlled breaker retrofit will add a measure of safety to a facility and can provide better circuit protection. While the cost to retrofit the breakers must be considered, it is generally less expensive to retrofit than to completely replace the equipment. The use of remotely controlled devices should reduce long term labor costs and the downtime for simple tasks requiring de-energization of the equipment will be much less, both of which are benefits for the building owner.