Arc Flash Hazards, Selective Coordination

What's a facility manager to do?

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Published in Medical Construction & Design - June 2012

Over the last decade awareness of the arc flash hazard associated with working on energized electrical equipment is increasing, while at the same time relatively new code requirements for selective coordination make managing the arc flash hazard much more difficult.

Healthcare facilities operate 24/7 and the electrical power system is relied upon to continually support systems vital to patients. Healthcare facilities also constantly change the function of various spaces, remodel, or add on, which necessitates revising or adding connections to electrical power sources. If the power source serves loads that are not being changed, it can be difficult to find a time to de-energize the equipment and safely make an electrical connection. The only alternative is to see if the connections can be made while leaving the equipment energized. Working on live electrical equipment can expose the worker to an arc flash hazard.

If a tool drops onto an exposed conductor, a short circuit will occur and arcing between the tool and the conductor is probable. The magnitude of the arc flash is dependent on the available energy at the point of the fault and the length of time it takes to stop the flow of energy. As a general rule, the closer the equipment is to the source of energy or the greater the capacity of the system, the greater the amount of energy that can flow. However it's possible for a low current fault that rides under the trip point of an upstream circuit breaker or fuse to also create a significant amount of energy.

To address the arc flash hazard, electrical workers must don personal protective equipment. The Institute of Electrical and Electronics Engineers identifies five categories of PPE. Category 0 is relatively simple natural fiber clothing, a helmet, gloves, and eye and ear protection. Category 4 is the highest level of protective equipment available and is often described as a moon suit. Unfortunately, many larger healthcare facilities have very large sources of electrical power that create so much energy during a fault that even Category 4 PPE cannot offer the needed protection. Electrical studies can identify the Category of PPE needed at each level of equipment, and a label noting the PPE requirements can be placed on the equipment. If Category 4 PPE is inadequate the equipment cannot safely be worked on while energized and instead of a PPE Category the label simply states: DANGEROUS.

SELECTIVE COORDINATION

Electrical systems rely on an overcurrent protective device, usually a fuse or a circuit breaker, to open if a short circuit occurs. When a fault occurs, the short circuit current is sensed by all protective devices that are between the fault and the power source. If the protective device that is nearest to the fault opens before the other protective devices, the system is selectively coordinated. A selectively coordinated system can be achieved using fuses or circuit breakers, but generally, it is more difficult to selectively coordinate circuit breakers. Selectively coordinating

Drawout switchgear is often needed in healthcare facilities to meet code requirements for selective coordination.

Automatic transfer switches are a critical item of electrical systems that require arc flash-rated personal protective equipment, or PPE, during annual inspections.

a system requires an upstream overcurrent device sufficiently large enough to allow the short circuit current that will trip the downstream device to pass through it, without causing it to operate. Because a selectively coordinated system de-energizes a minimal portion of the system, a selectively coordinated system is more reliable than a non-selectively coordinated system.

Prior to 2005 the National Electric Code only required the main service overcurrent device and the next device downstream to be selectively coordinated for ground faults. Since 2005 the NEC has required the entire essential (life safety, critical, and equipment branches) system to be selectively coordinated

THE CONFLICT

Healthcare electrical distribution systems have multiple levels including service switchgear, distribution switchboards, automatic transfer switches, distribution panelboards and branch circuit panelboards. Most healthcare facilities prefer to use circuit breakers at the branch circuit panelboards closest to the load because of the convenience of rapid restoration after a known overload condition. All you have to do is reset the circuit breaker! If circuit breakers are used and the system is to be selectively coordinated, in almost all cases, all other overcurrent devices in the system must also be circuit breakers. To selectively coordinate the circuit breakers, the trip setting of the upstream circuit breaker has to have a time delay to allow the downstream circuit breaker to trip first. This delay cascades as the closer the circuit breaker is to the service or power source.

Allowing additional energy to pass through a selectively coordinated system means the system must withstand the added energy; it also means that the added energy can be present as an arc flash hazard. So at the same time as code makers are increasing the reliability of healthcare electrical systems they are also increasing the hazards associated with working on an energized system.

SOLUTIONS

Equipment manufacturers have responded to the arc flash hazard with several equipment renovations:

> Arc Resistant Equipment: Switchboards and motor control centers can be manufactured with construction features that permit certain maintenance functions to occur without exposing the operator to live parts.

> Zone Selective Interlocking: This feature is available on circuit breakers. If an upstream circuit breaker and a downstream circuit breaker both sense a fault, the upstream circuit breaker sends a trip signal to the downstream circuit breaker that forces it to immediately trip. In effect, this reduces the tripping time of the downstream circuit breaker, and thereby reduces the arc flash hazard.

> Maintenance Bypass: Circuit breakers can be outfitted with electronic fault current sensors that delay tripping of the circuit breakers, this feature is typically identified as short time delay. The delay increases the amount of energy that is let through the circuit breaker. Many manufacturers offer maintenance by pass switch that will turn this delay off, thereby temporarily decreasing the downstream arc flash hazard. This feature should be used cautiously as it does not have anything similar to the lock out, tag out

NEC 2011 code requires switchboards, panel-boards, industrial control panels, and motor control centers to be field marked to warn personnel of the potential electric arc flash hazards.

provisions are in place for assuring a de-energized work environment, even though reduction of the arc flash hazard is a goal that is comparable to de-energizing equipment.

One strategy might be to wait. The benefits of selective coordination in healthcare facilities remain a point of discussion among many code making and code enforcement authorities. It's possible that the 2014 release of the NEC will only require the essential system to be selectively coordinated for the period of time that a fault extends beyond 0.1 seconds, meaning that high energy faults can be interrupted in less than 0.1 seconds to help control the arc flash hazard.

Unfortunately, if you are the facility director of a large healthcare facility you may have very large arc flash hazards for which there is no readily available maintenance solution, other than planned outages, because your equipment is simply connected to too large of an energy source In this situation, consider a system design or operational strategy that creates redundant or duplicate paths to serve the critical loads, permitting one source to be de-energized when needed.

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