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GREEN LIGHTING

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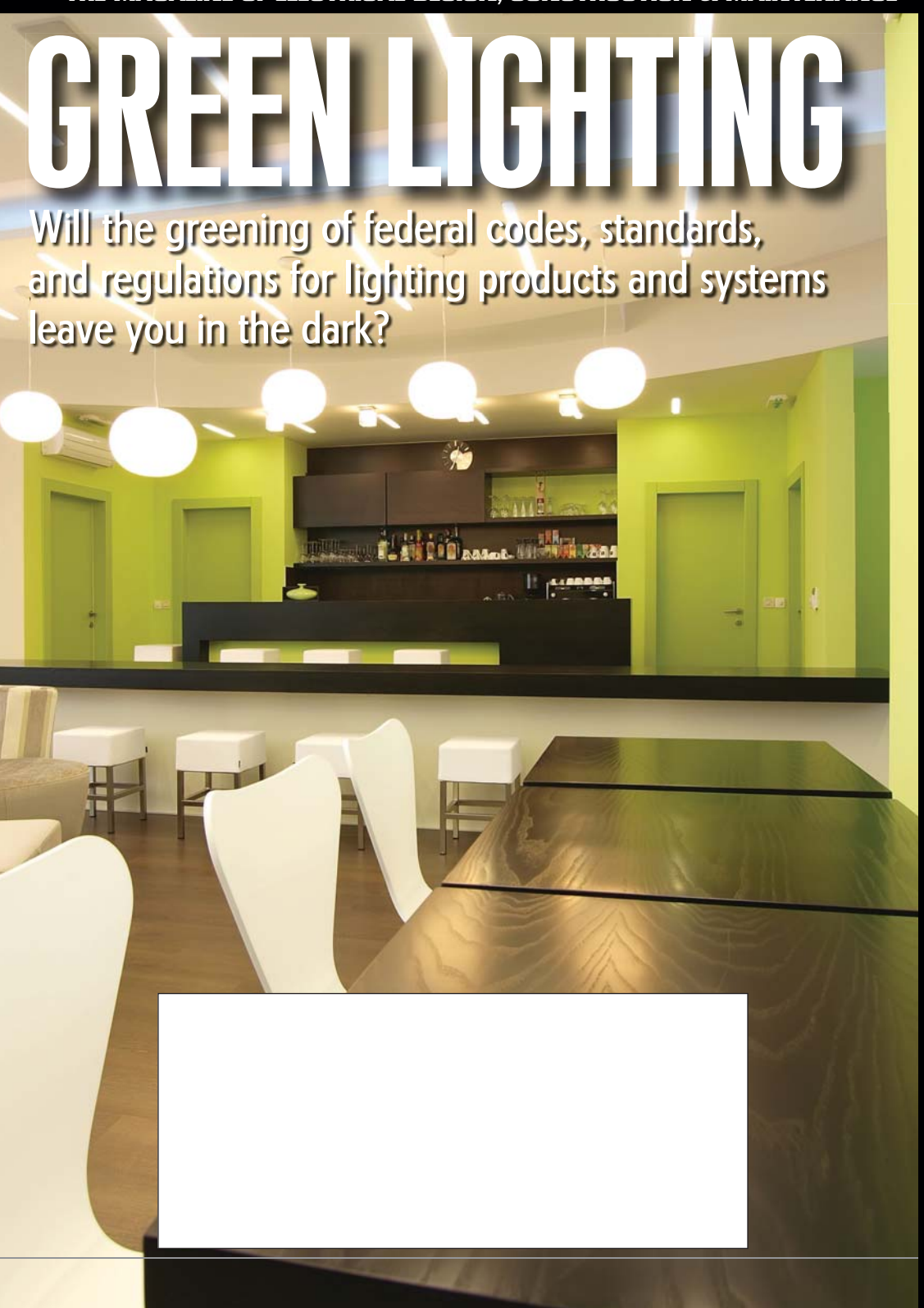

CODE BASICS

Wiring methods: Chapter 3, the sequel

SAFETY

FAQ on HRG: Arc flash safety as a three-letter word

CODE Q&A

Your questions answered: Plenum-rated cable uses? Bonding requirements for service raceways?

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Focus on LEDs: Application options continue to expand

A PENTON MEDIA PUBLICATION

Arc Mitigation Techniques

Webinar draws record number of questions from the field with 1,000+ audience members

On October 13, 2009, *EC&M* hosted a free webinar on "Arc Mitigation – A Total Systems Approach." The 1-hr event was sponsored by i-Gard, a Mississauga, Ontario, Canada-based developer and manufacturer of ground-fault protection and power-resistor-based solutions. The 45-min. presentation was led by Daleep Mohla, principal and owner of DCM Electrical Consulting Services in Missouri City, Texas. In fact, you can still view this archived webinar on *EC&M's* Web site. Access it by clicking on the link under the *EC&M* webinar header in the right rail of our home page (www.ecmweb.com).

In addition to reviewing mitigation technologies, such as arc-resistant switchgear, current-limiting devices, and thermal ionization equipment, Mohla shared his expert insight on NFPA 70E and discussed the pros and cons of high-resistance grounding (HRG) systems. The event drew more than 1,000 participants as well as an impressive number of questions submitted by attendees throughout the webinar. In fact, so many questions were posed that it took several days to follow up with attendees and provide them with answers.

As a follow-up to this webinar, we thought it would be worthwhile to present a summary of some of the more interesting Q&A items. From the magazine's viewpoint, it appears many electrical engineers, contractors, and maintenance professionals are searching for answers on how best to address the dangers of arc flash events as well as what types of arc flash mitigation technologies are available in the market. Many of the questions revolved around the use of HRG equipment and design configurations. We hope this summary will help you better understand this very important topic.

Photo courtesy of Salisbury Electrical Safety, LLC

Arc flash protection has come a long way in recent years.

The following answers were developed by Mohla and i-Gard technical representatives.

Q. What are your thoughts on arc-proof switchgear, which a lot of vendors are offering these days? To me, when you open the panel doors to work on the gear, it defeats the purpose of arc proofing it!

A. Arc-resistant switchgear is designed to contain the energy produced by an arcing event and to direct that energy away from personnel operating the switchgear. If compartment doors are open — or if panels are removed — the energy can no longer be directed away from personnel. It is also possible to have arc-resistant switchgear that is protected by arc flash mitigation relays. This combination not only helps minimize arc flash damage, but also allows you to place the damaged section of switchgear back in service more quickly.

Q. Does the NEC make any references on where I can use HRG systems?

A. Section 250.36 of the NEC allows the use of HRG on systems up to 1,000V. Make sure you note the three conditions

that are listed. Section 250.186 allows HRG at higher voltages.

Q. What are your thoughts or recommendations regarding the placement of 480V drives or motor starters in the same control panel as PLC and network-type equipment?

A. You may find your customers requesting that control equipment and 480V drives or any other 480V equipment be placed in different compartments or enclosures to ensure that the personnel operating or testing the PLC and/or network equipment will not need to wear personal protective equipment (PPE).

Q. Why is HRG considered a method to reduce arc flash hazard, since the IEEE 1584 equations for arc flash incident energy and all IEEE group testing are based on 3-phase bolted fault currents?

A. HRG is considered an arc flash mitigation technique in NFPA 70E and CSA Z462, because it reduces the risk of developing arcing faults from phase-to-ground faults. According to our research, anywhere from 80% to 98% of all electrical faults begin as ground faults.

Q. Where is the best place to locate a pressure arc detection device?

A. There are several places where you can locate a pressure sensor. You can install them in the cable compartment, bus compartment, or breaker compartment. You can also place these pressure sensors in the SF_6 bottles of a circuit breaker.

Q. Why is the relay detection time so important, especially when the circuit breaker opening time for medium-voltage units can be as high as eight cycles in the instantaneous setting range?

A. It has been documented that if the duration of an arcing fault is less than 100 msec, then the energy produced by the fault will not burn through the steel enclosure. Eight cycles in an instantaneous setting range is 133 msec. So if the breaker opening time (plus the detection system) is less than 100 msec, then less damage is likely to occur.

Q. Does installation of an HRG system introduce any problems with selective coordination of the power system?

A. The installation of an HRG system actually assists in selective coordination. With HRG, you do not have to trip on the occurrence of a ground fault. You can also prioritize up to 50 feeders and selectively trip the feeder of lower priority on the occurrence of a second fault.

Q. What is the difference between a pressure detector and an optical detector? Is one of these devices more selective than the other?

A. The main difference between an optical sensor and a pressure sensor is the time it takes for the respective device to detect and operate on the occurrence of an arc. The light produced from an arc travels at the speed of light and can be detected in less than 1 msec. The pressure wave produced from an arc propagates at the speed of sound. A pressure detector is typically a mechanical device that will react to a pressure difference in 8 msec to 18 msec. In both cases, the total reaction time, including detection and actuation of the circuit-isolating device, will be less than the 100-msec guideline for minimizing equipment damage.

Q. How do you determine the continuous current rating of a neutral grounding resistor?

A. The continuous current of a continuously rated neutral grounding resistor is equal to the system line-to-neutral voltage divided by the ohmic value of the resistor. The continuous current should be equal to or greater than the system capacitive charging current. The formula is as follows: $I_{NGR} = V_{LN} \div R$ (considering $I_{NGR} \geq I_C$, where I_C is the system charging current).

Q. If most arc faults start out as single phase-to-ground faults, will an HRG system really be effective?

A. HRG will be extremely effective in this case. The high-resistance device will limit the fault current to a low value (i.e., 5A or 10A), as opposed to tens of thousands of amperes. This will impede the progress of the arc, and the fault will remain as a single phase-to-ground fault instead of propagating into a phase-to-phase or 3-phase fault.

Q. Are arc flash requirements applied to low-voltage switchgear and motor control centers (i.e., 480V systems) or mostly medium-voltage equipment?

A. While arc flash requirements are more commonly applied to medium-voltage equipment, given the higher incident energy levels available on today's systems, they can be effectively applied to many 480V and 600V systems.

Q. Does HRG reduce the amount of arc flash energy in a phase-to-phase fault?

A. No, HRG will not limit the fault current in a phase-to-phase fault. It will only limit the fault current of a single phase-to-ground fault and reduce the risk of this type of fault developing into a phase-to-phase fault.

Q. Where should HRG configurations be installed?

A. HRG systems can be employed in networks that *do not* have a distributed neutral. Thus, they can be used on 480V, 600V, 2,400V and 4,160V systems. You can employ an HRG design on higher voltage systems, but consult with a professional engineer that has experience in this type of design prior to venturing down this path.

One limitation of the HRG system is that line-to-neutral loads cannot be served. Therefore, you will need to determine what percentage of the load is served by line-to-neutral voltages and estimate the cost of adding a transformer in the circuit to service these loads.

Q. Does an HRG system have an effect on the normal operation of the network?

A. The HRG system does not have any effect on normal short circuits or arc flash events, unless they are normal single phase-to-ground faults. In this

case, the HRG system will limit the fault current and prevent further damage and destruction.

Q. Should we focus on the line side or load side of a breaker when calculating the potential arc flash energy levels?

A. It depends on which side of the breaker you are working on. If you are working on the breaker itself, you should consider the nearest protective upstream device when making your calculations.

Q. Would you go so far as to say that a resistance grounded system is always superior to a solidly grounded system, or is there a place for both? Mostly what I see in use is the conventional 277/480V, 3-phase, 4-wire solidly grounded power system.

A. There will always be a place for both, as HRG is prohibited where there are neutral loads. For example, you will never see a 120/208V HRG system. However, if you have a 277/480V system and 20% to 30% of your load consists of 277V lighting equipment, you may consider using an HRG design. But if 70% to 80% of your load is rated 277V, then you should not consider an HRG design. The bottom line is there are many variables that come into play when making this type of decision. Therefore, you'll still need to consider arc flash mitigation protection on both types of systems.

Q. When using an HRG system, how can you be sure the equipment will clear a line-to-ground fault before a phase-to-phase arc fault occurs?

A. The benefit of an HRG system is that you do not have to clear a line-to-ground fault quickly. The equipment and tools are available for you to determine the location of the fault in a reasonable time. If you are concerned with clearing the first fault before a second fault occurs, you can install relays that will detect this scenario and automatically isolate one of the faults in a timely manner so that only one ground fault is present on the system at any given time. You can also set the system up to isolate the fault with the lowest priority. **EC&M**