SELECT MOTOR STARTERS WISELY TO REDUCE ARC-FLASH DANGERS

Taking proper precautions when working with the circuitry of motors used in building-automation systems is a key responsibility of the technicians performing the work.

BY BRAD HUBBARD

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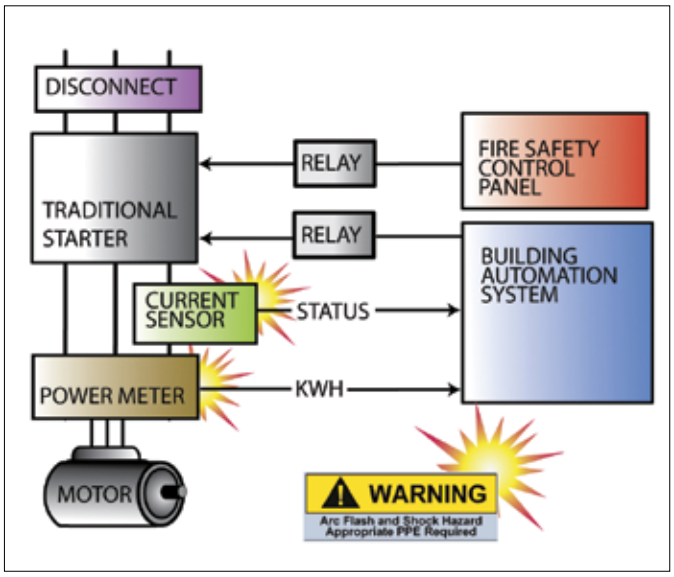


Figure 1 The area in close proximity to an HVAC motor starter is typically an area where installers and maintenance personnel work with open contacts and devices that require different voltages. Hence, it is a point of concentrated danger for arc flash.

The risks of working with high-voltage electricity are obvious to those who install and service electrical gear, yet accidents resulting in injury and death still occur. There are multiple danger zones in any electrical system, but one of the most serious involves the circuitry associated with the motor controls used in building-automation systems.

The typical motor starter has been a nucleus for adding on devices, making it a point of concentrated danger for installation and maintenance personnel. These devices include:

- External control relays to convert the low-voltage control signals coming from fire-safety control panels and building-automation systems to high-voltage contacts that operate the starter.
- Current sensors to monitor proof of flow and to provide status feedback to the building-automation system. When used to detect loss of load (such as belt loss), installers must typically adjust these sensors in an energized enclosure with the motor under full load.
- Over-/under-voltage relays often are added for additional motor protection.
- Power meters increasingly are added to enable the building-automation system to monitor power consumption as part of an energy-saving strategy. In order to prevent downtime, contractors and technicians often are tempted to install equipment live—despite the risk and often without the appropriate personal protective equipment, which includes clothing.

PPE

Personnel are at risk of arc flash when installing or calibrating equipment in an energized enclosure. "Arc flash" is the industry term for an explosive event that occurs when a low impedance path is created between high voltage and ground or a lower voltage. The resulting current flow can reach 1,000 A or more. This can rapidly vaporize the metal conductors, showering the area with molten metal and plasma with extreme force. The result often is substantial damage, fire or injury to humans near the fault. The human risk factors include the possibility of radiation burns, inhalation of vapors, temporary blindness, hearing damage, lung damage, barotrauma (pressure-related injury) and injury from projectiles.

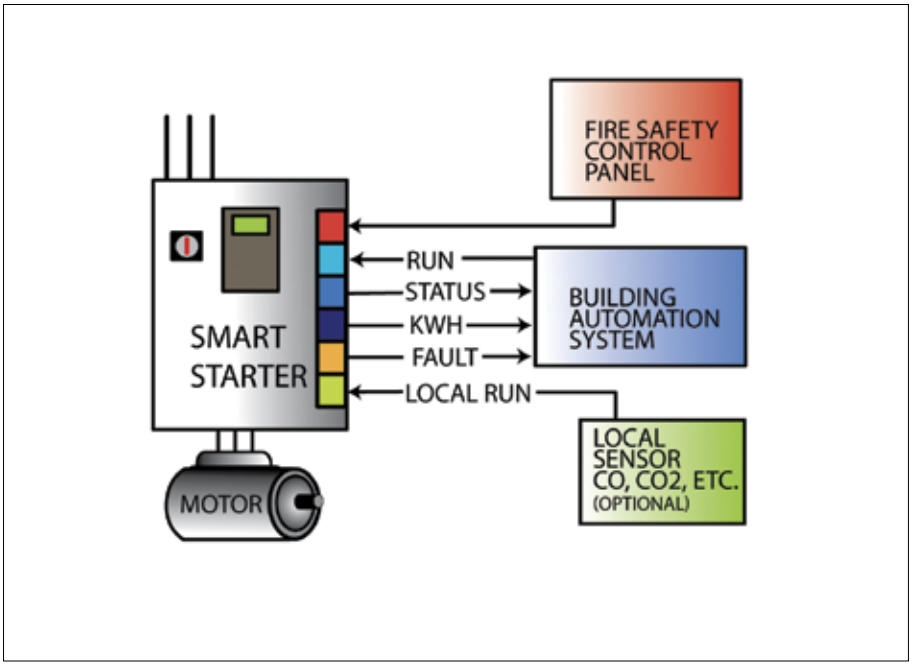
The risk of an arc-flash event increases when personnel are not careful integrating starters and controls. The National Fire Protection Association has established Standard NFPA 70E to reduce the risk of catastrophic events when unprotected workers are exposed to high-power contacts in electrical gear. The standard also provides guidelines for maintaining electrical safety in the workplace.

This standard is consistent with the National Electrical Code and OSHA's requirements for the use of protective equipment when working near potential electrical hazards (Standard 29 CFR 1910.335). These regulations were created to protect people, however acceptance and enforcement of such regulations has not been universal. NFPA 70E requires employers to conduct a flash-hazard analysis and to provide workers with clothing designed to protect against the level of risk associated with each task. The types of personal protective equipment required and restrictions on access to the areas increase with the risk.

Permits for working on "live" panels often are required as well. The permits may specify that a strict procedure be adhered to and that a series of approval signatures must be obtained. They also may require access-time limitations. These factors can cause onsite delays if not planned for properly. For installers of typical motor-starter devices, using traditional methods can often make adherence to the above mentioned regulations difficult. A full-body, fire-retardant suit and insulating gloves may be required, which can increase the difficulty and labor time associated with the installation.

SAFE EQUIPMENT OPTIONS

One safe option is for electrical contractors to install motor starters. Motor starters come from the factory with integrated controls functionality designed to reduce the number of arc-flash danger points in a system. This type of starter—called a "smart starter"—makes adding the extra devices shown in Figure 1 unnecessary. "Smart starters" are named as such because of their integrated control points and feedback systems, and they are gaining in popularity within the HVAC industry.



›› Figure 2 By selecting a motor starter with a high level of integrated functionality, the arc-flash danger can be significantly reduced.

A key feature of this new class of smart starters is accessibility to control and monitoring functions via an external control panel. This feature eliminates the need to open the starter enclosure and expose the electrical components and high-voltage connections. Similar LCD displays with keypads are used on VFDs. The displays recently have been applied to across-the-line starters, providing valuable feedback without requiring that the starter enclosure be opened.

Eliminating the need to install auxiliary components or make adjustments to internal devices while the panel is energized allows the technician to completely avoid the arc-flash hazard. Figure 2 shows how the dangers of the system in Figure 1 can be reduced using a highly integrated smart-starter device that is designed with these factors in mind. External relays are not required because the smart starter accepts low-voltage inputs directly (or arbitrary-voltage inputs via open/closed "dry" contacts). The current sensor and power meter also are supported via standard integrated metering circuitry within the starter enclosure.

COMPARING INSTALLATIONS

A traditional motor-starter installation for an exhaust fan with loss-of-load protection, energy-consumption monitoring and integration into a building-automation system generally follows this sequence of events:

1. The mechanical contractor supplies the motor starter, and then the electrical contractor mounts the starter on a wall or on the equipment if applicable. Next, a power meter is installed in the same area as the starter, and power lines in conduit are run from the starter to the power meter and finally to the motor.
2. An interposing relay is installed by the controls contractor inside the starter cabinet, to convert the incoming 24-Vac signal from the building-management system to 120 Vac. Most traditional starters are specified to be supplied with a 120-Vac contactor coil to energize the starter, while almost all building systems and controls contractors use 24-Vac control signals. Also installed at this point is an adjustable current sensor to monitor the status of the motor and a low current point intended to provide loss of load protection.
3. The equipment is then commissioned, after fan belts are adjusted, dampers and control interlocks are verified, and balancing is completed among other tasks.
4. After the equipment is energized, the motor's operating FLA can be measured. The FLA is necessary so the current sensor previously installed to catch a load loss or broken belt can be adjusted to the appropriate low current setting. The highest risk for arc flash commonly occurs here, as inside the starter cabinet is the only access to incoming power to the motor that is not in conduit. In order to measure the FLA of the motor, an amp meter must clamp around any phase of the incoming power, so the starter cabinet is opened while being energized by high-voltage power and controlled with low voltage, both ending inches from each other in the same cabinet. Following NFPA 70E regulations, this is when proper procedures and PPE must be applied, a crucial safety precaution often skipped for the sake of time and effort of obtaining the FLA.
5. The current sensor can be adjusted manually now, and any other programming for communications of the power meter or control interlocks is completed. The system is set to run automatically.

Installing a smart starter for an exhaust fan with loss of load protection, energy-consumption monitoring and integration into a BAS happens as follows:

1. The mechanical contractor supplies the smart starter, which includes power-consumption monitoring, 24-Vac or 120-Vac control and loss of load capabilities. The starter is mounted and power is run to the motor.
2. The equipment is now ready to be commissioned and the system is energized.

3. The FLA of the motor is displayed on the starter, and the load-loss protection can be adjusted from the keypad without opening the energized panel. Control interlocks are wired, and communications for motor status and power consumption are connected with the building-management system.

CONCLUSION

Selecting a motor starter that incorporates the monitoring functions in the standard product reduces installation work and decreases the chance of installation errors, thereby increasing reliability. Also, when maintenance is needed, smart starters provide more information on the status of the system in order to streamline the maintenance process while making it safer.

With an eye to integrating other features and functionality that improve safety, smart starters also can connect to local sensors. The sensors can provide information on air quality, safety systems and other factors. The information is available for uploading to central building automation systems over advanced communication networks—such as BACnet.

The best way to protect people from arc-flash exposure is to completely eliminate the arc hazard. One way to do this is by specifying motor starters that have been designed from the ground up with that goal in mind.

[*Editor's Note: For more information on arc-flash hazards and PPE requirements, see "Shining a Light on Shock and Arc-flash Hazards" in the February 2009* RSES Journal.]

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