White Paper

UNDERSTANDING THE CONCEPTS BEHIND SHORT CIRCUIT CURRENT RATINGS (SCCR)

Know the changes of NEC Article 409, the impacts it has, who's affected by them and how to comply with the standard code

The date of January 1, 2005 sits vividly in the minds of manufacturers within the industrial control panel field. That's because that's the day when the National Fire Protection Association's (NFPA) National Electrical Code (NEC) 2005 Article 409 officially went into effect. The code required that short circuit current rating be clearly marked on the industrial control panels in order to be inspected and approved. The markings made it easier to verify proper over-current protection against hazards such as fires and shocks on components or equipment, whether it be for initial installation or relocation. It was the beginning of an era when things would become a little more complicated, but for all the right reasons of ensuring more safety within the industrial world.

The main vision of the NFPA is to reduce or limit the burden of fire and other hazards on the quality of life by providing and advocating scientifically based consensus codes and standards, research, training and education. These codes and standards were established to minimize the possibility of and effects of fire and other risks. Due to misinterpretations, inconsistencies and advancements in technology over the years, they have had to update their codes with consistency in order to comply with existing standards.

Therefore, the focus of this paper will look at the changes that occurred due to Article 409, the impacts that it had, who was affected by the code and how to comply with the code. Precautions like this article had been enforced in the past, but they were too vague, so people found ways to get around them.

The biggest change that took place within the article was the new requirements adopted for industrial machinery electrical panels, industrial control panels, some HVAC equipment, meter disconnect switches and various motor controllers. For the purpose of this paper, we will be concentrating on industrial control panels which are specified as assemblies rated for 600V or less and intended for general use. All in all, it states that the above products must feature a safe design and be clearly marked with specific information concerning Short Circuit Current Rating (SCCR) in efforts of aiding with the designing, building, installation and inspection of the control panels. This way, the above users can both reference and apply all the needed requirements for all new products and installations as well as for modifying existing ones.

SCCR is defined as the maximum short circuit current that a component, assembly or piece of equipment (drive or panel) can safely withstand when protected by a specific over-current protective device including fuses, circuit breakers or a combination motor controller. One important aspect about the new short circuit current ratings is that it represents the maximum amount of fault current that the assembly can withstand under fault conditions. A benefit of assembly ratings is that they take into account all components within the equipment, rather than just the main over-current protective device.

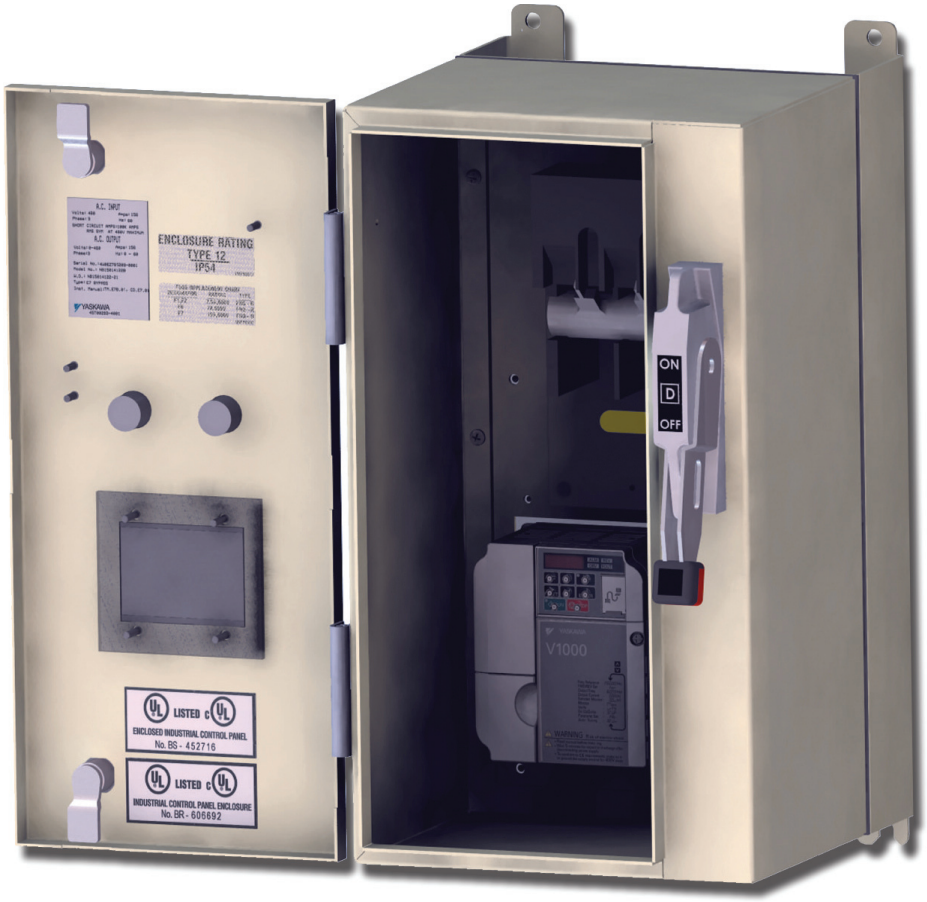

Figure 1 - Typical Industrial Control Panel

Markings Needed

As part of these requirements, the following six areas must be clearly visible on each and every industrial control panel as part of the new requirements. These requirements are pivotal in making sure that the necessary information is made available for all involved in the process types.

1. Manufacturer's name, trademark or other descriptive marking by which the organization responsible for the product can be identified and contacted if needed.
2. Supply voltage, phase, frequency and full-load current must be listed accordingly.
3. The short circuit current rating of the industrial control panel must be included based on one of the two scenarios:

   a) Short circuit current rating of a listed and labeled assembly.

   b) Short circuit current rating established using an approved method such as the UL 508A 2001 Supplement SB.
4. If the control panel is intended as service equipment, then it must be properly marked to identify that as its suitable use.
5. An electrical wiring diagram or the number of the index to the electrical drawings that shows the diagram.
6. Finally, an enclosure type number shall be marked on the industrial control panel enclosure.

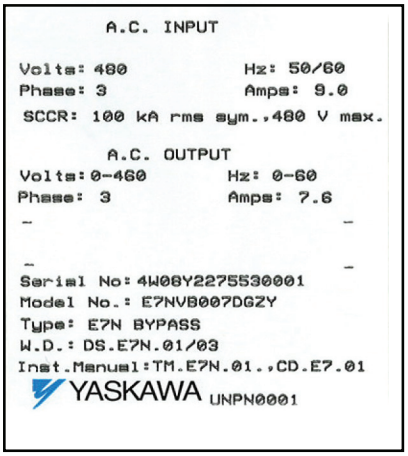

Figure 2 - (The new markings must be visible, displaying information such as manufacturer's name; supply voltage, phase, frequency and full-load current; short circuit rating; and electrical wiring diagram.)

There is a Difference Between SCCR and Interrupt Rating (IR)

The short circuit current rating of a component or equipment represents the maximum short circuit current level which the device or equipment can safely withstand without compromising the safety for buildings and personnel. It should be mentioned that one must be careful not to misinterpret short circuit current ratings (SCCR) and interrupt ratings (IR), as they are commonly thought to be the same, although they are not.

Interrupt ratings are ratings associated with over-current protective devices such as fuses or circuit breakers, and are referred to as the ability of the over-current protective device to safely interrupt a short circuit at the specified marked interrupt rating. It should not be assumed that the interrupt rating of the over-current protective device represents the short circuit rating of the assembly. In fact, that couldn't be more untrue, as in most cases where many control components are used in the control panel (disregarding tested starter assemblies), the assembly short circuit rating will most likely be less than the over-current protective device interrupt rating.

Table 1 - SCCR vs. Interrupt Rating

SCCR ≠ Interrupt Rating	
Damage may occur to the components within the panel	
Protective Device is O.K.	**Fuse cleared safely**
	CB tripped
No hazard present (safely withstands)	**Risk of Fire prevented**
	Risk of Shock prevented
	Enclosure/Equipment intact (door did not open, no damage to ground or phase conductors)

How Can the SCCR be Determined?

Figuring out how the SCCR can be determined can be done in one of three ways to be labeled on the control panel. Although some ways are easier and more effective, they all come up with the same desired result.

1. The first possible way is to test each panel construction and record the construction in their follow-up procedure. With the multitude of possible product combinations within a panel, this option can require a lot of testing and maintenance. That's why third-party testing and certification may also be required.
2. Secondly, one can purchase previously tested constructions (combinations) from a major supplier of the equipment that can be tabulated in the control or machine panel builder's procedure. Once you have all the component ratings, try utilizing an outside service such as Underwriters Laboratories Inc. in their UL 508A, Supplement B, which can be found at their web site: UL.com.
3. Finally, all testing should be based on the weakest link approach. In other words, the assembly should be limited to installation where fault levels don't exceed the withstand rating of the devices with the lowest short circuit current rating.

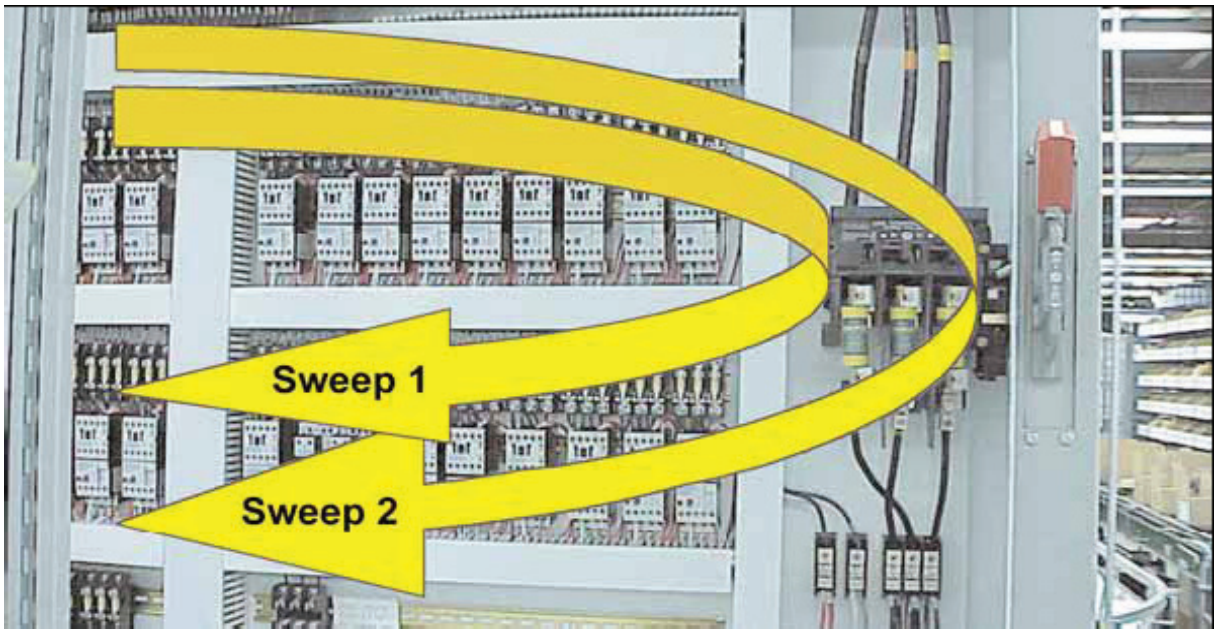

Figure 3 - A Two-Sweep Method Can be Used to Determine the Assembly SCCR (In the first sweep, check the component with the lowest short circuit current rating. In the second sweep, check for the lowest interrupting rate of any over-current protective device used in the panel.)

What is UL508A 2001 Supplement SB?

So, one may ask what is UL508A 2001 Supplement SB and what is the process for using it? Supplement SB from Underwriters Laboratories Inc. can be used to determine the SCCR of an industrial control panel, and to do so, there are three distinct steps to be followed for establishing the rating. Effective April 25, 2006, UL required that all industrial control panels be marked with a proper short circuit current rating. In efforts of helping the manufacturers determine the SCCR, Supplement SB in UL508A was created.

Step 1 - First, determine the rating of the individual components within the control panel by using either:

a) The component marking or instruction marking, which may require specific over-current protection.

b) The unmarked component rating determined by Table SB4.1, the supplement.

c) Testing of a component or combination of components per UL 508A.

Step 2 - When the current limiting protective devices are included in a feeder circuit, determine the modified rating (SB4.3) based upon the let-through values of the current limiting protective devices.

Step 3 - Lastly establish the overall rating (SB4.4) which cannot exceed the rating of the circuit, including the modified rating determined in Step 2 above. Each one of these steps is further detailed in the UL Supplement.

What is the Difference Between UL508A and UL508C?

UL508A is responsible for defining the safety requirements for industrial control panels. This standard is most commonly used because it does not require test verification, so many suppliers choose it over the UL508C alternative, which mainly addresses stand-alone AC drives. Although there is no test verification, one must be able to comply by using engineering data in proving their analysis. The UL508A requires that all devices within the enclosure be individually UL listed or recognized components.

Suppliers who use this standard apply a UL serialized label and maintain records in accordance with UL508A requirements. UL508A also concentrates on the panel construction, spacing, accessibility, power circuit wiring, power circuit protection, control wiring, and control circuit protection and marking. The UL508A standard is only applicable when equipment is intended for installation in ordinary locations, in accordance with the National Electrical Code, ANSI/NFPA 70, where the ambient temperature does not exceed 40°C (104°F).

UL508C is most commonly applied to open or enclosed equipment that supplies power to control a motor or motors operating at a frequency or voltage different than that of the input supply. It deals specifically with AC drives and soft start controllers. Although open and panel style drives must be UL508C listed, there is a common practice in the industry to use the UL508A listings for packaged drive offerings while referencing the UL508C listings. For the user, the benefit of a UL508C listing for enclosed drives is that the required testing and design validation process is applied to the entire enclosed drive assembly.

What if a Higher SCCR Rating is Needed?

Sometimes a panel requires a higher SCCR rating than the one provided. This can be accomplished if the manufacturers apply one of three options available listed below:

1. It's possible to perform testing, but many suppliers find this option objectionable because of the expense, time and test lab availability that it requires.
2. Another option is to use tested combinations of components in specified enclosures with qualifying data provided by electrical manufacturers, to provide higher SCCRs.
3. Finally, one can conduct the SB method. Although suppliers can provide SCCRs under the SB without verification testing, some elements of enclosed drive reliability can't be accounted for without qualification testing. When enclosed AC drives are connected to distribution systems with high available fault current, changes occur in thermal management and power wiring stress levels. If these changes aren't accounted for in design and layout validation, safety and product reliability can be compromised when equipment is installed near the limit of the specification envelope.

Why is Determining the SCCR so Important?

Determining the SCCR of a unit and displaying it on the control panel is important for many reasons, and Article 409 has solutions for the possible problems before they occur. Below is a look at several reasons why the control panels should be properly marked by listing unique conditions, the issue at hand and how the new requirement helps. ***(Note: These suggestions are made available by 2005 Cooper Bussmann.)***

1. **Condition:** Industrial panels can be moved around from installation to installation.
   Issue: The movement may result in varying electrical systems, environments, grounding means and available SCCR levels. Therefore, it is critical to supply the ratings associated with the industrial control panel assembly via markings to ensure safe installation.
   Requirement Helps: By providing the markings, the installer can obtain the appropriate information needed to ensure a safer installation by comparing the SCCR of the equipment with the available short circuit current.
2. **Condition:** There are an increasing number and variety of components, equipment and devices being used within the control panels each year.
   Issue: The increased level of information needed to ensure proper application is a difficult process, leading to oversights and unsafe installations.
   Requirement Helps: These new marking requirements help to make sure that critical information needed for the proper application of the components, devices and equipment being used in the industrial control panels will be provided.

3. **Condition:** Numerous control panels are assembled within the field, therefore not done so according to a product standard.
   Issue: Compliance with field-assembled control panels is a complex process that may lead to the omissions and unsafe installations due to, but not limited to, confusion over appropriate requirements by assemblers or increased demand on Authority Having Jurisdiction (AHJs) to ensure compliance.
   Requirement Helps: The new SCCR marking requirement ensures that field-assembled panels, where product standards are not used, are properly marked, which lessens the burden on AHJs to make sure it's in compliance with NEC 110.10.
4. **Condition:** It is also a possibility that control panels may be constructed by a manufacturer, but yet installed by someone else outside the company.
   Issue: Without an exchange of information between the installer and the manufacturer, any special requirements associated with the panel will not be known by the installer and possibly cause an unsafe installation.
   Requirement Helps: These new requirements ensure that a proper exchange of information is attained through the equipment markings.

Summary

Overall, the adoption of NEC 2005 Article 409 that required proper SCCR markings on the panels was a very important and beneficial addition to all of those involved. It prevents against accidental improper installation of the panels, limits the possibility of fires or other safety hazards, and allows for easy inspections to be performed. Sometimes spending a little more time and effort now pays off in the long run, as there is no price tag that can be put on one's life, personal belongings or safety.

The underlying goal of a control panel is to be efficient and serve their purpose, but at the same time ensure personal safety and reduce the risks of fires or damage. There is no excuse why control panel builders can't provide and guarantee safe, reliable and code-compliant products. As long as the designer, builder, installer and inspector are on the same page, it will reduce or eliminate the chance for confusion, accidents and misuse. Everyone involved in the control panel process should be working together, as they are all striving for the same goal. By working together from the designer to the inspector, it can be made certain that these new changes accomplish what they are intended to do. This by far won't be the last adjustment made within the standard codes, but it's certainly another step in the right direction.

Note: The Graphic used in Figure 3 is from Cooper Bussmann Educational Material on Short Circuit Current Ratings.