Understanding NFPA, NEC 2005 Article 409

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NFPA's mission is to "reduce the worldwide burden of fire & other hazards..."

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NFPA 70, NEC 2005: Article 409
Industrial Control Panel Short Circuit Panel Ratings

Executive Summary

Many panel shops are providing industrial control panels with improper short circuit current ratings or no short circuit current ratings at all. This creates a potential for accidental improper installation of control panels by trained installers, plus a possible fire and safety hazard. The National Fire Protection Association (NFPA) has implemented strict and very concise rules in the latest National Electric Code (NEC) to facilitate the safe design, marking, installation, and inspection of industrial control panels (ICP).

This white paper provides an overview of the following:

- The National Fire Protection Association's jurisdiction and actions
- NEC changes that affect proper marking for industrial control panels (ICPs)
- Methods that can be used to ensure that an ICP is in compliance with the new code
- When the new NEC code will be enforced
- Examples that illustrate these topics and show how ICP's should be marked to meet the new NEC code

Introduction

NEC 2005 has incorporated a brand new article, Article 409, to facilitate the safe design, marking, installation, and inspection of industrial control panels (ICP). The new article closes the loop and addresses areas of inconsistencies found in previous versions of the National Electric Code (NEC).

This paper will discuss brief background information regarding NFPA and NEC code, Article 409, types of panels affected, enforcement timing, and methods that can be used to ensure panels meet Article's 409 short circuit marking requirements.

Who is the NFPA?

The National Fire Protection Association (NFPA) was established in 1896 and is a nonprofit organization. The organization consists of more than 75,000 members representing approximately 100 nations and over 300 employees around the world.

Their mission is to "reduce the worldwide 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."

The NFPA has developed 300 codes and standards that are intended to minimize the possibility of and effects of fire and other risks. One of the most widely used NFPA electrical codes is the National Electric Code (NEC), NFPA 70. The NEC code has evolved over time (since 1897) and is updated approximately every 3 years. Like any set of evolving "rules", inconsistencies can develop within the code. The NFPA eventually identifies and corrects these inconsistencies.

NEC 2005 – Key Change Affecting the ICP Industry

Industrial control panels are currently installed based on general requirements from various NEC Articles. Because of inconsistent practice of installing equipment drawn from various

articles, NEC 2005 has been updated to address this issue. One of the key changes within NEC 2005 is to focus on the safe design, application, and inspection of industrial control panels. The most influential change is the inclusion of Article 409 on – Industrial Control Panels. Article 409 was added because of the increasing misapplication of ICP's caused by inadequate short circuit ratings. Refer to Figure 1 to understand some of these conditions and how the new requirement helps.

The NEC defines and Industrial Control Panel as follows:
"An assembly of a systematic and standard arrangement of two or more components such as motor controllers, overload relays, fused disconnect switches and circuit breakers and

Unique Condition	Issue	How this new requirement helps
Industrial control panels can be moved around from installation to installation thus encountering varying electrical systems, environments, grounding means, and short-circuit current levels.	Therefore, it is critical to supply the ratings associated with the industrial control panel assembly via markings in order to insure a safe installation.	These markings help the installer understand the equipment's ratings to ensure a safe installation. They allow comparison of the equipments ratings with the location's maximum short circuit current.
Many industrial control panels are constructed by a manufacturer and installed by someone else.	Without an exchange of information between the installer and manufacturer, any special requirements associated with the panel will not be known by the installer and possiblly cause an unsafe installation.	These new requirements ensure a proper exchange of information through equipment markings.
Many industrial control panels are field assembled and not assembled according to a product standard.	Compliance of field assembled control panels is a complex process. Often unsafe installations are due to: * Assemblers confused over what rule applies (NEC, NFPA79,etc. * AHJ's not able to meet review demand * Miscommunication	The new short circuit current rating marking requirement ensures that field assembled panels where product standards are not used, are properly marked and lessens the burden on AHJs to ensure compliance with 110.10.
There are an increasing number and variety of components, devices and equipment being used in industrial control panels.	The increasing amount of information needed for safe application is difficult to manage leading to accidental unsafe installations.	These new marking requirements will ensure that cricial information needed for the proper application of the components, devices and equipment being used in industrial control panels will be provided.

Fig. 1 - Benefits associated with inclusion of Article 409

IAEI's, January/February 2005, Short-Circuit Current Rating Requirements Facilitate compliance with 110.10, used by permission of IAEI News.

related control devices such as pushbutton stations, selector switches, timers, switches, control relays, and the like with associated wiring, terminal blocks, pilot lights, and similar components. The industrial control panel does not include the controlled equipment"

Industrial control panels are also specified as assemblies rated 600V or less.

The main goal of the new article is to ensure that all ICP's are marked with a proper short circuit current rating. Properly listed short circuit current ratings allow the safe installation and relocation of ICP's within the intended location. The article addresses general requirements for all industrial control products. In addition to Article 409, all other appropriate articles relating to the construction and installation of ICP's used in specific

The main goal of Article 409 is to ensure that all ICP's are marked with a proper short circuit current rating.

Compliance of field assembled control panels is a complex process.

Withstand ratings & interrupt ratings should not be confused.

applications such as Article 430 (Motors, Motor Circuits, and Controllers), Article 440 (AC and Refrigeration Equipment), Article 620 (Elevators, Escalators, etc), and Article 670 (Industrial Machinery) still must be referenced and followed in order to complete the code requirements.

What is Meant by Short Circuit Rating?
It is important to note that Article 409 addresses field and factory assembled control panels. This implies short circuit ratings for an entire *assembly* not just the rating of the main overcurrent protective device. By assembly, we mean all components contained within an enclosure.

The short circuit current rating of a component or equipment represents the maximum short circuit current level the device or equipment can safely withstand without compromising safety for buildings and personnel.

It is noteworthy to mention that withstand ratings and interrupt ratings should not be confused. Interrupt ratings are ratings associated with overcurrent protective devices, such as fuses or circuit breakers, and is referred to the ability of the overcurrent protective device to safely interrupt a short circuit at the specified marked interrupt rating. One should not assume that the interrupt rating of the overcurrent protective device represents the short circuit rating of the assembly. In fact, in most cases where many control components are used in the control panel (disregarding tested starter assemblies), the assembly short circuit rating will likely be less than the overcurrent protective device interrupt rating.

How is the Assembly Short Circuit Rating Determined?
Article 409.110 (3) clearly summarizes how the short circuit rating of an ICP is to be determined. According to 409.110, the short circuit current rating of an ICP must be based on one of the following methods:
1. Short circuit current rating of a listed and labeled assembly
2. Short circuit current rating established utilizing an approved method

(Note: UL508A-2001, Supplement SB, is an example of an approved method)

The use of method one above may fair well with OEM equipment that has a fixed and consistent design but does not fair well for panel shops where every panel will likely be different. Once an overall assembly has been tested, one small change in the design requires the panel to be retested. Since most panel shops build unique panels to meet a customer specific requirement, method one would be time consuming and cost prohibitive for most panel builders.

Therefore, method two is typically the method of choice for determining an ICP short circuit current rating.

What is UL 508A-2001, Supplement SB? ①
UL508A-2001, Supplement SB is one approved method for determining an ICP short circuit current rating. Supplement SB contains the following instructions for determining the short circuit rating:

Step 1: Determine the short circuit current rating of individual power circuit components by using one of the following methods:
- A. Use the short circuit current rating marked on the component or on the instructions provided with the component.
- B. For unmarked components, use the assumed short circuit current rating from Table SB4.1 (see below) of Supplement SB.
- C. Use the tested short circuit current rating from a combination of components or component from UL508A

① Summarized from UL508A, used by permission of UL

Step 2: When current limiting components are included within a portion of a circuit in the panel, modify the available short circuit current based on the let-through values of the current limiting device.

Step 3: Determine the overall panel short circuit current rating according to SB4.4 of Supplement SB.

Note: All power circuit components must have a short circuit current rating (expressed in amperes or kilo-amperes and voltage) except the following:

Components exempt from short circuit current ratings:

1. Power Transformers
2. Reactors
3. Current Transformers
4. Dry-type Capacitors
5. Resistors
6. Varistors
7. Voltmeters

Component	Short circuit current rating, kA
Bus bars	10
Circuit breaker (including GFCI type)	5
Current meters	a
Current shunt	10
Fuseholder	10
Industrial control equipment	
a. Auxiliary devices (overload relay)	5
b. Switches (other than mercury tube type)	5
c. Mercury tube switches	
• Rated over 60 A or over 250 V	5
• Rated 250 V or less, 60 A or less, and over 2kVA	3.5
• Rated 250 volts or less and 2kVA or less	1
Motor controller, rated in horsepower (kW)	
a. 0-50 (0-37.3)	5a
b. 51-200 (38-149)	10c
c. 201-400 (150-298)	18c
d. 401-600 (299-447)	30c
e. 601-900 (448-671)	42c
f. 901-1500 (672-1193)	85c
Meter socket base	10
Miniature or miscellaneous fuse	10b
Receptacle (GFCI type)	2
Receptacle (other than GFCI type)	10
Supplementary protector	0.2
Switch unit	5
Terminal block or power distribution block	10

a. A short circuit current rating is not required when connected via a current transformer or current shunt. A directly connected current meter shall have a marked short circuit current rating.
b. The use of a miniature fuse is limited to 125 volt circuits.
c. Standard fault current rating for motor controller rated within specified horsepower range.

Table SB4.1 - Assumed maximum SSCR for unmarked components
(Note: Reference only – refer to UL508A Supplement SB for determining SSCR's)

The steps above are very generalized and can become very complicated depending on the complexity of the industrial control panel. The goal of this paper is to simply provide a basic understanding of the concept. Contact the factory to obtain short circuit current ratings for ICP's of interest. A couple of basic examples have been included below to help illustrate some of the basic concepts.

For unmarked components, use UL508A, Table SB4.1 for assumed SCCR values.

Combination tested components can increase the ICP's SCCR.

Example #1 – ICP Rating for Untested Combinations
This example illustrates how an ICP must be marked for a simple combination motor starter (20HP at 480V) where the circuit breaker/motor starter has not been short circuit tested as a combination. This particular example uses the assumed short circuit current rating for the contactor/overload from UL 508A Table SB4.1 from Supplement SB.

Since the circuit breaker and starter combination has not been tested together for a short circuit current rating, we must use Step 1: A and B & Step 3 only from "What is UL 508A-2001, Supplement SB?" above. We cannot use Step 1: C.

The first step is to determine each individual component short circuit current rating. The ratings for this example are shown in Figure 2 below. The next step is to determine the lowest

Required ICP Marking: 5kA

Fig.2 - Example #1,
Industrial Control Panel

short circuit current rating of the lowest rated component. In this particular case, 5kA is the smallest short circuit current rating. The industrial control panel must be marked with the lowest rated component: 5kA.

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Example #2 – ICP Rating for Tested Combinations
This example illustrates how an ICP can be marked for a simple combination motor starter (20HP at 480V as before) where the circuit breaker/motor starter has been tested as a combination.

Since the circuit breaker and starter combination have been tested together for a short circuit current rating, we can use Step 1: C & Step 3 from "What is UL 508A-2001, Supplement SB?" above.

ABB has tested the A26 contactor with a S3 100A circuit breaker as a combination. This tested combination has a 35 kA rating. Remember, these components have been stringently tested as a set of combination components by UL.

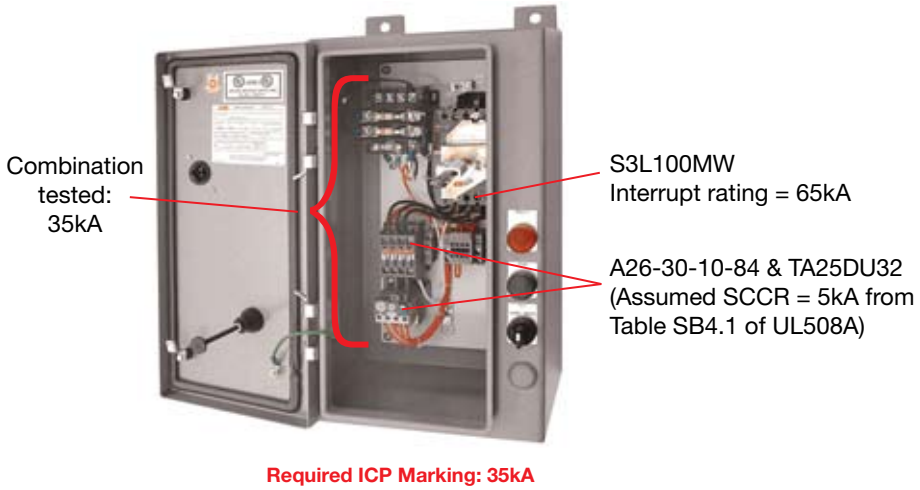

Fig.3 - Example #2, Industrial Control Panel

Since the only component in this example is the combination starter and it has been tested as a combination, the ICP can be rated 35kA. By using a tested combination, the ICP short circuit current rating has been significantly increased.

When will NEC 2005 be Enforced?
NEC 2005 is effective January 1, 2005 for jurisdictions that immediately adopt this version of the code. Currently, there are 25 states that have implemented Article 409. It is very important that all OEM's and panel builders in the industry are made aware of the new code requirements. The OEM and panel builder should check the existing code requirements for their jurisdiction to determine the enforcement of the new article.

Underwriters Laboratory (UL) will begin enforcing the new requirements associated with Article 409 by April 2006.

Conclusion
Industrial control panels must be supplied with the proper short circuit current ratings to ensure panels are safely installed. Proper marking allows the installer to positively identify if the location's available short circuit current ratings could exceed the panels safe design limits. The goal is to ensure panels are designed to maximize equipment and personnel safety and to reduce the risk of fires. By following the basic guidelines within the specified

Fig.4 - Sample label

OEMs & panel shops should check their jurisdictions for current code requirements.

UL begins enforcement April 1, 2006

time period presented in this paper, panels shops can be certain to provide safe, reliable, and code compliant products. ABB demonstrated it's industry leadership by implementing the new NEC code requirements a full year in advance of UL's target date. Processes and procedures are implemented to include short circuit current ratings on all enclosed control panels (see illustration).

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