



# EQUIPMENT SCCR AND AVAILABLE FAULT CURRENT

**HOW TO SATISFY YOUR CUSTOMER NEEDS**

By Daniel R. Neeser

Photo by John Watson



*Per NEC 110.3(B), electrical equipment must be applied in accordance with its listing and labeling. There are several equipment ratings that must be considered for National Electrical Code (NEC) compliance and product listing requirements, but one rating that's often overlooked is the equipment short-circuit current rating (SCCR). Equipment SCCR, as defined in NEC Article 100, is the highest amount of fault current equipment can safely withstand. From a safety perspective, it's vitally important to ensure the calculated available short-circuit (fault) current does not exceed the equipment's marked SCCR as required per NEC 110.10.*

**T**he 2017 NEC highlights the importance of adequate short-circuit protection with the updates to the following requirements:

- 1) Marking electrical equipment with its SCCR
- 2) Marking and/or documenting available fault current at various types of equipment
- 3) Preventing installation of equipment where the available fault current exceeds the equipment SCCR

As a result of the 2017 NEC changes, equipment SCCR and available fault current will draw more attention during design and installation. It's extremely important that the electrical system designer determine and communicate the available fault current to equipment manufacturers or to the party responsible for ordering equipment so that party can communicate the available fault current to equipment manufacturers. In addition, the electrical system designer must review the equipment submittals to confirm the required equipment SCCR has been provided prior to releasing the equipment. After following these procedures, the equipment inspection by the Authority Having Jurisdiction (AHJ) should go smoothly. To ensure this happens, some jurisdictions provide check-lists for equipment that require SCCR markings as well as other equipment that must be either marked and /or documented with the available fault current.

#### **What equipment needs to be marked with SCCR?**

For many years, electrical distribution equipment, such as panelboards and switchboards, have been marked by the manufacturer with SCCR in accordance with the UL product standard. The 2005 NEC added SCCR marking requirements for equipment that was often overlooked such as industrial control panels and HVAC equipment. This created some challenges for the original equipment manufacturers (OEMs), particularly because the level of SCCR protection needed was often not specified or communicated. Today, determining the available fault current at the point of installation and communicating the required SCCR is largely being addressed by the electrical system designers. Another challenge is the manufacturer's ability to provide equipment with the required SCCR, as it may require redesigning their equipment. This may require additional cost and changing some of the devices used in their equipment. In instances where equipment manufacturers have not responded to the market needs for SCCR, they have had to resort to other solutions, such as impedance methods (e.g., using an isolation transformer), to reduce the available fault current to a value below their equipment SCCR. This, unfortunately, can add delays and additional costs that could be avoided with properly designed equipment.

NEC Explicit Requirements for Equipment SCCR Marking*	
NEC Section	Equipment Type
409.110(A)	Industrial control panels
430.8	Motor controllers
430.98	Motor control centers
440.4(B)	<i>Air Conditioning and refrigeration equipment</i>
620.16(A)	<i>Elevator control panel</i>
670.3(A)(4)	Industrial machinery
700.5(E)	<i>Equipment transfer switches for emergency systems</i>
701.5(D)	<i>Equipment transfer switches for legally required standby systems</i>
702.5	<i>Equipment transfer switches for optional standby systems</i>
708.24(E)	<i>Equipment transfer switches for critical operations power systems</i>

**Table 1. NEC Explicit Requirements for Equipment SCCR Marking.**

\*It is typical for Underwriter's Laboratories (UL) product standards to require most electrical power equipment to be marked with a short-circuit current rating.

In addition, adding an isolation transformer may create voltage regulation problems which may negatively affect the performance of the equipment.

Table 1 shows equipment that's required to be SCCR marked per the 2017 *NEC*. All SCCR markings are required to be made by the manufacturer. Of these required SCCR markings, compliance will likely be the most challenging for elevator control panels and transfer switches, since this equipment has been largely overlooked in the past. For more information on the transfer switch and elevator control panel SCCR marking, see previous IAEI articles on these topics, as well as additional information in the resources and tools section of this article.

### **What equipment must be documented/marked with the available fault current?**

For all types of electrical equipment, to comply with *NEC* 110.10, the available fault current at the installed location must be calculated based on the electrical system's characteristics. However for some equipment, the available fault current must

be additionally documented and/or marked on the equipment. The *NEC* does not require a particular fault current calculation method, so any industry recognized method may be used. Commercially available software programs are available that use complex methods such as the per-unit method, but this can be costly. There are simple to use, no cost online programs or mobile applications (Eaton's Bussmann™ series FC<sup>2</sup> Fault Current Calculator) that are available based on the "Point-to-Point" method, which has been widely recognized by the industry as an acceptable and easy fault current calculation method.

Once the available fault current is determined (and documented and/or marked in some cases), to comply with *NEC* 110.10 and with additional *NEC* sections, the equipment marked SCCR must be equal or greater than the available fault current. Table 2 identifies the electrical equipment that must be either documented and/or marked with the available fault current at the installed location. It also indicates other *NEC* sections that have language similar to that in *NEC* 110.10 – the available fault current cannot exceed the equipment's marked SCCR.

NEC Section	Equipment Type (mark/document fault current)
110.24	Service entrance equipment (mark/document)
409.22(B)	Industrial control panels (document)
430.99	Motor control centers (document)
440.10(B)	<i>Air Conditioning and refrigeration equipment (document)</i>
620.51(D)(2)	<i>Elevator control panel (mark)</i>
670.5(2)	Industrial machinery (mark)
NEC Section	Equipment Type (fault current can not exceed SCCR)
409.22(A)	Industrial control panels
440.10(A)	<i>Air Conditioning and refrigeration equipment</i>
620.16(B)	<i>Elevator control panel</i>
670.5(1)	Industrial machinery

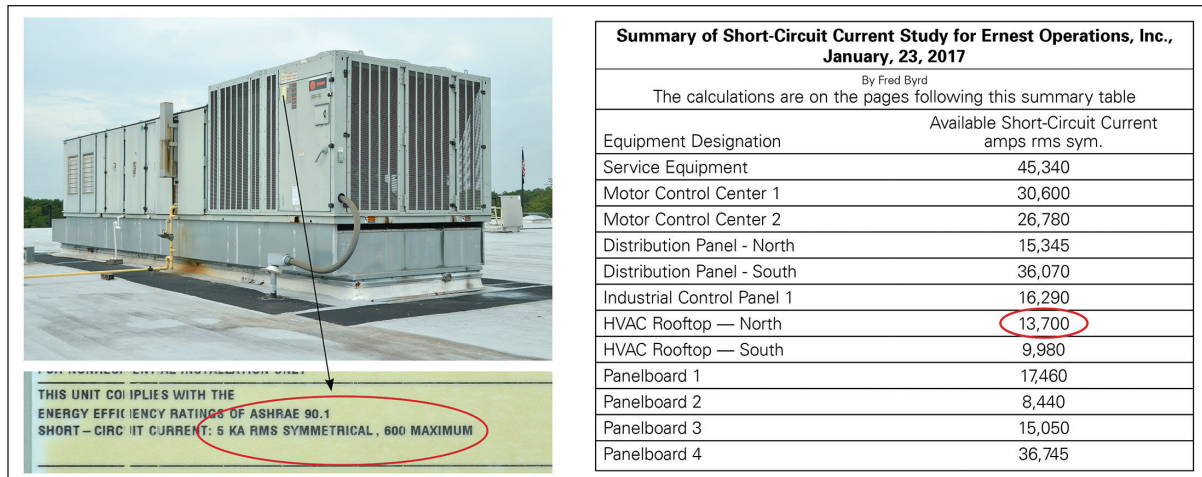
**Table 2. Equipment Type (mark/document fault current)**

### What level of SCCR is needed?

This is a difficult question to answer if a single number is desired. Many large industrials often select a 65 kA SCCR requirement. For equipment that's supplied from a grid-connected system, such in a downtown location, the requirement maybe 200 kA. For most installations, a single transformer supplies the equipment and it's easy to identify the required SCCR based on the transformer kVA and impedance and the distance from the power source. In this case, it's very important to work with the utility to determine the "worst case" available fault current. Many utilities will provide this information based on the electrical system service transformer kVA. For instance, if the service is anticipated to require a 1500 kVA transformer, the utility will provide a table with the transformer kVA and impedance, and resulting available fault current at the transformer's secondary. It's important to realize that although the anticipated kVA required for the electrical system's desired capacity (service load) is not always what's supplied. For instance, a 1500 kVA transformer is needed for the anticipated electrical service load, but the utility only supplies a 1000 kVA transformer at the initial

installation. Caution should be given if using the available fault current from the 1000 kVA transformer when selecting electrical equipment, since it may be changed later. If the kVA increases or impedance decreases, the available fault current will also increase and may result in an inadequate SCCR for the electrical equipment.

Once the available fault current from the power source is determined, then a calculation considering the effect of the impedance of the conductors can be done. Applying this calculations on the conductors from the service point to the service entrance equipment will give the available fault current value at the service entrance equipment required to be marked and documented per NEC 110.24. Additionally, motor contribution must be considered, since across-the-line started motors will back-feed current into a fault. This is especially important for industrial facilities where a large portion of the load are motors. The typical value used for this is four times the connected motors' full-load amps at the service bus voltage. So, if the service was 480 V, simply sum the full-load current of all 480 V motors and multiply that number by four. Any motors at 208 V or 120 V would not have to be considered.



**Figure 1. Code violation: HVAC equipment marked with a 5 kA SCCR but installed in a location with an available fault current of 13.7 kA.**

From this point, additional calculations are required to determine the available fault current at downstream feeder and branch equipment. This will require either a conductor fault current calculation and/or a transformer fault current calculation if the service voltage is reduced. It's necessary to complete these calculations instead of using "rules of thumb." I have personally seen instances where the design engineer specified 65 kA service equipment and then arbitrarily specified distribution panels at 25 kA and lighting/appliance panels at 10 kA. These may have been poor assumptions and caused issues with inadequate SCCR for electrical equipment. Since conductor length and size determines the anticipated equipment SCCR required for the electrical equipment, the design engineer must be cautious concerning these values when estimating them in the design phase. He/she should consider adding some "head-room" to the required SCCR in case the actual conductor is larger or shorter than anticipated.

#### Who is responsible for adequate SCCR?

This is a tricky question. From the equipment manufacturer's perspective, they are only required to mark the SCCR. They assume the design engineer, installer and owner are responsible for ensuring the equipment is adequate and applied per its listing and labeling. If no information is provided for required SCCR, then it is not

their responsibility. From the installer's perspective, it is assumed this falls on the design engineer to communicate with the equipment manufacturer. With the new *NEC* requirements for marking and/or documenting the available fault current, the installer has more visibility to this issue, as they typically are the ones providing the field installed label and/or documentation. In addition, with the increased electrical inspector (AHJ) education on this issue, they are now looking for adequate SCCR and proper documentation and/or labeling of the available fault current. From the electrical design engineer's perspective, they typically recognize the fact that they are responsible for determining and communicating the electrical system available fault current. In fact, many electrical design engineers are now calculating the available fault current and putting this information on the project specifications and documentation. They assume the equipment manufacturers and installers will then provide equipment suitable for the available fault current as indicated on these documents. However, the electrical design engineer is not always responsible for ensuring all the equipment has adequate SCCR. For instance, HVAC equipment is typically specified by the mechanical engineer, and the elevator control panel is typically specified by the architect. The challenge is to ensure that the mechan-



ical and architectural engineers are ensuring the equipment they specify has adequate SCCR.

### **What if the SCCR is not adequate?**

Responsibility for SCCR can be a challenge for all parties involved. Ideally, the electrical design engineer will determine the anticipated available fault current and communicate this requirement to all other parties and the equipment manufacturers. During the equipment approval stage, the design engineer responsible for the specific equipment will verify that adequate equipment SCCR has been provided prior to releasing the equipment for production. However, some equipment manufacturers design to the minimum 5 kA and do not offer a design with a higher SCCR. This leads to situations where the SCCR of the equipment is inadequate, such as in Figure 1 where the HVAC equipment marked with a 5 kA SCCR was installed in a location with 13.7 kA available fault current.

If a situation like this occurs, there are a few options to bring the equipment into compliance with the *NEC*, subject to approval by the AHJ:

- 1) Install an isolation transformer ahead of the equipment that reduces the fault current (such as a 480-480 V transformer with a kVA adequate for the load). The resulting available fault current can be determined via Eaton's Bussmann series FC<sup>2</sup> mobile app (which also produces labels and documentation).

- 2) Install additional conductor length to reduce fault current. The additional conductor length can be added in Eaton's Bussmann series FC<sup>2</sup> mobile app to determine the fault current.

- 3) Modify the equipment as needed and recertify the equipment through field evaluation so the resulting equipment SCCR (relabeled) is adequate for the fault current. The equipment manufacturer is not permitted to make any changes to the equipment after it leaves their manufacturing facility and retain the original listing. The modification can be done by a qualified person, however relabeling must be provided by a third party Nationally Recognized Testing Laboratory (NRTL).

The NRTL will not provide guidance on how to modify the equipment; they only evaluate the equipment as installed. A list of current NRTLs can be found on the OSHA website.

- 4) Install a current-limiting overcurrent device, such as a Class RK1 or J fuse, that reduces the calculated available fault current to a value equal to or less than the equipment SCCR. When using the specific manufacturer let-through data, it is suggested to mark the specific fuse required on the equipment. For instance, "Replace with only Eaton Bussmann series LPJ 60 A fuses." This method is only suitable for protecting "passive" components in the equipment. It is NOT suitable for non-passive devices such as circuit breakers and fuses. Circuit breakers or fuses must have an interrupting rating adequate for the calculated available fault current. This limitation is based on *NEC* 240.86(A), which indicates that using an engineered series combination rating is only permitted for existing systems, and is not permitted where the circuit breakers are non-passive. Circuit breaker manufacturers state that all modern circuit breaker designs are non-passive, so an engineered method is generally not permitted.

### **Resources and tools**

Eaton's Bussmann Division offers the following resources:

- 1) Eaton's Bussmann series FC<sup>2</sup>: A free mobile application that can calculate the available fault current and provide labels (in English, Spanish and French) that indicates the available fault current at equipment, and documents the calculation as required by the *NEC*.

- 2) Eaton's Bussmann series 2017 *NEC*® Code changes: This document (publication number 10508) provides additional detail on the 2017 *NEC* changes to equipment SCCR and available fault current.

- 3) Eaton's Bussmann series Selecting Protective Devices (SPD) Handbook (based on the 2017

*NEC*): This document (publication 3002) provides information on all topics related to overcurrent protection. Specific sections cover fault current calculations, equipment SCCR, industrial control panels and UL 508A, as well as a check-list for interrupting rating and equipment SCCR.

### Conclusion

To ensure proper equipment protection and application, all parties must be aware of and consider the equipment SCCR and the available fault current for every electrical equipment installation location from the service entrance to branch circuit equipment. The *NEC* and/or UL product standards now require the majority of electrical equipment to be marked with the equipment SCCR. For some equipment, such as transfer switches, an additional exterior field marked SCCR is required. It is now required to either field mark and/or document the available fault current for various electrical equipment types at their installed location, and it is the

responsibility of all parties involved to ensure the available fault current does not exceed the marked equipment SCCR. The required SCCR for equipment can vary depending on the electrical system configuration. This makes it difficult to determine an SCCR that can be widely applied to any system. Unfortunately, the minimum 5 kA equipment SCCR is typically not sufficient for most commercial and industrial facilities. Where equipment with a 5 kA SCCR is the only option, other fault current reduction or equipment modification and relisting methods must be considered and are subject to approval by the AHJ. ■

*Dan Neeser is a Field Application Engineer for Eaton's Bussmann™ series products. He has been employed by this company since 1996 and specializes in training on the design and application of overcurrent protective devices in electrical distribution systems in accordance with the National Electrical Code (NEC®), and equipment in accordance with the various product standards. He participates in IEEE (Senior Member) with Industrial and Commercial Power Systems, NEMA, NFPA (committee member for NEC CMP-13 and NFPA 79), UL® STP (508/60947-4 and 508A) and IAEI activities.*

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