

TechTopics No. 85

Temperature limitations for user's power cables

Siemens has been asked about the limitations on temperature for user's cable connections to switchgear for many years. ANSI/IEEE C37.20.2 (for metal-clad switchgear) and ANSI/IEEE C37.20.3 (for metal-enclosed interrupter switchgear) indicate that the temperature in the cable termination compartment should not exceed 65 °C when the equipment is operating at its full continuous current rating with the switchgear in a location with an ambient of 40 °C. In ANSI/IEEE C37.20.2-1999, this temperature limit inside the cable connection compartment is indicated in clause 5.5.5, excerpted below:

5.5.5 Temperature limitations for air surrounding insulated power cables

The temperature of the air surrounding insulated cables within any compartment of an enclosed assembly shall not exceed 65 °C when the assembly is

- a) Equipped with devices having maximum current rating for which the assembly is designed.
- b) Carrying rated continuous current at rated voltage and rated power frequency.
- c) In an ambient air temperature of 40 °C.

NOTE — This temperature limitation is based on the use of 90 °C insulated power cables. Use of lower temperature rated cables requires special consideration.

This has caused some users concern because this would suggest that cable ampacity must be adjusted downward due to excess temperature. We think this is not necessary in most cases.

First, ANSI/IEEE C37.20.2 specifies that the temperature rise for cable connection pads (the surface to which a cable lug is attached) must be limited to 45 °C rise at full load, instead of the normal 65 °C rise allowed for a bolted bus bar connection joint. This limit was selected for compatibility with 90 °C cables. As a side note, the cable terminals (cable lugs) which we provide are UL-listed for 90 °C.

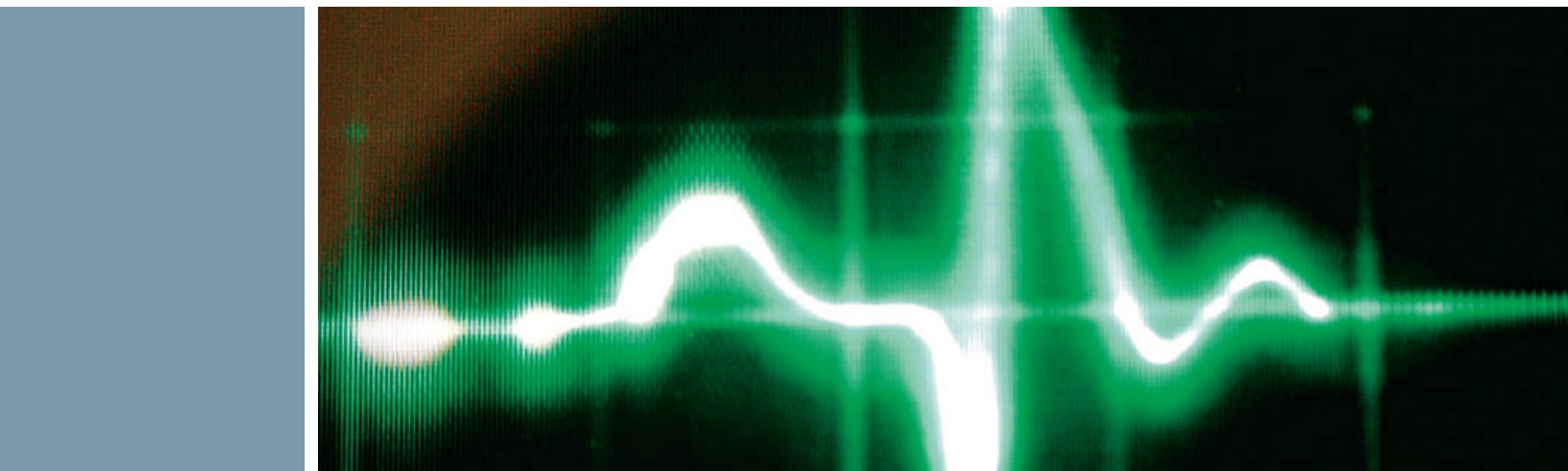
Second, the National Electrical Code® (NFPA 70®) contains language that would exempt most installations from having to adjust cable ampacity. Specifically, article 310.60 indicates:

310.60 Conductors Rated 2001 to 35,000 Volts.

(B) Ampacities of Conductors Rated 2001 to 35,000 Volts. Ampacities for solid dielectric-insulated conductors shall be permitted to be determined by tables or under engineering supervision, as provided in 310.60(C) and (D)

(1) Selection of Ampacity. Where more than one calculated or tabulated ampacity could apply for a given circuit length, the lowest value shall be used.

Exception: Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity shall be permitted to be used beyond the point of transition, a distance equal to 3.0 m (10 ft) or 10 percent of the circuit length calculated at the higher ampacity, whichever is less.



In a typical section of metal-clad switchgear, the length of cable from the point of entry to the cable lug is about 32" (813 mm) for a connection near the entry point (for example, bottom entry cables to a circuit breaker in the lower cell), or about 82" (2,083 mm) for a connection far from the entry point (for example, bottom entry cables to a circuit breaker in the upper cell). The exception in NEC clause 310.60(B)(1) indicates that if the length of cable inside the higher ambient area (the switchgear) is less than 10 percent of the length of the circuit, then the adjustment of ampacity is not needed. So, for the two examples, the circuit length would have to be more than 320" (about 27') (8.1 m) or 820" (about 69') (20.8 m) in order to avoid decreasing the cable ampacity.

Most external circuits would be significantly longer than these limits, and therefore, calculation of a lower cable ampacity should be unnecessary.

This discussion is premised on the equipment being used at its rated continuous current capability. At rated continuous current, the temperature rise limits of the ANSI/IEEE standards may be approached (but not exceeded). Since circuit heating is proportional to the square of the current in the circuit, we recognize that the actual temperatures in the equipment will be considerably reduced when the current is less than rated continuous current. Because of the square relationship, even a small reduction in current from the rated current makes a large difference in heating. Consider a circuit breaker operating at 90 percent of rated current. Based on the square relationship, the heating in the conductors would be only 81 percent of that at rated current.

A final point to consider is that the NEC, article 210.19(B) generally requires that the branch circuit conductors be sized for 125 percent of the continuous load (but the NEC has many supplemental qualifiers). If a user is following this NEC requirement, the temperature of the cables will be well below the limits imposed by the cable temperature class.

Because of this, there is even less need to consider ampacity derating of cables connected to the switchgear.

Specific situations for a particular project may require that the user adjust the ampacity, and each circuit and each application should be individually considered.

Siemens believes that most applications will not need to consider adjustment of the cable ampacity.

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