

## TechTopics Topic: "Bus Bracing" in Metal-Clad Switchgear

For decades, users and specifiers of Metal-Clad Switchgear have used the phrase "bus bracing" to define a specific level of mechanical strength for the bus system of Metal-Clad Switchgear. However, this term is not used in any of the standards that contain the major requirements for Metal-Clad Switchgear. Further, no specific rating for bus bracing is specified in the standards. This problem with ill-defined terms has been confusing for years. The purpose of this issue of TechTopics is to discuss the requirements for switchgear buses and to define what is meant when the term "bus bracing" is used.

The principle standard applicable to Metal-Clad Switchgear is ANSI/IEEE C37.20.2-1999. As it relates to the bus ratings, this standard defines several ratings:

- **Rated momentary withstand current:** This is the maximum rms total (asymmetrical) current that the switchgear bus must withstand, and is measured at the major peak of the maximum cycle of the maximum offset phase. The test to verify this rating requires a test duration of at least ten cycles of power frequency. During this test, the peak current at the major peak in the maximum cycle must be at least 260% of the rated short-time current of the switchgear.
- **Peak withstand current:** This is not strictly a rating, but it is the peak current value (260%) that must be attained during the momentary withstand current test described above.
- **Short-time withstand current rating:** This is the average symmetrical current that the switchgear must be able to withstand for a period of two seconds.

How do the above ratings relate to the ratings of the components used in the switchgear assembly? As you would expect, the ratings directly correlate to produce a coordinated system:

- **Momentary current and peak withstand current:** Historically, the standards specified a momentary current (rms asymmetrical, or rms total current) rating. In fact, the NEC 490-21 still uses "momentary" to designate the maximum asymmetrical current. However, for many years, the ANSI/IEEE C37-series of standards have been moving away from the concept of the asymmetrical rms current towards the concept of the peak current. The reason for this is that it is the magnitude of the peak current which determines the maximum forces applied to the conductors. Because of this shift in the philosophy of the standards, the equivalent requirements are stated somewhat differently in the various standards:
  - For circuit breakers rated on the "constant MVA" basis (see TechTopics 4), the momentary rating is most often expressed in rms amperes, and is the "close & latch" rating. However, the close & latch rating may be specified in peak amperes. The rms rating was listed in C37.06-1979, while the peak current value was used in C37.06-1987.
  - For circuit breakers rated on the "constant kA" basis (see TechTopics 4), the peak withstand current corresponds to the close & latch rating of the circuit breaker, in C37.06-1997 or C37.06-2000, expressed in peak amperes.
- **Short-time current rating:** Here, the standards have been consistent over time. The short-time current rating of the switchgear buses and connections must match the "maximum permissible tripping delay" value for the associated circuit breakers (see clause 5.8.2.3 of C37.04-1999 and Table 1 of ANSI C37.06-2000), which is 2 seconds for the circuit breakers used in Metal-Clad Switchgear. (Note that the standard allows use of devices in the switchgear which have a rated short-time current duration of less than 2 seconds. Most notably, low ratio current transformers or wound type current transformers may fall into this category. The protective device coordination study must take these reduced durations into account).

OK, so much for theory. What are the equivalent ratings? The following table is based on the “kA rated” circuit breakers in accordance with the coordinated standards issued in 1999-2000:

Circuit breaker rating or characteristic	Units	Value	Coordinating Switchgear rating or characteristic
Short-Circuit (Interrupting) Current (C37.04-1999, clause 5.8.1)	kA sym	100% = $I_{ST}$	Short-time withstand current (C37.20.2-1999, clause 5.4.6)
Short-Time Withstand Current (C37.04-1999, clause 5.8.2.3.b)	kA sym	100% of $I_{ST}$	Short-time withstand current (C37.20.2-1999, clause 5.4.6)
Maximum permissible tripping delay (C37.06-2000, Table 1)	Seconds	2 s	Short-time withstand current duration (C37.20.2-1999, clause 5.4.6)
Close & latch current (C37.04-1999, clause 5.8.2.3.a)	kA peak	260% of $I_{ST}$	Peak withstand current (C37.20.2-1999, clause 5.4.3)
Close & latch current (calculated rms current corresponding to the peak current) (refer to the introduction discussion in C37.06-2000 on closing & latching current)	kA rms	155% of $I_{ST}$	Momentary current (C37.20.2-1999, clause 5.4.3)
Close & latch current duration (C37.09-1999, clause 4.8.4.1)	Cycles	10 cycles	Momentary current duration (C37.20.2-1999, clause 5.4.3)

Finally, the “bus bracing” is most commonly considered to be the momentary current expressed in rms current, because this equates to the historic usage of the “momentary” term. However, bus bracing may be expressed either in rms current (155% of  $I_{ST}$ ) or in peak current (260% of  $I_{ST}$ ), as either form demands the same performance from the switchgear buses and connections.

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