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## Metal Clad Switchgear and Circuit Breaker BIL Ratings

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It's not all that uncommon to see specifications for metal clad switchgear equipment where the basic lightning impulse insulation level (BIL), now renamed lightning impulse withstand in the relevant IEEE circuit breaker and switchgear standards, is mismatched between the switchgear equipment and the circuit breakers specified. This happens for 15.0 and 38.0 kV equipment with some regularity.

According to IEEE C27.20.2 Standard for Metal-Clad Switchgear the BIL requirements for 15.0 and 38.0 kV metal clad switchgear are, and historically always have been, 95 and 150kV respectively. However, a number of specifications request circuit breakers to have 110kV BIL for 15.0 kV class equipment and 200kV BIL for 38.0 kV class equipment.

Why does this happen? I believe the answer is twofold, with both reasons being relatively simple. First, in many cases the specifications that require the higher BIL are from utilities that have a great deal of experience dealing with outdoor circuit breakers. Second, the standards are not crystal clear with regard to the differences in insulation capability requirements of circuit breakers.

Historically circuit breakers in IEEE standards have been segregated into indoor and outdoor, which are now referred to as Class S1 and S2 respectively in IEEE C37.04. The BIL requirements differ between indoor and outdoor circuit breakers with indoor circuit breakers being rated lower than outdoor circuit breakers. This difference is primarily due to the likelihood and severity of lightning strikes being higher for outdoor circuit breakers which are normally directly connected to overhead lines than for indoor circuit breakers which are not normally directly connected to overhead lines.

The ratings tables found in IEEE standards are clear in the distinction of preferred ratings for indoor (S1) and outdoor (S2) circuit breakers with the notable exception of insulation capability ratings. For ratings such as voltage, continuous current, short-circuit current, and interrupting time both indoor and outdoor circuit breakers have separate tables that are clearly labeled. However, for insulation capability ratings both indoor (S1) and outdoor (S2) circuit breakers are lumped together in the same table with no clear guidance which line numbers in the table apply to either type. To make things a little more confusing there are 4 lines in the table that are applicable to 38.0 kV circuit breakers.

So which ratings apply to indoor circuit breakers that are applied in metal clad switchgear? For 15.0 and 38.0 kV ratings the answer is found in IEEE C37.04 under the power frequency 10 s wet rating column. Outdoor circuit breaker primary insulation is exposed to normal precipitation, whereas indoor circuit breaker primary insulation is not. Therefore no 10 s wet rating is required for indoor circuit breakers and the power frequency 10 s wet rating in the table is marked as "not required". For 15.0 and 38 kV circuit breakers, if there is no 10 s wet rating the circuit breakers are rated for indoor use in metal clad switchgear.

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