
 TECHNICAL NOTE

Temperature ratings for primary cables connecting to ANSI MV metal-clad switchgear

It is a common practice to connect medium voltage insulated power cables to the switchgear bus for incoming lines or loads. As manufacturers, we are often asked to make recommendations as to what temperature ratings should be used for these insulated power cables.

There are two primary requirements within the IEEE Std C37.20.2¹ for which ABB medium voltage metal-clad switchgear is designed, constructed and tested to that determine what the cable temperature ratings should be. These are the temperature limits and temperature rise limits for buses and connections as defined by section 5.5.3, and the temperature limitations for air surrounding insulated power cables found in section 5.5.5.

Table 3 of section 5.5.3 provides the temperature rise and total temperature of several different types of bus and finishes used for connections.

Table 3 Temperature limits and temperature rise limits for buses and connections as used in switchgear assemblies

Type of bus or connection ^{b, c, d}	Limit of hottest-spot temperature rise (°C)	Limit of hottest-spot total temperature rise (°C)
Buses and connections with unplated copper-to-copper connecting joints	30	70
Buses and connections silver-surfaced or equivalent connecting joints	65	105
Buses and connections tin-surfaced or equivalent connecting joints	65	105

¹ANSI/IEEE C37.20.2-2015 IEEE Standard for Metal-Clad Switchgear

Table 3 Temperature limits and temperature rise limits for buses and connections as used in switchgear assemblies

Type of bus or connection ^{b, c, d}	Limit of hottest-spot temperature rise (°C)	Limit of hottest-spot total temperature rise (°C)
Connection to insulated cables unplated copper-to-copper ^a	30	70
Connection to insulated cables silver-surfaced or equivalent ^a	45	85
Connection to insulated cables tin-surfaced or equivalent ^a	45	85

^a Based on 90°C insulated cable. Refer to 5.5.5

^b All aluminum buses shall have silver-surfaced or equivalent, or tin-surfaced or equivalent connecting joints.

^c Welded bus connections are not considered connecting joints.

^d When buses or connections have differing materials or coatings, the allowable temperature rise and end temperature values shall be those of the conductor or coatings having the lowest value permitted in the table.

ABB MV metal-clad switchgear uses copper bus with silver or tin plating on all bus joints and connections. Therefore, the hottest total temperature that is allowed at the connection point is 85°C.

Per section 5.5.5, the air surrounding insulated cables within the switchgear compartment is tested to ensure it does not exceed 65°C within the following conditions:

- a) The assembly is equipped with devices having maximum current rating for which the assembly is designed
- b) The assembly is carrying rated continuous current at rated voltage and rated power frequency
- c) The assembly is in an ambient temperature of 40°C

Section 5.5.5 concludes with the statement that this temperature limitation is based on the use of 90°C insulated power cables.

So, what happens if lower or higher temperature rated cables are used?

If lower rated cables, such as 75°C, are used and sized for the fully rated current of that circuit, then if the cables would potentially be subjected to 85°C, exceeding the cable temperature rating. Use of these lower cable temperature ratings are not recommended by ABB.

If higher rated cables, such as 105°C, are used and sized for the fully rated current of that circuit at the 105°C rating, then the cables could run hotter than the bus connection joint was tested for and exceed the temperature limitation of the bus. Therefore, when these higher temperature cables are used, they should be sized according to the full load ampacity at 90°C, or rated at 125% to ensure overheating of the bus joint does not occur if cables are to be loaded at the full rating of the switchgear bus.

The above two scenarios represent the worst cases, whereby the actual full load circuit is equal to that of the switchgear continuous current rating. When the actual full load current is less than the switchgear bus rating, then the lower or higher cable temperature ratings may not be an issue.

NEC code 110.40 has specific requirements for medium voltage applications and ultimately refers you to tables 310.60(C)(67) through 310.60(C)(86). The 90°C rating is the lowest allowed by those tables. Customers should also consult the NEC codes, any local codes or Authorities Having Jurisdiction (AHJs) to determine if any other considerations are required.

For applications where compliance to CSA 22.2, no. 31² is required, that standard has a requirement of a maximum 15°C rise over a 40°C ambient for a total of only 55 degrees total temperature for the primary incoming or outgoing cables. However, section 8.4.5 of the standard does allow higher temperature ratings if a warning label is included to indicate the types of wiring to be used.

²Canadian Standards Association, CSA 22.2, no. 31-18 – Switchgear Assemblies

Summary:

ABB ANSI MV metal-clad switchgear is designed and tested to IEEE Std C37.20.2 as well as CSA 22.2, no. 31 and is most suited for cable temperature ratings of 90°C. The temperature limitations and air surrounding the cables within the switchgear should be taken into consideration when sizing and determining cable temperature ratings.

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