Temperature Rating of Conductors Connected to Molded Case Circuit Breakers

December 2, 1993

Books can be written, and probably have been written, on the subject of proper sizing of conductors to meet all the various requirements of the National Electrical Code. This PTB will address one small facet of that overall problem: the temperature rating of conductors connected to the terminals of molded case circuit breakers.

The NEC, as a general principle, requires most material used in electrical systems to be listed by a third-part certifier, such as UL, and to be installed in accordance with the conditions attached to that listing. In UL's Electrical Construction Materials Directory ("Green Book") we find the following conditions attached to the listing of circuit breakers:

> 2. Circuit breakers with a current rating of 125 amperes or less are marked as being suitable for 60°C, 75°C only, or 60/75°C rated conductors. It is acceptable to use conductors with a higher insulation rating, if the ampacity is based on the conductor temperature rating marked on the breaker.
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> 3. Circuit breakers rated 125 amperes or less and marked suitable for use with 75°C rated conductors are intended for field use with 75°C rated conductors at full 75°C ampacity only when the circuit breaker is installed in a circuit breaker enclosure or individually mounted in an industrial control panel with no other component next to it, unless the end use equipment (panelboard, switchboard, service equipment, power outlet, etc.) is also marked suitable for use with conductors rated 75°C.
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> 4. A circuit breaker with a current rating of more than 125 amperes is suitable for use with conductors rated 75°C.

In view of these rules, you might ask why anyone would want to use conductors with a higher temperature rating than the breaker rating, when these higher rated conductors are presumably more expensive than lower rated conductors. Outside of the possibility of convenience (the 90°C wire was laying around doing nothing), you may find that other derating factors applying elsewhere in the conductor run will reduce the allowable ampacity so that the 60°C or 75°C rating at the terminal is met without difficulty.

As an example, a #4/0 AWG copper conductor with 90°C insulation has an ampacity of 260 A per Table 310-16 of the NEC. However, if you connect this conductor to a molded case circuit breaker terminal, its ampacity is limited to the ampacity of the same size conductor with 75°C insulation, or 230 A. The MCCB terminal temperature rating is the limiting factor in this conductor application. Now, let's look at a circuit with two of these conductors per phase in parallel, with all size conductors run in the same conduit. Note 8 to Table 310-16 requires an adjustment of the ampacity to 80% of the ampacity listed in the table when there are 4 to 6 current carrying conductors in one raceway.

Powell Industries, Inc.
PO Box 12818
Houston, TX • 77217

Tel: 713.944.6900 • Fax: 713.947.4453
www.powellind.com
info@powellind.com

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The two 90°C cables now have an ampacity of 2 x 260 x 0.8 = 416 A. At the MCCB terminals, the allowable current is twice the 75°C rating of the cable, or 460 A. Now the MCCB terminal temperature is no longer the limiting factor, and the use of the 90°C insulation is advantageous. If 75°C insulation were used, the wire size would have to be 250 kcmil to carry 408 A, and the conduit size would have to be increased from 2½" to 3".

Baldwin Bridger, P.E.
Technical Director

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www.powellind.com
info@powellind.com