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TEMPERATURE LIMITATIONS-
CONDUCTORS VS. NONMETALLIC RACEWAYS

Charles W. Forsberg

A key element of electrical safety is the use of conductors within their temperature limitations. Section 310-10 of the National Electrical Code states:

"310-10. Temperature Limitation of Conductors.

No conductor shall be used in such a manner that its operating temperature will exceed that designated for the type of insulated conductor involved. In no case shall conductors be associated together in such a way with respect to type of circuit, the wiring method employed, or the number of conductors that the limiting temperature of any conductor is exceeded."

The ampacity tables of Article 310 then give us guidance to select the conductor that will be safe for a given ampacity. We can select the temperature rating, insulation style, and wire material from these tables with some degree of flexibility to meet our needs.

Some confusion may be generated when one reads uses prohibited in Sections 331-4(3) (ENT), 347-3(d) (RNMC), 352-22(b)(6) (SNMR), and 362-16(4) (NMWW). In the '99 NEC, Section 331-4(3) states, "Where subject to ambient temperatures in excess of 50° C (122° F) unless listed otherwise." A question most often asked is, " Will I exceed the ambient temperature rating of a nonmetallic raceway if I install 90° C rated conductors?" The answer to this is "no", if the raceway is listed for 90° C conductors in accordance with Sections 331-4(4), 347-3(e),352-22(b)(7), and 362-16(5)... Now for the explanation.

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UL places an ambient temperature restriction on plastics so that the physical properties of the product will be maintained under high operating temperatures. Without doing any testing, the basic ambient temperature limit is arbitrarily assigned as 10° less than the heat distortion temperature of the plastic compound. That 10° is a safety factor which will assure that the physical properties of the plastic product will be maintained. Since the heat distortion temperature of rigid PVC is 60° C, the 10° reduction results in the 50° C rating.

Based on the NEC requirements that are stated in the last sentence of the second paragraph above, UL also requires that nonmetallic raceways, other than liquidtight, be evaluated for conductor insulation ratings. Again, the "default" insulation rating is 60° C, but raceways can be evaluated for higher temperatures by testing. In this test, the raceway is placed in a test chamber at the maximum ambient temperature (50° C), filled with conductors to the raceway's 40% area capacity, and then the conductors are supplied with their maximum ampacity, based on their temperature rating. If the test is for 90° conductors, then no point on the surface of the installed conductor insulation, even within the "bundle", is permitted to exceed 90° C. (This is measured by thermocouples.)

The reason this test is conducted is that plastics are generally insulators, and do not conduct heat away from the conductors as metal raceways do. This test verifies that the nonmetallic raceway will allow the conductors to dissipate the

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heat generated by their full ampacity even when the raceway is at it's maximum ambient temperature.

To summarize, when using a nonmetallic raceway, other than liquidtight, there are three temperature considerations that are important:

1. The temperature rating of the conductor insulation.
2. The ambient temperature rating of the raceway.
3. The rating of the raceway for a specific conductor insulation temperature.

Keeping the ratings separate in this fashion will simplify the issue.

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