



On the surface, a 'groundbreaking' advance for General Cable

Two news stories in this issue (see p. 14) are about contracts awarded to General Cable Corporation to supply its new "groundbreaking" E3X™ Technology for overhead aluminum conductors. As not all new technology is equal, *WJI* asked the company to explain why they consider E3X to be such an advance. As interesting as the details about their new technology are, so is the company's discussion about historical assumptions that exist for overhead transmission line ratings. Below, Cody Davis, General Cable Lead Product Engineer, Electric Utility, discusses the technology. For more details, go to <http://e3x.generalcable.com>.



Davis

WJI: What is E3X Technology and what makes it qualify as "groundbreaking"?

Davis: E3X is a patent-pending innovative coating material that provides high emissivity and low solar absorp-

tivity characteristics, thereby allowing conductors to operate at lower temperatures, maximizing available line thermal capacity (normal and emergency) while minimizing capital investment and electrical losses. This is important because a bare overhead conductor's available thermal rating is limited by the aluminum's low emissivity.

WJI: How is E3X applied?

Davis: We don't comment on proprietary processes, but we can say that the coating is so thin that it increases conductor weight by an

exceedingly small amount, less than 0.4%, well within the manufacturing tolerances of the aluminum weight. The coating is factory-applied post-stranding to the surface of any General Cable overhead conductor.

WJI: How does E3X affect emissivity and absorptivity?

Davis: Those two material properties (characteristics) are key to the thermal rating of conductors. The emissivity of an overhead conductor quantifies the efficiency with which it dissipates heat via thermal radiation: the higher the emissivity, the more heat dissipates, and the higher the thermal rating. The absorptivity of a conductor quantifies the amount of solar heat absorbed from the sun: the lower the absorptivity, the less heat is absorbed, which improves the thermal rating. Therefore, the ideal material properties for an overhead conductor are high emissivity and low absorptivity. Now, with E3X Technology, these desirable material properties can be achieved by

simply applying a coating to the surface of any overhead conductor design. New conductors with E3X Technology offer engineered emissivity and absorptivity values of 0.9 and 0.2 respectively, which are utilized in the IEEE 738 Standard for calculating the current-temperature of bare overhead conductors.

WJI: How are emissivity and absorptivity values currently determined?

Davis: The industry commonly calculates the current-temperature relationship of bare overhead conductors by utilizing an emissivity and absorptivity value derived from curves that were developed in the 1950s and 1960s for use on lower-temperature lines (below 100°C) and were based on regional data. The prevailing industry belief during that era was that a new conductor with both low emissivity and low absorptivity would have a similar line rating to

an aged conductor with high emissivity and high absorptivity. At traditional operating temperatures (below 100°C) during the 50s and 60s, this range in different values had almost no impact on line rating. Therefore, it is not uncommon for environmental parameter values used in thermal rating calculations today to be overestimated and the effect of emissivity on line ratings is assumed negligible because absorptivity is assumed to be similar.

WJI: How does E3X Technology reduce the performance risk in line ratings?

Davis: The risk of incorrect assumptions for overhead transmission line ratings has been magnified by the increased temperatures of transmission lines being built today. With newer high-temperature line designs, the temperature error from using assumed high emissivity values can exceed 100°C, more than enough to cause excessive sag, conductor damage, or even sudden line failure of a valuable transmission path at a time when it is most needed. E3X Technology offers engineered “fixed” emissivity and absorptivity values in place of what had been previously a significant “variable” in line rating, thus reducing a source of risk when calculating the optimal thermal capacity of a transmission line.

WJI: Will utilities be willing to invest in this technology?

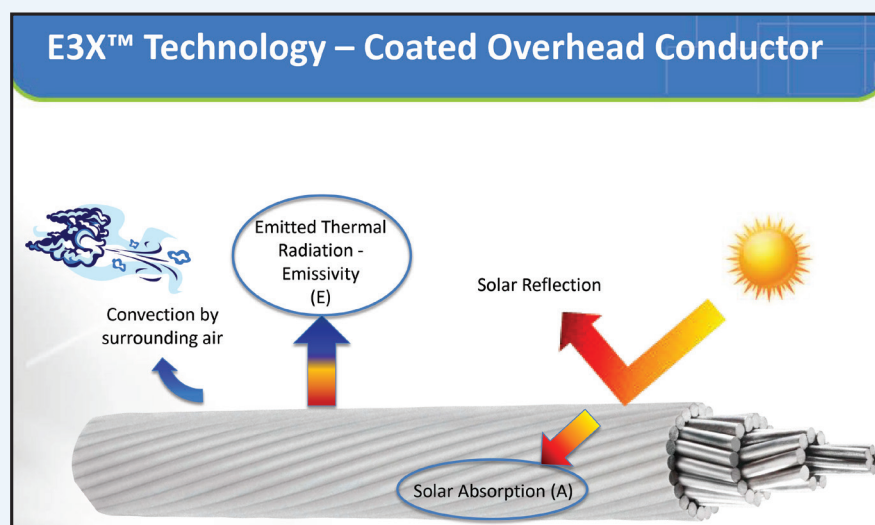
Davis: Yes, when they understand its advantages. Maximum design temperatures for bare aluminum overhead transmission lines have increased substantially over the past several decades to allow for more thermal capacity. We know that having accurate data on the mechanical, electrical, material and environmental parameters properties of a conductor is critical in maximizing available line thermal capacity (normal and emergency) while minimizing capital investment and electrical losses. E3X Technology allows utilities to optimize the power grid by adding more power and controlling

losses with significant first-cost and long-term operational savings. This, in turn, will enhance the long-term performance of the grid to supply safe, clean, reliable and cost-effective power for generations to come.

WJI: How did you verify the effectiveness of E3X?

Davis: We know that E3X is a groundbreaker not just because of extensive General Cable assessment but also from the results of testing over four years by a General Cable-directed team of expert development

ical testing (sheave roller, Aeolian vibration, galloping, and tension cycling) demonstrated no visible change to the coating. Additional testing to heat and humidity, salt exposure, or acid rain also shows no susceptibility. Testing has revealed that the E3X coating is not affected by the thermal expansion and contraction of the aluminum. The coating is flexible and strongly adhered to the underlying aluminum, demonstrating no flaking, damage or removal of the coating after 500 current cycles per ANSI C119.4.



partners, independent test laboratories which included Kinectrics and Oak Ridge National Laboratory, and utilities, which have an inherent focus on energy efficiency and reliability. The coating has been tested to the most stringent protocols above and beyond what is required for standard overhead conductor, and it has been evaluated through extensive validation in field trials. And yes, we can verify that it is groundbreaking.

WJI: Could this coating over time lose its effectiveness?

Davis: General Cable developed the E3X coating to be as durable as the conductor itself: 50 years and beyond. Our performance testing shows no reduction in performance after 10,000 hours in the weather-o-meter test. Sequential mechan-

WJI: How cost-effective is the coating?

Davis: While the upfront costs of an E3X-coated conductor may only be slightly higher, the overall transmission line project costs associated with designing a system with E3X Technology are significantly lower than that of a conductor without it. E3X offers a compelling payback period, less than two years on average for the incremental investment.

WJI: Could this technology be applied to existing transmission lines?

Davis: At this time, General Cable is only supplying E3X Technology for newly manufactured bare aluminum overhead transmission and distribution conductors. The technology to coat existing transmission lines is under development. Please stay tuned.