Driving New Concepts through the National Electrical Code

By Mike Anthony, Jim Harvey, and Jim Sanguinetti

Fifteen years in the making, the APPA Code Advocacy Task Force has undertaken one of the largest contributions of any industry toward U.S. sustainability ambitions.

Installed electrical supply services at most educational facilities have been at least 50 percent larger than what has been proven to be necessary since at least the 1950s. This excess capacity results in significantly oversized electric service equipment, in the related loss of building enterprise space in electrical rooms, and in waste heat. The oversizing is the result of the build-up of National Electrical Code safety factors that begin at every outlet, lighting fixture, and item of HVAC equipment. Admittedly, the cumulative build-up of safety factors also owe something to the conservative nature of design engineers. An overview of transformer oversizing can be seen in Figure 1.

The underutilization of transformers was recognized in the Energy Policy Act of 2005. Since the U.S. Department of Energy (DOE) understood—correctly—that it would be easier to legislate manufacturers to build more efficient transformers than to change National Electrical Code load calculation methods—the National Electrical Manufacturers Association (NEMA) TP-1 2002 standard became public law. NEMA followed up with its "Premium Efficiency Transformer Program," a program that identifies low-voltage transformers with losses 30 percent lower than TP-1.

Even with transformers built to operate more efficiently, capacity underutilization remains; a condition verified in a data-gathering effort that revealed that most transformers in our industry are only loaded 20 to 40 percent. This represents about $1 billion to $10 billion in annual avoidable cost to our $200 billion industry. Because of APPA's desire to contribute to wide-ranging sustainability ambitions, this issue was made the CATF's highest priority as Issue 11-6 in the Public Policy Agenda.

Unwinding the existing NEC calculation methods that bring more energy into a building than necessary, is difficult to handle politically, technically, and economically, for the following reasons:

1. Insurance companies, who project their interests through testing agencies, have not yet rationalized the relative risk of wiring fire safety versus the hazards of electricians working on energized equipment with high-incident energy.
2. Consultant design compensation is based upon construction costs. The larger the equipment specified, the larger the design fee.
3. Utility tariffs—designed for an economy that grew 7 percent annually—contain incentives for larger services to accommodate future load growth assumptions.
4. State and local enforcement authorities base their inspection fees in proportion to the ampere load. A 1200A service inspection brings in more revenue than a 600A service, for example.
5. Section 90.8 of the NEC which asserts conditions for "future expansion and convenience" is broadly inter-

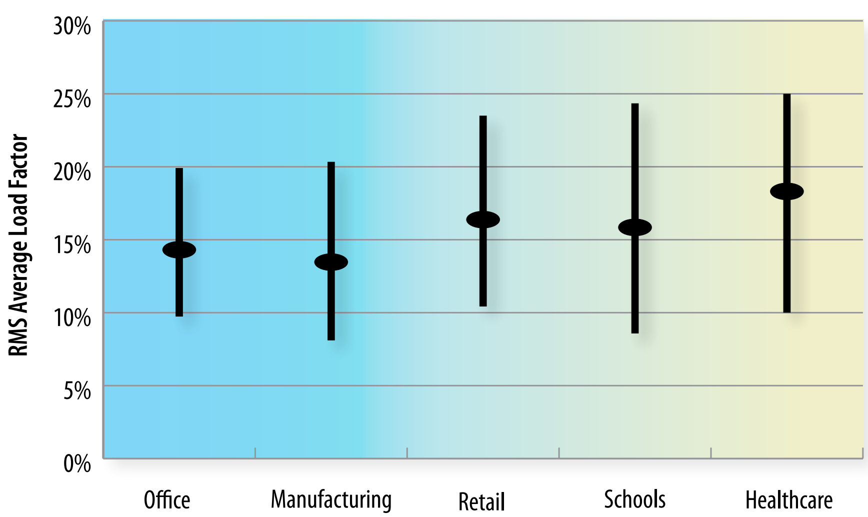

Figure 1: Data from a 1999 U.S. Department of Energy study of building types in the northeast United States

preted by designers; typically upward to design in 10 to 15 watts per square foot when, in fact, our industry only sees 3 to 5 watts per square foot.
6. Labor unions benefit from higher wage electricians through dues and training programs for workers who do riskier work on medium voltage systems.
7. Transformer and switchgear manufacturers have no incentive to sell smaller equipment, period.

Now there are many cases where transformers with redundant capacity is necessary. Double-ended substations in healthcare facilities, laboratories, and critical processes, for example. In high-rise facilities large fire pumps may require larger transformers to protect contingencies. These are a minority of cases, however, and many transformers already have significant overload capability already built into them. No one knows how many transformers overload their continuous rating. No catastrophic or "marquee" disasters are recorded in the media or trade journals; however, IEEE literature reveals that some service substations are so large that they cannot be worked on live. Anecdotally, it is assumed that overloads are rare—certainly infrequent compared to the frequency of electricians working on live equipment—and that overcurrent devices deenergize transformers before they are damaged.

Within this context, at the January 2012 meeting of the 2014 NEC technical committee meetings, the authors set the agenda with a group of 19 proposals aimed at reducing transformer sizes. The proposals integrated two years of discussion and data contributions from APPA member institutions and business partners. Because of the complex interdependencies of the NEC, the concepts underlying our proposals spanned a range from small concepts (that can be accomplished in one revision cycle) to disruptive concepts (that can be accomplished in multiple revision cycles). Figure 2 is a reproduction of the presentation slide that builds a case for a win-win-win scenario for all interest groups.

Win-Win-Win

1. Adoption of education facilities industry Article 220 proposals sets in motion project financing architectures that draw from sustainability and workplace safety resources to help fund electrical upgrades.

2. Replacement of oversized medium voltage installations with smaller transformers or low voltage services mean that less energy is brought into a protected premises with corresponding reduction in fire and arc flash hazard. Majority of general commercial buildings can be supplied at about 5W/SQFT instead of the present 10W/SQFT required by the NEC.

3. Switchgear replacement with lower voltage and ampere ratings recover transformer space for the building program for Owners and leave more working space in legacy electrical rooms.

4. Reduced transformer no-load losses will be on the order of $43,800 per 10,000 kVA, connected.

5. Release of funding for new services will accelerate Smart-Grid. Engineers an specify services with energy management equipment that controls feeder load, and provides for future interactive-distributed resource equipment that deploys renewable energy sources and increases power reliability.

Figure 2: The win-win-win scenario

The committees responded with acceptance of two of them involving Table 220.12; the design requirements for lighting load calculations. It represents a provisional, code "win" for APPA because it permits a partial, though significant, reduction in the transformers sizes.

GOING FORWARD

The authors would like thank the electrical professionals, APPA executives, and business partners that have supported this effort. While the 2014 NEC revision process is only in the first of three stages, it is a solid start. In the second stage of NEC revision we will redouble our effort to see similar reductions in transformer size carried into load calculations for HVAC equipment. Our hope is that when the 2014 NEC is adopted as public law, APPA members will immediately see $10,000 to $100,000 of first-cost savings for every new building, and $1,000 to $10,000 per year annual avoided losses throughout the life cycle of the building. When coupled with the consortia of education healthcare and government (ex-military), this code change will significantly affect the energy and material cost of 5 percent of the $15,000 billion U.S. annual gross domestic product.

Further information about the subjects covered in this column are available at *www.appa.org/standardscatf.cfm.*

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