



## COOPER PROVIDES UTILITIES DOE 2010 STANDARD-EFFICIENT DESIGNS

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On October 12, 2007, the U.S. Department of Energy (DOE) issued its long-awaited transformer efficiency standard. The standard establishes required efficiencies for new distribution transformers rated 2500 kVA and below sold in or imported to the U.S. after January 1, 2010. The standard defines a legal requirement rather than merely a guideline or recommendation for these transformers.

Cooper Power Systems is offering a proactive approach to meeting requirements of the DOE standard early packaged along with innovative Envirotemp FR3 fluid to provide utilities with “green” energy-efficient transformers. These highly efficient FR3 fluid-filled transformers combine the most environmentally favorable dielectric fluid available with energy-saving, high-efficiency designs. The result is a more favorable carbon footprint along with reduced energy generation requirements.

### Background

The U.S. Federal government has been setting energy efficiency standards for products for several years. These products include home appliances such as air conditioners, washers, dryers, and refrigerators, as well as fleet miles-

per-gallon averages for automobiles. There are several objectives for these efficiency standards; deferral of additional generation and transmission capacity, reduced greenhouse gas emission, and less dependence on imported energy. Reducing energy consumption decreases the amount of power that is required to be generated and allows postponement of building new power plants and transmission lines. It also reduces the amount of primary fuels like coal and natural gas burned in power plants to generate electricity. Gasoline and electric power generation primary fuels are both big sources of greenhouse gasses. Additionally, reduction in consumption of gasoline and other petroleum products lessens U.S. reliance on foreign petroleum products.

### Implications for Transformer Manufacturing

Transformer buyers typically specify evaluation formulae for losses which dictate the most economical transformer design given their cost of power. By one manufacturer's estimate, at least 60% of distribution transformers purchased in 2007 were below the DOE's efficiency levels established for 2010. This implies that in order to comply with the DOE

standard, the majority of transformers sold in the U.S. will require redesign before 2010. Higher grades of conductor material and core steel will be necessary to obtain required efficiencies. In some cases, aluminum conductors will be replaced with copper and in most cases, lower-grade M5 core steel will be replaced with lower-loss M2 and M3 core steel to increase transformer efficiency to compliant levels.

Transformers represent a small sliver of total mild steel, aluminum, and copper use. The large markets for these metals will be primarily influenced by world-wide demand from all sectors—rather than changes in demand from the transformer industry. Surging economic growth in the emerging Asian and Far East markets will be primarily responsible for the price pressure for these commodities.

However, it is estimated that price and availability of mild steel, copper, and aluminum will be largely unaffected by the DOE's action. The same is not necessarily true for the specialty grain-oriented silicon core steel used in distribution transformers. Transformers represent a very large portion of the consumption of this core steel; therefore, the prices for M2 and M3 core steel are quite inelastic with transformer demand.

Complicating the issue, there are very few manufacturers of this magnetic core steel and adding capacity at these mills is an extremely lengthy and expensive undertaking. Capital expansion projects at the steel mills can take years to implement and cost millions of dollars. Global demand for the premium core steel is expected to surpass global supply, and it may take several years for the small number of existing suppliers to catch up.

### Proactive Approach Helps Customers Now

Quite a number of customers are proactively moving to DOE efficiency levels rather than waiting until the mandate to purchase DOE-compliant transformers. These customers have chosen to take advantage of higher-efficiency transformers sooner—locking in the lower cost and smaller-size designs while there is M2 and M3 core steel available.

In the future, when transformer manufacturers cannot get enough of the low-loss, efficiency-friendly M2 and M3 core steel to meet demand, they may be required to make do with sub-optimal designs using the more plentiful M5 core steel. The resulting designs will be larger, heavier, and more expensive than the optimal M2/M3 core steel designs.

Dimensions, weight, and cost can increase anywhere from 10% to 30% when lower-grade core steel must be used instead of the optimized M2 or M3 core steel-based designs. Additionally, for overhead transformers, the increased weight of the transformer may require more expensive and heavier-duty utility poles. Replacing utility poles typically costs utilities \$3,000 to \$4,000 in material and labor costs.

For pad-mounted transformers, existing concrete pads may be too small to accommodate the larger designs. And for all transformers, larger and heavier transformers mean fewer per truck, increasing logistic costs and fuel used in transportation. Transformer consumers will definitely be at an advantage if they can obtain the scarce M2 and M3 core steel for their designs. Late adopters will most likely be left to settle for the best configurations that can be obtained with the inferior core materials and the higher transformer costs and larger units that go with M5 core steel limitations on design.

### Soy-Based Transformer Fluid Helps Meet Green Objectives

The redesign efforts necessary to meet the DOE minimum efficiency requirements also present a great opportunity for



**First installation of a FR3 fluid-filled transformer at ComEd in March 2008.**

customers to re-evaluate dielectric fluid options. Fully embracing the “green” effort includes specifying FR3 fluid, which is made almost entirely from soy oil. Growing soy consumes CO<sub>2</sub> and produces O<sub>2</sub>. Even considering the CO<sub>2</sub> produced to support the growth of seed crops, the soy is a net CO<sub>2</sub> consumer rather than producer, and CO<sub>2</sub> reduction is a big reason why the DOE established its standard efficiencies.

FR3 fluid is also non-toxic<sup>1</sup> and fully biodegradable per an EPA Standard test<sup>2</sup>—extremely beneficial properties in the event of accidental spill. Specifying FR3 fluid also reduces the demand for petroleum-based mineral oil and requisite drilling activities. Finally, the life-extending properties of FR3 fluid mean that transformers do not require replacement as often. More infrequent transformer replacement means less aluminum, copper, and steel required for manufacture. Production of each of these materials introduces greenhouse gasses to the environment.

Studies show that using FR3 fluid instead of conventional petroleum-based mineral oil will reduce a company’s carbon footprint. As related to transformers, per NIST BEES report, the soybeans used in FR3 fluid consume CO<sub>2</sub> from the air while they are growing. The CO<sub>2</sub> impact from the soy is still a net reduction for the environment even after considering the tractor fuel, fertilizer, processing and transport used in production of FR3 fluid. This contrasts with mineral oil which is a

net CO<sub>2</sub> emitter in the drilling, refining, processing, and transport processes.

The list of utilities opting to convert to DOE standard efficiency levels includes Alliant Energy, ComEd, Xcel Energy, and American Electric Power. They have all selected FR3 and DOE compliant designs in 2008. Many more customers are in the process of converting to DOE standard efficiency early and including FR3 fluid in their conversion plans. These utilities are embracing both the intent and the letter of the DOE standard. Their proactive actions benefit both the customers and the environment—a win for all involved. ■

1. Per OECD G.L.203

2. EPA OPPTS 835.3110

For more on greenhouse gas emission, refer to the related article, *FR3 Fluid Provides Sustainable Alternative for Reducing Carbon Footprint*, on page 7.