Utilities Choose Envirotemp® FR3™ Transformer Fluid as a Solution for Future Regulatory Relief

by Jonathan Piel, Product Manager, Envirotran

Fluid Options. To the public, transformers are unnoticed devices that blend into the fabric of our modern landscape. However, transformer fluids occasionally enter the environment when transformers are damaged or leak. Since the 1970s, public awareness has grown about PCB-based transformer oils and their environmental hazards. While most PCB oil-filled transformers have been retrofilled or replaced with PCB-free mineral oil or alternate fluids, the replacement fluids themselves are of environmental concern.

The most common transformer fluid is mineral oil, which is a petroleum hydrocarbon. More technically, mineral oil is a hydrotreated light naphthenic petroleum distillate. According to the State of California Environmental Protection Agency (EPA), the International Agency for Research on Cancer (IARC) has identified certain mineral transformer oils as a carcinogen, based on experimental data for animals. A less common transformer fluid is silicone oil. Silicone oil is a dimethyl polysiloxane identified as a teratogen, and has been linked to reproductive problems based on experimental data on animals. Silicone has been found in estuaries and there are reports that such silicone can combine with mercury to form the very hazardous and bio-accumulating compound called methyl-mercury. Less common fluids also were introduced that had extreme environmental and health risk issues due to the presence of halogen compounds, most of which are no longer available.

Cooper Power Systems' Envirotemp® FR3™ fluid is increasingly becoming an environmentally preferred solution. FR3 fluid, unlike most other transformer fluids, is a vegetable oil-based fluid. FR3 fluid does not contain petroleum hydrocarbons, silicones, or halogens. It is made from food grade ingredients and is not subject to Federal Regulation of Used Oils (Title 40, No. 279).

Leader in Environmental Initiatives. Indiana's electrical cooperative, Tipmont REMC, is leading the industry in environmental initiatives – even in advance of regulatory relief. The Tipmont REMC board has been investigating environmentally friendly products and agricultural-based products. While 15 co-ops in Indiana already use transformers filled with FR3 fluid, Tipmont is the first to commit to FR3 fluid for all of their overhead transformers.

Chris Novak and Michael Bryja (both of Indiana Soybean Board) with CPS Envirotran™ Pole-Mounted Transformers filled with Envirotemp FR3 fluid Fluid for Tipmont REMC.

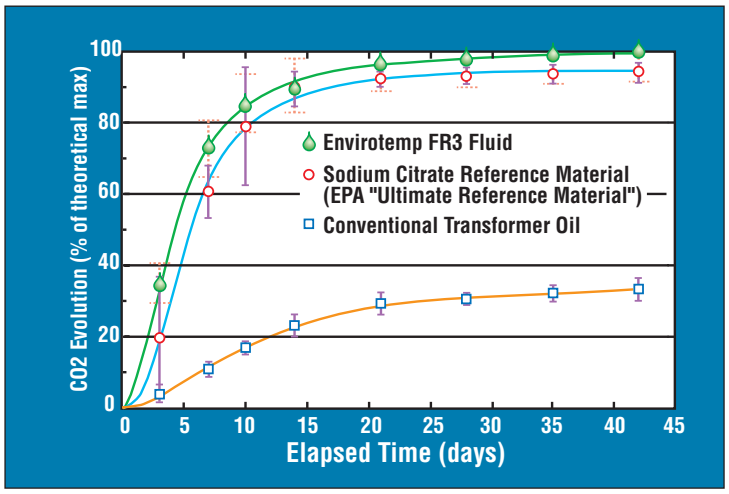
A significant benefit of FR3 fluid is the easier cleanup of spills, since the fluid is more benign to the environment than petroleum oil. According to Dave Sermons, Tipmont's engineering and operations manager, FR3 fluid-filled transformers represent one of the best steps they can take today to provide future regulatory relief.

Soy oil serves as the base vegetable oil for FR3 fluid. Indiana has a significant soy-growing constituency, along with 28 other states. Standardizing on FR3 fluid means that Tipmont REMC is also able to use an agricultural product to serve an agricultural community.

Non-Toxicity. Substance toxicity is measured by how harmful it is to living organisms. FR3 fluid has been tested for toxicity by third parties in accordance with standard aquatic toxicity test methods defined by the Organization for Economic Co-operation and Development (OECD) and Environment Canada. These tests used very young rainbow trout that are particularly susceptible to toxins. During the four-day exposure tests, there was zero trout mortality. The EPA has subsequently issued an affirming statement through the Environmental Technology Verification Program (ETV) (which can be found at http://www.epa.gov/etv/pdfs/vrvs/06_vs_cooper.pdf). No mineral oil or silicone oil based dielectric coolants currently feature the ETV certification.

Rapid Biodegradation. Two of Envirotemp FR3 fluid's most differentiating environmental features are its rapid biodegradation rate and non-toxicity. Biodegradation can take place when there are adequate amounts of water, oxygen, organisms, and heat. Inside a sealed transformer, these elements do not exist together in sufficient quantities to promote biodegradation. Outside a transformer, FR3 fluid biodegrades rapidly, from which the by-products are essentially carbon dioxide and water. The U.S. and California EPA have run their own tests to validate and certify the aquatic biodegradation for FR3 fluid, using standardized testing methods. The chart on page 4 illustrates the results of the tests including comparisons to other materials. FR3 fluid biodegraded faster than the EPA baseline reference material of sodium citrate and subsequently qualifies as an EPA-defined "ultimate biodegradable material."

In 21 days, mineral oil biodegrades just 25% while FR3 fluid biodegrades in excess of 99%. So the mineral oil cannot even be EPA classified as "readily



biodegradable," which is a lower classification than "ultimate biodegradable" material. Silicone oil does not biodegrade.

Preserving the Waterways. Steuben County in Northeastern Indiana is the home of 101 natural lakes, so transformer proximity to waterways has always been difficult to avoid. When it has come time to replace transformers in these sensitive areas, Jamie Shields of Steuben County REMC has been selecting transformers filled with FR3 fluid, including the application pictured near Wall Lake.

Committed to the Environment. Orcas Power and Light Cooperative (OPALCO) has standardized on distribution transformers filled with FR3 fluid, in alignment with its mission statement to "have a real commitment to the environment."

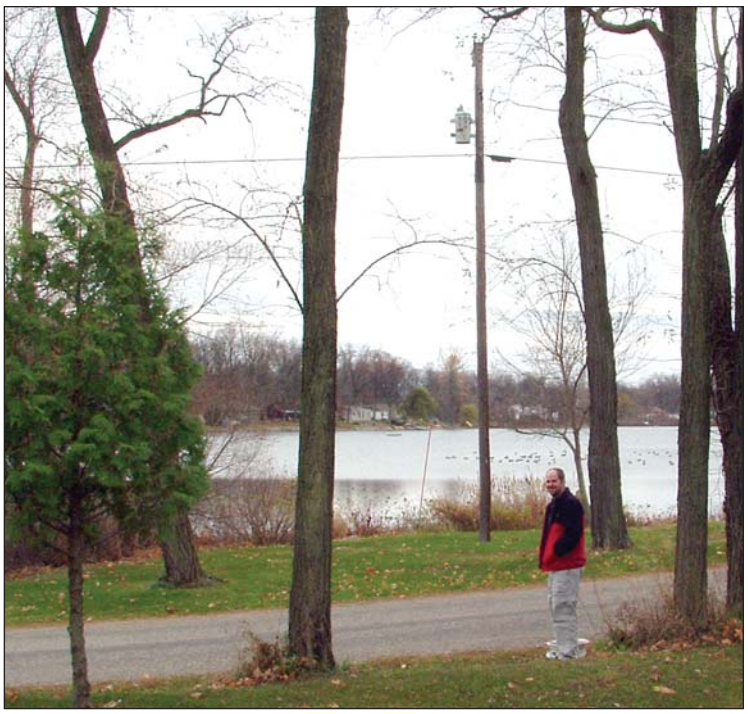
OPALCO services a pristine chain of islands off the coast of Washington state. According to Mark Tilstra, Manager of engineering for OPALCO, "The environmental concerns of OPALCO staff and our members have initiated a cooperative effort to take reasonable and economic steps to maintain the pristine environment of the San Juan Islands. With islands surrounded by salt water and numerous streams and lakes within the perimeter, it makes good sense to protect these waterways whenever possible (see cover photo and photo on page 3, upper right). We were also impressed with the fire retardant qualities of the product, which provides an additional personal safety feature and the ability to improve the efficiency and loading capabilities of the transformers themselves. We look forward to using FR3 fluid in future applications, such as retrofits, which will improve our power transformer maintenance program."

Insurance Regulation. Insurance companies have a vested interest in understanding the failure modes of transformers and the possible financial consequences. One of the largest insurance companies, FM Global® (formerly Factory Mutual), recognizes that there are fewer financial risks in supporting a transformer that contains biodegradable fluid certified by a third party. According to FM Global Property Loss Prevention Data Sheets 5-4 (May 1993), if surface-mounted transformers contain a fluid which is certified as a biodegradable fluid by the Environmental Protection Agency, and there is no exposure to a navigable waterway, then containment is not required for volumes over five times that of mineral oil. No mineral oil or silicone oil qualifies for this exemption.

Cost Justifying Environmental Concerns. In Waverly, Iowa, a commercial truck backed into a transformer resulting in a 20-gallon (75-liter) transformer fluid spill. The trucking company insurance subsequently paid $27,500 for the costs associated with the environmental clean-up. According to Glenn Cannon, general manager of Waverly Light & Power, "The costs associated with that one incident would more than offset the incremental costs of going to 100% environmentally friendly fluid for years to come." Cannon adds that being able to cite that the fluid is of a food-grade soy oil base would have significantly improved media exposure. Since this incident, Waverly Light & Power has standardized on vegetable oil based fluid-filled transformers and is proactively publicizing that environmental initiative.

National Regulation. The Edible Oil Regulatory Reform Act-1995 requires the head of any federal agency to differentiate between oils of vegetable origin and other oils in issuing certain regulations and for other purposes. FR3 fluid is covered by this act. As a result, the US Department of Transportation (DOT) has differentiated vegetable oils under 49CFR130.1. For transportation-related response plans, the DOT plan threshold quantity for vegetable oil-based FR3 fluid is 42,000 gallons (159,000 liters), while the mineral oil threshold is just 3,500 gallons (13,250 liters). (Other agencies may also have jurisdiction of the spill area and may have different spill reporting regulations other than the DOT.)

The U.S. EPA, under the Spill Prevention, Control & Countermeasure (SPCC) requirements, has not yet differentiated between types of oils in defining reportable spill quantities into "navigable waterways" or its minimum threshold site volumes requiring an SPCC "Plan".



Jamie Shields (Steuben County REMC) at Wall Lake with Cooper Power Systems Envirotran pole-mounted transformers filled with Envirotemp FR3 Fluid.

Beyond reporting, Envirotemp FR3 fluid may be differentiated within the SPCC as it applies to "control." If gravel is used around outdoor transformers, vegetable oil-based FR3 fluid is less likely to percolate through earth and gravel, thus impeding transmission to groundwater. Mineral oil typically does percolate more readily through earth and gravel than does FR3 fluid. FR3 fluid may also be differentiated as it applies to "countermeasure," since one of the spill responses may be bioremediation (natural or accelerated biodegradation). Acceptance of gravel or earthen containment (as opposed to concrete basins) and bio-remediation (as opposed to soil removal/disposal/ replacement) is at the discretion and responsibility of the professional engineer. Such acceptance must be considered in conjunction with state soil spill regulations.

State Regulations.

Each state has different environmental requirements that may include hazardous substances, industrial waste, or oil spills. FR3 fluid does not contain petroleum, is readily biodegradable and is not listed as a hazardous substance under the EPA's 40 CFR Table 304.2, or as a contaminate under EPA's drinking water program. Cooper and Cargill are actively pursuing and summarizing the state-by-state requirements to serve as a better resource for transformer specifiers and users. Many defer to the U.S. EPA SPCC for waterway spills. Some defer to the U.S. government definition of hazardous substances and/or hazardous waste (for which vegetable oil is not defined as hazardous material). Most have requirements for petroleum spills on soil.

State of Massachusetts.

In Massachusetts, the reportable spill quantity does differentiate between oil types. The minimum reportable quantity for vegetable-oil-based Envirotemp FR3 fluid is 55 gallons (208 liters), while the minimum quantity for mineral oil is just 10 gallons (38 liters). This differentiation is significant for one major utility, which has identified the cost of documenting a reportable spill as several hundred dollars. The savings may be enough that any company should investigate the potential savings in their state.

McAdam wellfield pumphouse and transformers filled with Envirotemp FR3 fluid.

Breakthrough in Meeting Environmental Objectives.

NB Power is also leading the industry in pursuing solutions that meet the power needs of the community while protecting the environment. The village of MacAdam in New Brunswick, Canada developed a new underground wellfield. This water supply area was regulated by the Wellfield Protected Area Designation order under the New Brunswick Clean Water Act. This act included a key restriction that there could be no hydrocarbon liquid in an amount greater than seven gallons (25 liters) within 270 yards (250 meters) of the wellhead. The challenge for NB Power was to supply each wellhead pumphouse with three-phase power delivered over a two-mile (3km) section. Since mineral oil-filled transformers were not an option, two expensive alternatives included locating transformers 440 yards (400 meters) away from the pump house or using dry-type transformers.

NB Power's Distribution & Customer Service Environmental team found that Envirotemp FR3 fluid met or exceeded key mineral oil specifications, especially in flash and fire ratings. NB Power Distribution & Customer Service then applied to the New Brunswick Department of Energy and Local Government (NBDELG) for the use of FR3 fluid. NBDELG confirmed that FR3 fluid is not a hazardous material, is not toxic, is not regulated by the Petroleum Product Storage and Handling Regulation, and could be used in the Wellfield Protected Area. There was no change in installation procedures, design, or delivery. NB Power considers the FR3 fluid solution a breakthrough in meeting its environmental objectives, and has featured this success in its Annual Report to shareholders.

The Future.

Cooper Power Systems offers a dedicated line of Envirotran™ transformers, designed specifically to take advantage of FR3 fluid performance attributes. Cooper is actively educating engineers on the FM Global documented FR3 fluid fire resistance and IEEE® published transformer insulation life extension attributes. Using the life extension features of FR3 fluid, Cooper is also leading the industry in moving to a 75ºC temperature rise transformer design standard.

The legislative and regulatory landscape for transformer fluid has changed significantly in recent years to favor FR3 fluid. Cooper, with Cargill, is actively pursuing even more regulatory recognition and differentiation of vegetable oil-based FR3 fluid. In January 2005, Cooper and Cargill met with EPA representatives to continue the process for EPA differentiation between petroleum and vegetable oil-based dielectric coolants. Specifically, they met to raise the site oil volume thresholds requiring an SPCC plan and for reporting/remediation requirements for transformers which contain an EPA ETV biodegradable fluid. A similar focused effort will be applied to state regulations.

Clearly, there is growing support for Envirotemp FR3 fluid-filled transformers by soy boards, regulatory bodies, media, environmental advocates, and utilities themselves. As this momentum of differentiation, use, and publicity continues, more utilities and industries are choosing FR3 fluid-filled transformers as the right thing to do from several points of view: consistency with corporate environmental initiatives, positive media exposure, and reduction of equipment life-cycle costs. ■