



THE EVOLUTION OF SOYBEAN BASED TRANSFORMER OIL AT WAVERLY LIGHT AND POWER

The concept for a soybean based transformer oil for Waverly Light and Power (WLP) began in 1994 when a truck knocked down a bank of transformers in Waverly. An approximate 20 gallon spill of PCB contaminated mineral oil cost the utility \$30,000 in clean up costs. Ironically, the PCB transformer was only one of four PCB transformers left on the system at the time.

The spill inspired WLP General Manager, Glenn Cannon, to come up with the idea for a non-toxic transformer oil. Iowa is in a sea of soybeans and the University of Northern Iowa's Ag-Based Industrial Lubricants (ABIL) Research Program, located in Waverly, was doing research on industrial uses for soybean oil. Cannon and ABIL Director, Dr. Lou Honary, began exploration of dielectric fluid requirements and ABIL began researching oil variations.

The research process included laboratory tests conducted at the ABIL facility as well as field tests conducted in Waverly. The first soybean based transformers were retrofilled units and were put into service on the WLP distribution system in 1997.

"We went through several years observing their performance in the winter time and summer time and everything performed fine," Honary said. "Showing the actual application and use in the field helped bring a lot more confidence in the product."

These units are still in service; except the very first transformer which was given to Cargill, Inc. for display at its world headquarters in Minneapolis.

In December, 1999 the American Public Power Association's DEED Research and Development Program provided a grant to do more extensive research on the oil now called BioTrans™. The DEED study was completed and showed extremely promising results. Also in 1999, the first of five patents were issued for soybean and vegetable-based oils. In addition, a trademark was gained for BioTrans™. The fluid was non-toxic, non-flammable, readily biodegradable, and had passed the BEES (Building for Environmental and Economic Sustainability) test as an environmentally preferred oil by the National Institute of Standards and Technology, U.S. Department of Commerce.

In January 2001, the Tennessee Valley Authority's (TVA) Public Power Institute awarded WLP a \$20,000 contract to conduct a series of field tests. In 2002, Nashville Electric Service, Appalachian Electric Cooperative and Gibson EMC in Tennessee completed two year field demonstration tests. At that point BioTrans™ was being used in utilities from Alaska to South Carolina.

Also in 2002, Cargill, Inc. purchased the patents and trademark rights and began manufacturing BioTrans™ transformers in concert with ERMCO, Inc. As one of the world's leading producers of food-grade vegetable oils, Cargill's worldwide network of processing facilities allows for the product to be available in ample supply and closer to the customer, utilizing in-country oilseed-based resources. Royalty agreements remain for WLP.

In the early 1990's, Cooper Power Systems (CPS) of Houston began development of a vegetable based transformer oil. Cargill and CPS joined forces in 2004 to market, produce and distribute an environmentally preferred oil.

"It makes more sense if we could join forces with another company that had a much stronger position in the marketplace and still achieve our overall goals of developing the bio-based initiatives," said Luis del Valle, Cargill Global Marketing Director.

The alliance between CPS and Cargill was created to cost-efficiently produce and distribute Envirotemp® FR3™ fluid, a revolutionary insulating product that is safe for the environment and the public.

"There's a lot of interest in developing new markets for bio-based products to have three benefits: help the rural economy, reduce the dependence on foreign oil and help the environment," del Valle said.

Cooper Power Systems, a leading manufacturer of electrical distribution equipment, sold dozens of transformers with Envirotemp® FR3™ fluid in 1997 for customer beta testing. Utilities around the world are recognizing the advantages offered by this revolutionary fluid over traditional dielectric fluids (non-conductive fluids used to insulate and cool electrical distribution products such as transform-

ers), including added performance and environmental characteristics. Envirotemp® FR3™ fluid uses as its base food-grade vegetable oil.

Envirotemp® FR3™ fluid received the U.S. Environmental Protection Agency's (EPA) Environmental Technologies Verification, which confirmed its environmental attributes. But the EPA has not yet made any significant differentiation in the Spill Prevention, Control and Countermeasure (SPCC requirement) for non-edible oils versus edible oils.

"The EPA has expressed that they are studying the matter and they are considering possibly differentiating it in the future," said Patrick McShane, Cooper Power Systems Dielectric Fluids Product Line Manager. "We're actually looking beyond that. Envirotemp® FR3™ is not only an edible oil, but it's shown to be non-toxic and has an ultimate biodegradability rate, the highest per EPA definition or classification. Regulations aside, it's right for environmental stewardship."

Envirotemp® FR3™ fluid is non-toxic to trout fry according to testing per the guidelines developed by the Organization for Economic Cooperation and Development (OECD), a worldwide standard setting body.

Envirotemp® FR3™ fluid also enhances the performance and life of a utility's transformer assets. The fluid extends paper insulation life, lowering life cycle costs. The increased insulation life also translates to extended and enhanced transformer life or the ability to carry higher loads during peak demand periods without leading to premature insulation failure.

"Performance is a key component for transformers," McShane said. "The aging rate of transformer insulating paper improved five to eight times in our tests. That's another reason that it becomes a very viable interest in the industry."

The fluid also has excellent fire resistant qualities. Recognized testing laboratories, including Underwriters Laboratories (UL™), have listings allowing Envirotemp® FR3™ transformer installations outdoors and indoors, typically without costly fire protection devices.

Envirotemp® FR3™ fluid also creates a new market for soybeans, one of the largest grown crops in the U.S. According to del Valle, the price that farmers get for their soybeans is driven by supply and

demand, and right now the primary market for soybean oil is for use in food products.

"By going into industrial products like Envirotemp® FR3™ fluid, it creates a new demand stream that on average would tend to increase the price to the farmer," del Valle said. "The long-term effect on farmers should be positive."

So far the market for Envirotemp® FR3™ fluid has been encouraging. In fact, McShane said over the last three years, the demand for the fluid has doubled yearly.

"We're definitely on track to double it again in 2005," McShane said. "I'm projecting we'll double it again in 2006. With petroleum prices going through the roof, there will be more and more interest in renewable sources for transformer dielectric coolants than the hydrocarbon oils. The USDA Biobased Products Preferred Procurement Program will also drive up demand."



The market for Envirotemp® FR3™ fluid has expanded beyond North America. In February 2005, Cooper Power Systems and Cargill, Inc.

announced that the fluid will now be available to the European Union, South America, Central America, Australia, New Zealand and Korea. Del Valle is pleased to see the alliance expand globally.

"It is exciting in that it's a big market potential down the road," he said, "but right now we're really focusing on expanding the market in the U.S. and North America in general."

Cargill and Cooper Power Systems give credit to WLP for its role in the development of soybean based transformer oil market.

"Part of our success today and the volume of FR3™ fluid being sold today is directly related to what Waverly Light and Power started," del Valle said. "So their involvement was very critical."

Today WLP uses FR3™ fluid almost exclusively in its transformer applications for not only the environmental characteristics, but for its safety, lower life cycle costs and reduced usage of imported oil. WLP remains active in the promotion of FR3™ and is proud to be a part of the history of bringing soybean based transformer oils to market.