

The Next Step In The World Of Transformers



Envirotran™ Transformers Set Higher Environmental, Fire Safety and Performance Standards

Envirotran™ Transformers Advance the Evolution of Electrical Distribution Safety and Performance

Envirotran transformers signal the beginning of a new era in liquid-filled transformer design¹. They are the industry's first transformers to use an edible vegetable oil-based, high fire point dielectric coolant¹. This technological and environmental design breakthrough is the result of years of research and development in dielectric fluids and their use in transformers. Confirmed with extensive laboratory and field testing, Envirotran transformers are safer for the earth and its inhabitants. They have exceptional performance characteristics making them ideal for any indoor or outdoor installation.

Environmentally Desirable

Envirotran transformers are friendlier to the environment. While traditional liquid-filled transformers use mineral or synthetic oils, Envirotran transformers use the revolutionary vegetable oil-based dielectric coolant, Envirotemp® FR3™. Envirotemp FR3 is a unique dielectric coolant whose base oils come from a renewable natural resource—SEEDS. Specially formulated with performance-enhancing food-grade additives, this non-toxic, readily biodegradable insulating fluid is the



first truly **green** fluid. Because of its special formulation, Envirotemp FR3 fluid is not subject to the Federal Regulation of Used Oils. Instead it is covered by the Edible Oil Regulatory Reform Act—making Envirotran transformers a more favorable option when considering environmental risk—and regulations.

Envirotran transformers also provide a more favorable return when Total Environmental Life Cycle Cost Analysis is used to compare alternatives. They deliver all the inherent efficiencies of liquid-filled transformer design. Testing per ANSI/IEEE C57.100 shows that Envirotran transformers have a longer insulation system thermal life than even conventional oil-filled transformers. And finally, when the time arrives for decommissioning, virtually all the materials in these transformers can be easily and economically recycled or reclaimed.

Schools, parks and ecologically sensitive locations are just some of the applications that are benefiting from the positive environmental characteristics of Envirotran transformers.

The Envirotran transformer has already won several awards for environmental stewardship and product innovation.

¹ Patent US 6,037,537 US 6,184,459 B1
US 6,352,655 B1 US 6,398,986 B1

Safer in Any Environment



Enhanced Fire Safety

Not only are they safer for the environment, Envirotran transformers are safer for the people and buildings they serve. Based on electrical fire code regulations and nationally recognized testing laboratory certifications, Envirotran transformers can be installed indoors, and outdoors adjacent to buildings, walkways or on roof tops, typically without additional fire safety requirements. Envirotemp FR3, the fluid used in Envirotran transformers, has an exceptionally high fire point of 360°C (690°F). It has a fire point 200°C (392°F) higher than conventional mineral oil and 60°C higher than the minimum Code requirements for less-flammable liquids. This enables it to meet the requirements for recognition

as a fire safeguard by Section 15 of the National Electrical Safety Code (Accredited Standards Committee C2-1997) and also meet the 2002 National Electrical Code Section 450-23 requirements for use as a listed less-flammable liquid. This additional margin of safety makes Envirotran transformers ideal for commercial or industrial complexes, office buildings, institutions and other fire safety sensitive applications.

Easy Code Compliance and Verification Option

Now you can specify a “Code-Listed” transformer design, making National Electric Code® (NEC) Section 450-23, *Less-Flammable Liquid-Filled Transformer Requirements* compliance verification easier.

When you specify the Code-Listed FM Approved Envirotran transformer, you choose a practical and more dependable solution. Typically, there is no need for a fire vault, automatic sprinklers, or special clearances. The “FM Approved” transformer designs come with a special nameplate listing the transformer’s protective devices and other compliance requirements, so the on-site inspector can easily and quickly verify code compliance for both indoor and outdoor installations. For additional information on Code compliance, request the NEC/NESC Requirements Guideline, Cooper Power Systems, Bulletin 92046.



Envirotran transformers will serve Miller Park—Home of the Milwaukee Brewers National League Baseball Team.

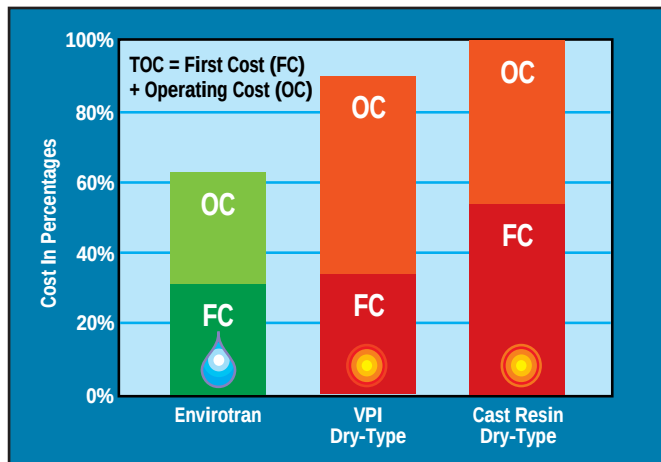


Superior Liquid-Filled Performance and Value

Higher Performance Lower Total Owning Cost

Envirotran transformers provide all the inherent advantages of liquid-filled transformers when compared to dry and cast resin types, including higher overload capacity, higher efficiencies, cooler and quieter operation, sealed construction, and longer life. Envirotran transformers also have a lower Total Life Cycle Cost and Total Owning Cost. Liquid-filled transformers typically are lower in initial price and are less expensive to install than open dry types with comparable ratings and features, and are much lower when compared to cast resin types. They also require less room than comparable dry-type transformers.

Typical Transformer Total Owning Cost Comparison



As with all liquid-filled transformers that comply with ANSI/IEEE C57 standards, Envirotran transformers can also tolerate greater overloads for much longer periods than dry types, without abnormal loss of insulation life.

With higher efficiencies and lower standard operating losses, liquid-filled transformers save substantial energy when compared to the standard dry-type design. They also run much quieter and cooler. In contrast, dry types have a much higher standard noise level, and generate excessive heat that adds a costly burden to air conditioning systems.

Envirotran transformers can be readily repaired if needed. If repairing them is not an option, they can be easily recycled and still provide a return on the initial investment. This is not the case with cast resin dry types.

Typically, liquid-filled transformers reliably operate for decades, so the investment and the savings are amortized over many more years than dry-type designs. When the cost-saving features inherent to liquid-filled designs are added to the environmental and fire safety benefits provided by Envirotran transformers, they become the clear economic choice over silicone, dry and cast resin type transformers.

Insulating Medium Relative Performance Characteristics

Characteristic	Envirotemp FR3 Fluid	R-Temp Fluid	Mineral Oil	Silicone Oil	Dry/Cast Resin
Efficiency	Good	Good	Good	Good	Poor
Noise Level	Good	Good	Good	Good	Poor
Insulation Life	Excellent	Good	Good	Good	Fair
Recyclability	Excellent	Good	Good	Fair	Poor
Fire Safety Record	Excellent	Excellent	Poor	Good	Good
Fault Detection Capability (DGA)	Good	Good	Good	Fair	Poor
Natural Resource Conservation	Excellent	Fair	Fair	Fair	Poor
Biodegradability	Excellent	Good	Good	Poor	Poor
Differentiable Per Edible Oil Act	Yes	No	No	No	N/A

Field-Proven

The Envirotran transformer design and its dielectric coolant, Envirotemp FR3, have undergone one of the most thorough and lengthy research and development processes ever undertaken by Cooper Power Systems. Years of careful material selection and small-scale tests were followed by years of full scale testing per the "Lockie Method" (ANSI/IEEE C57.100 Test Procedure for Thermal Evaluation of Oil Immersed Distribution Transformers) as well as additional demanding variations of the method. Upon the successful performance of the thermal evaluation tests, extensive field installation trials were initiated in 1996. Units in all configurations have been installed across North America (overhead, pad-mounted, and substation type) from the Southeast to the Pacific Northwest. All are performing flawlessly.

The Right Transformer for Severe Harmonics

For systems with problems caused by severe non-linear loads, an Envirotran K-Plus™ transformer can be designed to meet specific harmonic load level ranges. Because of their inherently superior overload capability, Envirotran K-Plus transformers can withstand harmonic levels that exceed the specified load range without suffering insulation damage. K-rated dry-type transformers, in contrast, can suffer irreparable damage or failure if harmonic levels exceed specified load level ranges.

Filled with the Exceptional Dielectric Fluid, Envirotemp® FR3™

Edible Oil Sets New Standard

Formulated from edible vegetable oils, combined with food-grade performance enhancing additives, Envirotemp FR3 fluid sets a new standard for an environmentally desirable dielectric coolant. The edible oils come from a renewable resource—commodity seeds—and are easily recyclable and reusable. Biodegradation tests show that Envirotemp FR3 fluid quickly and thoroughly biodegrades. Final breakdown products are simply carbon dioxide and water. The fluid does not bio-accumulate and is non-toxic to animals. It replaces non-renewable petroleum and synthetic oils for a more earth-friendly installation.

Because Envirotemp FR3 is formulated from food-grade oils and additives, it is not subject to the *Federal Regulation of Used Oils (Title 40, No. 279)*. It is instead covered by the *Edible Oil Regulatory Reform Act (Public Law 104-55, 1995)*, and therefore eligible for current and future regulatory relief. The option of alternative spill response procedures, such as natural bioremediation, becomes more viable because the fluid's viscosity and polymerization rate at normal ambient temperatures impede surface and subsurface migration. In addition, fluid accumulation over time is a much smaller probability as a result of the favorable biodegradation and non-toxic properties of the fluid.

Comparison of Transformer Dielectric Fluids—Typical Values

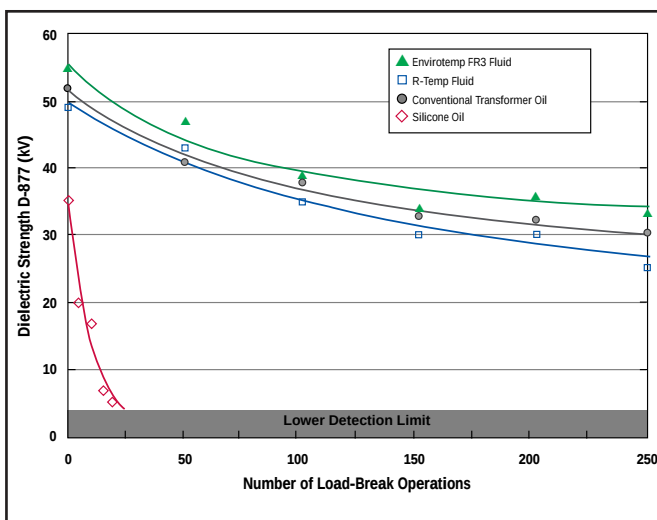
	Envirotemp FR3 Fluid	R-Temp Fluid	Mineral Oil	Silicone Oil
Electrical				
Dielectric Strength (kV) ASTM D877	56	56	45	40
Physical				
Viscosity (cSt) 40°C - ASTM D445	33	120	9.2	39
100°C - ASTM D445	8.0	12	2.3	17
Flash Point (°C) - ASTM D92	330	276	147	300
Fire Point (°C) - ASTM D92	360	312	165	343
Specific Heat (cal/gm/°C) ASTM D2766	0.45	0.46	0.39	0.36
Pour Point (°C) - ASTM D97	-21	-21	-50	-55
Specific Gravity - ASTM D1298	0.92	0.87	0.87	0.96
Environmental				
Biochemical Oxygen Demand (ppm) - 5-Day SM5210B	> 200	6.3	< 6	0
BOD/COD Ratio (%)	45	17	7	0
Biodegradation Rate (%) 21-day CEC-L-33	> 99.0	27.1	25.2	0.0

Unmatched Safety and Performance

Envirotemp FR3 fluid also has superior fire-resistant properties. With an exceptionally high fire point of 360°C and a flash point of 330°C, it provides enhanced fire safety. It is Classified by Underwriters Laboratories and Approved by Factory Mutual for use in both indoor and outdoor installations. It also meets all the listing requirements as a less-flammable transformer fluid per NEC Article 450-23.

Envirotemp FR3 dielectric coolant has better dielectric withstand than conventional transformer oil. The fluid's cooling performance is superior to other high fire point fluids. It has cold start capabilities tested to -30°C. Load-break switching tests using Envirotemp FR3 fluid prove that a higher dielectric strength is maintained compared to switching in other dielectric coolants. So you can select in-tank load-break switches and fuses in your transformer design with complete assurance of long life expectancy.

Fluid Load-Break Dielectric Strength Retention Comparison



Its compatibility with conventional transformer construction materials is excellent, helping to assure long, trouble-free service life. Envirotemp FR3 fluid demonstrates excellent stability over time in normal transformer operation. It has exhibited no measurable change in viscosity over exhaustive testing cycles, and has not produced any visible sludging in accelerated aging tests. The fluid has superior water absorption characteristics, helping to draw out retained moisture, and the moisture generated by insulation paper degradation. It chemically helps prevent the paper fibers from severing when exposed to heat. These attributes enable the fluid to significantly reduce the aging rate of transformer paper, and consequently helps extend transformer insulation life.

How to Specify

Transformers shall be Cooper Power Systems Envirotran, designed in accordance with the requirements of ANSI/IEEE C57.12.00. Insulating fluid shall be comprised of edible vegetable oils and food grade performance enhancing additives. The fluid shall be non-toxic, non-bioaccumulating and be readily and completely biodegradable per EPA OPPTS 835.3100. It shall result in zero mortality when tested on juvenile trout per OECD G.L. 203. It shall not require oils derived from genetically altered seeds. The fluid shall have a minimum open cup fire point (ASTM D92) of 350°C and be FM Approved, UL Classified less-flammable Envirotemp FR3, all in accordance with current NEC Section 450-23. The fluid shall be tested and verified by the US EPA through the Environmental Technology Verification Program.

Product Scope

Single- and Three-Phase Overhead, Pad-Mounted and Substation Class: 5 to 10,000 kVA
Primary Voltage: Through 46 kV Classes, 250 kV BIL
Secondary Voltage: Through 15 kV, 95 kV BIL

Envirotran K-Plus

K-Factor (F_{HL}) Ratings: K4, K9, K13, K20



Envirotran Transformers

- Friendlier to the Environment
- Safer for People and Buildings
- Superior Liquid-Filled Performance & Value
- Field Proven Experience
- "Code Listed & Labeled" Option
- Filled with the Exceptional Dielectric Fluid, Envirotemp FR3:
 - Edible Vegetable Oil-Based
 - Readily and Completely Biodegradable
 - Exceptionally High Fire Point
 - Classified by UL® and Approved by FM
 - Improved Insulation Life Expectancy
 - US EPA Environmental Technology Verification Program



Award Winning

- Wisconsin Environmental Working Group: 1998 Business Friend of the Environment
- *Plant Engineering*: 1998 Product of the Year
- Cooper Industries: 1998 Environmental Excellence Award
- 2000 Governor's New Product Award and Spirit of Ecology Award



You Can Count On Cooper Power Systems Down The Line.

COOPER Power Systems