September 6, 2023

VIA FEDERAL EXPRESS
AND ELECTRONIC MAIL
Ms. Melanie A. Bachman, Esq., Executive Director
Connecticut Siting Council
Ten Franklin Square
New Britain, CT 06051

Re: **PETITION NO. 1580** – CT Solar PDF, LLC petition for a declaratory ruling, pursuant to Connecticut General Statutes §4-176 and §16-50k, for the proposed construction, maintenance and operation of a 1.45-megawatt AC solar photovoltaic electric generating facility located at two parcels on the Medtronic campus at 86 Quinnipiac Avenue and 195 McDermott Road, North Haven, Connecticut, and associated electrical interconnection.

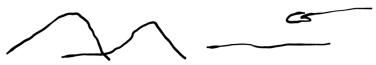
Dear Attorney Bachman:

On behalf of CT Solar PDF LLC ("Petitioner"), please accept the enclosed responses to the second set of interrogatories provided by the Connecticut Siting Council ("Council") on August 30, 2023.

Consistent with Council requirements, Petitioner submits one electronic version, an original, and fifteen hard copies of all necessary documents.

Please do not hesitate to contact me with any questions.

Sincerely,



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STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

IN RE:	:	
	:	
PETITION FOR A DECLARATORY RULING, PURSUANT TO CONNECT GENERAL STATUTES, §4-176 AND §16-50k, FOR THE PROPOSED CONSTRUCTION, MAINTENANCE AND OPERATION OF A 1.45-MEGAWATT AC SOLAR PHOTOVOLTAIC ELECTRIC GENERATING FACILITY LOCATED AT TWO PARCELS ON THE MEDTRONIC CAMPUS AT 86 QUINNIPIAC AVENUE AND 195 MCDERMOTT ROAD, NORTH HAVEN, CONNECTICUT, AND ASSOCIATED INTERCONNECTION.	:	PETITION NO. 1580
	:	SEPTEMBER 6, 2023

RESPONSES OF CT SOLAR PDF LLC TO CONNECTICUT SITING COUNCIL INTERROGATORIES

On August 30, 2023, the Connecticut Siting Council ("Council") issued a second set of Interrogatories to CT Solar PDF LLC, relating to Petition No. 1580. Below are Petitioner's responses.

46. **What is the number of panels and energy output for each of the three array areas?**

RESPONSE: The number of panels and energy output for each of the three array areas are as follows:

Roof-mount array: 2,100 panels with an energy output of 1,177,165 kilowatt-hours/year.
Ground-mount array: 396 panels with an energy output of 292,966 kilowatt-hours/year.
Canopy array: 1,508 panels with an energy output of 1,021,570 kilowatt-hours/year.

47. **Referring to interrogatory response 13, is the entire 1.45 MW AC Project energy output subject to the LREC contract? If not, what portion is included within the contract?**

    RESPONSE: Yes, the entire 1.45 MW AC Project energy output is subject to the LREC contract.

48. **Referring to the canopy site plan provided in interrogatory response 19-Exhibit B, would the optional snow guards be included in the final design?**

    RESPONSE: The optional snow guards in the canopy site plan are not planned for the final design at this time.

49. **How many acres comprise the 86 Quinnipiac Avenue parcel? How many acres comprise the 195 McDermott Road parcel?**

    RESPONSE: The 86 Quinnipiac Avenue parcel is comprised of approximately 7.55 acres. The 195 McDermott Road parcel is comprised of approximately 31.34 Acres.

50. **Referring to interrogatory response 31, approximately how many gallons of FR3 oil are contained within the transformer? If a leak occurred, is excavation of soil/remediation required?**

    RESPONSE: The Project will have two transformers. One of the transformers will contain approximately 270 gallons of FR3 oil. The second transformer will contain approximately 350 gallons of FR3 oil.

    The facility's data acquisition system will monitor a pressure gauge on the transformers and will be alerted of an FR3 oil leak. If a leak occurred, bio-based remediation procedures are recommended rather than soil excavation. Cargill Incorporated, the producer of FR3 oil, recommends "accelerating the bioremediation process by spreading active yeast over a spill site and adding water to activate the micro-organisms contained in the yeast. The microorganisms will consume the FR3 fluid, thereby effectively removing it from the environment…". See Appendix A for a data sheet on FR3 oil and Appendix B for Cargill's recommended spill cleanup procedures.

EXHIBIT A: FR3 OIL DATA SHEET

FR3® fluid: Acceptable delivery specifications

Electrical Apparatus
R2000

DESCRIPTION

Cargill FR3® fluid is a renewable, biobased natural ester dielectric coolant for use in distribution and power class transformers where its unique fire safety, environmental, electrical, and chemical properties are advantageous. Acceptance limits for new fluid are shown in Table 1. More than 20 years of field experience - with more than two million FR3 fluid filled transformers in service - confirms excellent performance.

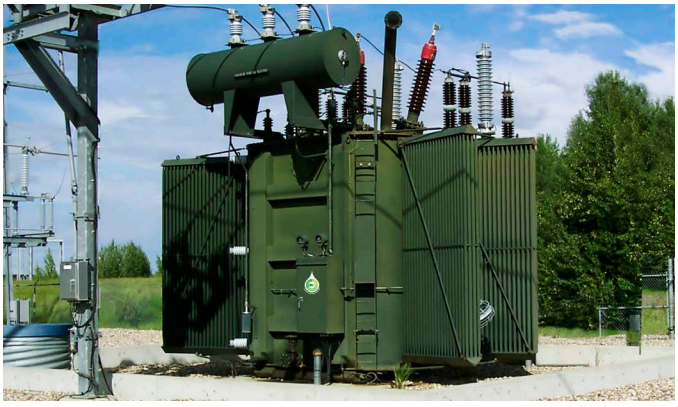
FR3 fluid is formulated from seed oils and performance enhancing additives. It does not contain petroleum, halogens, silicones or corrosive sulfur. It quickly and thoroughly biodegrades[1] in the environment. The fluid is non-toxic in acute aquatic[2] and oral toxicity tests[3].The Color Green tint reflects its favorable environmental profile (See Table 2) and readily distinguishes it from petroleum based oils.

FR3 fluid has exceptionally high flash/fire points of approximately 330/360 °C - the highest ignition resistance of any high fire point dielectric fluid currently available. It qualifies as a “high-fire-point,” “less-flammable,” “IEC Class K,” and “non-propagating” fluid. FR3 fluid is Approved[4] by FM Global and Classified[5] by Underwriters Laboratories as a Less-Flammable Dielectric Liquid for use in complying with the National Electric Code[6] (NEC) and insurance listing requirements[7].

FR3 fluid is compatible with standard transformer construction materials and components. FR3 fluid should be stored, handled, and processed in a similar meticulous manner as transformer mineral oil. See Cargill’s FR3 Fluid Storage and Handling Guide, S10, for additional information.

A transformer filled with FR3 fluid complies with the transformer temperature operating range requirements defined in IEEE C57.12.00 and IEC 60076-2.

In addition to new distribution and power class transformers, a variety of other equipment, including voltage regulators, sectionalizing switches, transformer rectifiers, and electromagnets use FR3 fluid. The fluid is also used in retrofill applications for transformers and other fluid-filled distribution and power equipment.



Acceptable limits for receipt of shipments of Cargill FR3 fluid

Table 1
FR3 Fluid Acceptance Limits

	Standard test methods		ASTM D6871/IEEE C57.147	IEC 62770	FR3 fluid
PROPERTY	**ASTM**	**ISO/IEC**	**As-received new fluid property requirements**	**Unused new fluid property requirements**	**TYPICAL**
Physical					
Color	D1500	ISO 2211	≤1.0	–	0.5
Flash Point PMCC (°C)	D93	ISO 2719	–	≥250	260-270
Flash Point COC (°C)	D92	ISO 2592	≥275	–	320-330
Fire Point (°C)	D92	ISO 2592	≥300	>300	350-360
Pour Point (°C)	D97	ISO 3016	<-10	≤-10	-18 to -21
Density at 20°C (g/cm³)	–	ISO 3675	–	≤1.0	0.92
Relative Density (Specific Gravity) 15°C	D1298	–	≤0.96	–	0.92
Viscosity (mm²/sec)	D445	ISO 3104			
100°C			≤15	≤15	7.7 - 8.3
40°C			≤50	≤50	32 - 34
0°C			≤500	–	190
-20°C					650*
Visual Examination	D1524	IEC 62770 4.2.1	bright and clear	clear, free from sediment and suspended matter	clear, light green
Biodegradation	OECD 301B		readily biodegradable	readily biodegradable	readily biodegradable
Aquatic and Oral Acute Toxicity	OECD 202, 203, OECD 420		non-toxic	non-toxic	non-toxic
Electrical					
Dielectric Breakdown (kV)	D877	–	≥30	–	>45
Dielectric Breakdown (kV)					
2mm gap	D1816	–	≥35	–	60-70
2.5mm gap	–	IEC 60156	–	≥35	70-80
Dielectric Breakdown under Impulse (kV) 25.4mm gap	D3300		>130		140
Gassing Tendency (µl/min)	D2300	–	≤0	–	-79
Dissipation Factor					
25°C (%)	D924	–	≤0.20	–	0.010 - 0.15
90°C (tan δ)	–	IEC 60247	–	≤0.05	0.01 - 0.03
100°C (%)	D924	–	≤4.0	–	1.00 - 3.85
Chemical					
Corrosive Sulfur	D1275	IEC 62697	non-corrosive	non-corrosive	non-corrosive
Water Content (mg/kg)	D1533	IEC 60814	≤200	≤200	4 - 50
Acid Number (mg KOH/g)	D974	IEC 62021.3	≤0.06	≤0.06	0.01 - 0.05
PCB Content (mg/kg)	D4059	IEC 61619	not detectable	free from PCBs	not detectable
Total Additives	–	IEC 60666	–	Max weight fraction 5%	<2%
Oxidation Stability (48 hrs, 120°C)	–	IEC 61125 IEC 62770			
Total Acidity (mg KOH/g)	–	IEC 62621.3	–	≤0.6	0.1 - 0.3
Viscosity at 40°C (mm²/sec)	–	ISO 3104	–	≤30% increase over initial	17% - 23% increase
Dissipation Factor at 90°C (tan δ)	–	IEC 60247	–	≤ 0.5	0.1
Oxidation Induction Time 130°C/500psi (min)	D6186**				62±2 min

Measurement of viscosity near pour point may be inaccurate.
****A more specific version of the test indicated by ASTM D6186 is under development.***

NOTE: Specifications should be written referencing only the defined ASTM or IEC industry standard acceptance values and test methods. The listed 'typical' values are average values summarized from a significant number of data points over many years; they are not to be identified as acceptance values.

ASTM D6871 Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus. IEC 62770: Fluids for electrotechnical applications – Unused natural esters liquids for transformers and similar electrical equipment. A transformer filled with FR3 fluid complies with the transformer temperature operating range requirements defined in IEEE C57.12.00 and IEC 60076-1.

Table 2
FR3 fluid's environmental attributes

Attribute	Results	Method
Readily Biodegradation	Readily	EPA OPPTS 835.3110 or OECD 301B, C or F
Biodegradation	>99%	Comprehensive analysis[8]
Acute Aquatic Toxicity	Non-toxic	OECD 203
Acute Oral Toxicity	Non-toxic	OECD 420
Biobased Material Content	>95%	USDA Biopreferred Program
Total Life Cycle Carbon Footprint	Carbon Neutral	Department of Commerce NIST BEES V4.0
Overall Environmental Impact	1/4 impact of mineral oil	Department of Commerce NIST BEES V4.0

ENVIRONMENTAL AND HEALTH

FR3 fluid is specifically formulated to help minimize health and environmental risks. The base oils come from renewable resources - commodity seeds - and are recyclable and reusable.

The US and California Environmental Protection Agencies published CARGILL FR3 fluid's Environmental Technology Verification Report in 2003. The verification process includes biodegradation and toxicity testing. Results from the aquatic biodegradation test confirm that FR3 fluid's rate of biodegradation is the same as that of the standard reference material. FR3 fluid meets the "ultimately biodegradable" criteria (Figure 1). When tested for acute oral toxicity, FR3 fluid is not toxic.

The Edible Oil Regulatory Reform Act (US Public Law 104-55, 1995) makes FR3 fluid eligible for current and future regulatory relief. The options of alternative spill response procedures, such as bio-based remediation, are now available. The fluid's inherent viscosity and tendency of thin layers to polymerize help prevent migration along the surface and into subsurface soils.

The EPA, Occupational Safety & Health Administration (OSHA), and the Department of Transportation (DOT) do not list Cargill FR3 fluid as hazardous. Its Hazardous Material Information System (HMIS) rating is 1 for both health and reactivity. FR3 fluid is not classified as bio-accumulating or mutagenic. It is not listed as a carcinogen by National Toxicology Program (NTP), in International Agency for Research on Cancer (IARC) monographs, or by OSHA Regulation. The products of complete combustion of FR3 fluid are essentially carbon dioxide and water.

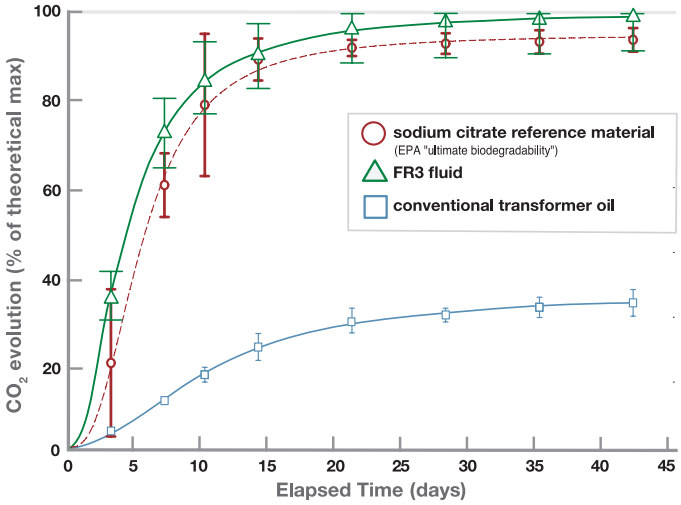


Figure 1
Aerobic Aquatic Biodegradation Graph EPA Test OPPTS 835.3100

SUSTAINABILITY

Building for Environmental and Economic Sustainability (BEES) software[9], available from the National Institute of Standards and Technology, uses a life-cycle assessment approach, analyzing raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management, to determine a product's global warming potential.

Table 3 shows the BEES amounts of greenhouse gas generated from raw materials through end of life for mineral oil and FR3 fluid. The cost of mineral oil, in terms of carbon emissions, is expensive. Meanwhile, FR3 fluid is relatively inexpensive, about 8.2 lb/gal less green house gas emitted to produce it. Additionally, the study reports that FR3 fluid's overall environmental performance impact score is 1/4th that reported for mineral oil (and that's without consideration for FR3 fluid's transformer insulation life extending properties). This cumulative score results from adding the impacts of water intake, smog, ozone depletion, indoor air, human health, habitat alteration, global warming, fossil fuel depletion, eutrophication, ecological toxicity, critical air pollutants, and acidification.

FR3 fluid, and transformers filled with FR3 fluid are listed in the US Federal BioPreferred℠ Products Program, making them readily identifiable as BioPreferred to all applicable Federal agencies. FR3 fluid is an excellent option for ISO 14000, Green Build, and other similar environmental programs that promote the use of alternative, environmentally preferable and sustainable materials and procedures.

Table 3
Greenhouse gases[a] attributed to transformer fluid for its complete life cycle.

	Grams Per Unit[b]		Tons Per 1000 Gallons	
Category	Mineral oil	FR3 fluid	Mineral oil	FR3 fluid
Raw materials	1,048,184	-381,590	2.306	-0.839
Manufacturing	544,363	160,212	1.198	0.352
Transportation	122,478	71,498	0.269	0.157
Use	154,124	153,450	0.339	0.338
End of life	30,825	30,690	0.068	0.068
Total	1,899,973	34,260	4.180	0.075

a carbon dioxide equivalents
b In BEES 4.0e, one unit is a 1000 kVA transformer containing 500 gallons of fluid

FIRE SAFETY

FR3 fluid has a fire point of approximately 360°C, well above the minimum of 300°C required for high fire point fluid classifications. Its flash point (approximately 330°C) is higher than the fire point of most other ignition resistant dielectric fluids in use today (Figure 2).

In laboratory and full-scale ignition tests, FR3 fluid has demonstrated greater fire resistance than other dielectric fluid types. Based on large-scale arc ignition testing, FM Global concluded that the probability of a pool fire evolving from FR3 fluid was so low that a heat release rate need not be determined or considered for FM Global approval.

Based on large-scale arc ignition and hot metal ignition tests, FM Global recognizes FR3 fluid as an equivalent safeguard to space separation, fire barriers, and fire suppression systems for most installations.

FM Global recognizes FR3 fluid as a component of Approved transformers per FM Global Standard 3990. When used in transformers containing 10,000 gallons of fluid or less, transformers' separation distance to buildings and other equipment may be up to 1/10th the distance required for mineral oil filled transformers, without fire walls or deluge systems.

OSHA recognizes this FM Global standard as fitting the definition of a Listed and Labeled Product per NEC Section 110-3(b). The standard permits FR3 fluid-filled transformers to be installed indoors, typically without sprinklers or vaults, with a minimum clearance to walls of just 3 feet (0.9m).

UL Standard 340 compares the fire hazard ratings of various fluids. Figure 3 shows the favorable rating assigned to FR3 fluid.

There are no known reports of dielectric pool fires involving FR3 fluid filled transformers.

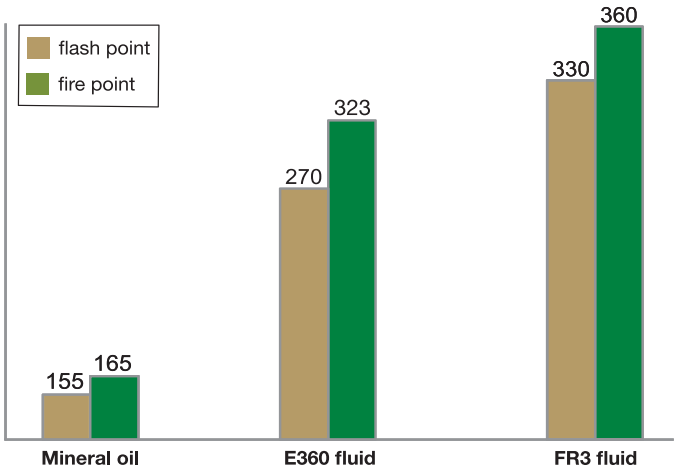


Figure 2
Flash & Fire Point of Dielectric Fluids (°C).

MEETING THE CODES

Less-Flammable fluids are recognized as a fire safeguard in Section 15 of the National Electrical Safety Code (Accredited Standards Committee C2) for generation and distribution substations. Cargill FR3 fluid meets the National Electrical Code Section 450-23 requirements as a listed less-flammable liquid. It is covered by OSHA Article §1910.305, Section 5(v).

FR3 fluid is FM Global Approved and Underwriters Laboratories Classified "Less-Flammable" per NEC Article 450-23, fitting the definition of a Listed Product per NEC. For additional information, request Cargill's NEC Requirement Guidelines 2008 Code Options for the Installation of Listed Less-Flammable Liquid Filled Transformers.

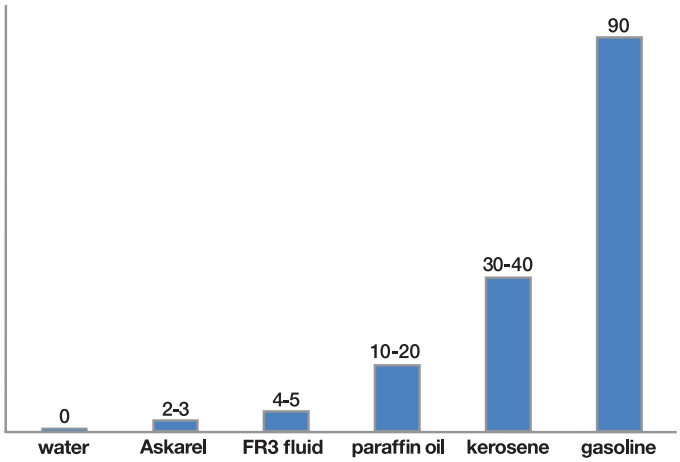


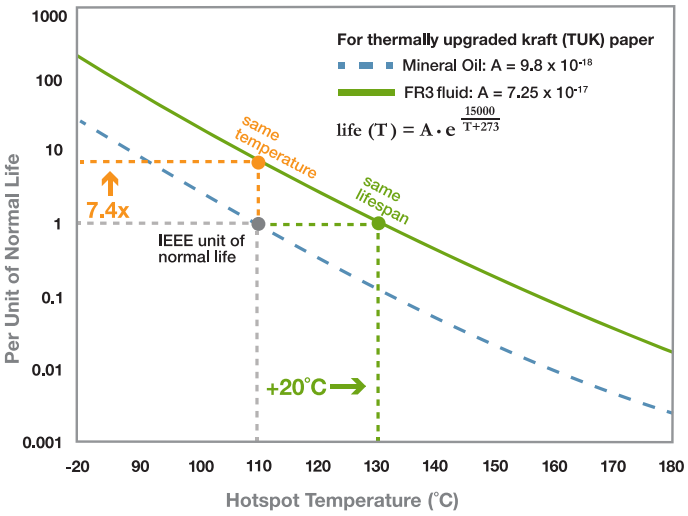
Figure 3
Fire Hazard Rating UL Standard 340.

FLUID/PAPER INSULATION SYSTEM

The unique chemical structure of Cargill FR3 fluid provides superior insulation system performance compared to other types of dielectric fluids. The thermal properties of FR3 fluid make it a more efficient coolant than higher molecular weight silicone and hydrocarbon dielectric coolants.

FR3 fluid has an exceptional ability to remove water generated by aging paper. This enables the fluid to significantly reduce the aging rate of transformer insulating paper. Per IEEE C57.100, accelerated aging tests show that Thermally Upgraded Paper (TUK) paper insulation aged in FR3 fluid takes 5-8 times longer to reach the same end-of-life points as TUK paper insulation aged in conventional mineral oil.

Table 4
Arrhenius curve for thermally upgraded kraft paper immersed in mineral oil and in natural ester liquids.



The chart presented in Table 4 brings the Arrhenius curves for TUK paper both immersed in mineral oil and in FR3 fluid, as in Annex B of IEEE C57.154 or in Annex C IEC 60076-14. The degradation rate of thermally upgraded kraft paper immersed in FR3 fluid is either reduced by 7.4x or the temperature can be increased by 20°C. Any balance in between leads to relevant benefits, including:

- Higher thermal class of cellulose insulation allows increasing average winding and hotspot temperature limits without sacrificing paper ife.
- Higher thermal class of liquid insulation allows increasing average winding and hotspot temperature limits without sacrificing paper life.
- Improved transformer reliability as, in a sealed unit, moisture content remains relatively constant through the years, preserving the dielectric capacity.
- No transformer outages from drying the insulation
- Extended capability and lifespan

APPLICATIONS

New Transformers

Distribution and Power class transformers filled with FR3 fluid for indoor, submersible and outdoor applications are available from manufacturers worldwide.

For indoor applications, FR3 fluid-filled transformers provide the proven technical and performance advantages of liquid-filled designs over dry types as well as a lower total life cycle cost when compared to all other transformer types.

Many types of FR3 fluid-filled transformers are in service: polemounted, pad-mounted, networks, reactors, small, medium and large substations, transmission substations, and generator step-ups. FR3 fluid-filled transformers are accepted in both industry and government. Contact Cargill for a copy of the FR3 Fluid User's List, Bulletin B110.

Retrofilling Transformers

FR3 fluid is especially suited for upgrading the environmental and fire safety of mineral oil-filled transformers. It is miscible with mineral oil, high molecular weight hydrocarbons and other ester fluids. FR3 fluid is not miscible with silicone and should not be applied in transformers previously containing silicone. FR3 fluid can also be used in PCB (Askarel) replacement initiatives.

Additional advantages of retrofilling with FR3 fluid include high dielectric strength, better match of dielectric constant to Kraft paper insulation, excellent lubricity, material compatibility, and a coefficient of expansion similar to conventional transformer oil. FR3 fluid has superior resistance to coking and sludge formation when compared to conventional transformer oil. In addition to passing the Power Factor Valued Oxidation (PFVO) test, Doble Laboratories' Sludge-Free Life tests resulted in no measurable sludge. The fluid also acts as a drying agent for transformer insulation that has become wet from aging, extending the useful life of the transformer insulation system.

Switching Devices

With excellent dielectric strength retention (Figure 5), lubricity, and gassing tendencies, FR3 fluid is an excellent switching medium at normal operating temperatures. Proven applications include new and retrofilled sectionalizing switches and transformers with load break accessories such as Bay-O-Net and current-limiting fusing, on-off and four position switches, and Vacuum Fault Interruption protection devices.

Accelerated life tests confirm stationary contacts are most stable in FR3 fluid[10]. In coking tests, FR3 fluid produced less than 1/20th of the deposits that were produced in conventional mineral oil.

Due to the low temperature viscosity difference of FR3 fluid compared to conventional transformer oil, the equipment manufacturer should verify applications at low ambient temperatures.

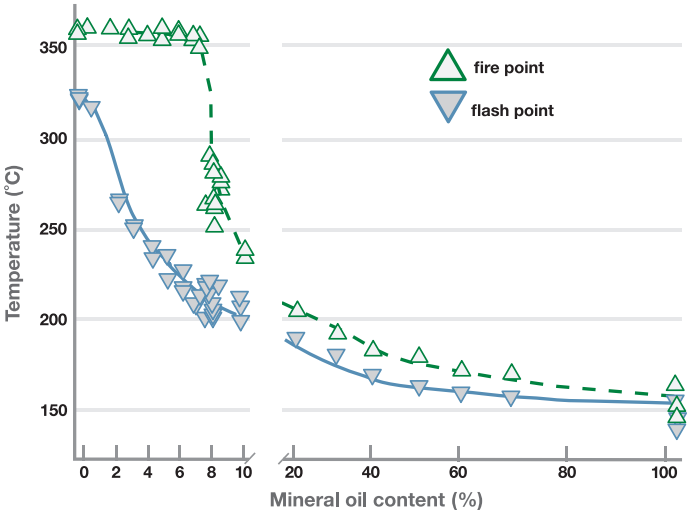


Figure 4
FR3 fluid Flash & Fire Point Variation with Conventional Transformer Oil Content.

Other applications

The inherent safety and performance properties of FR3 fluid have led to its application in electrical equipment other than transformers, including industrial electromagnets, superconducting motors, klystron modulators, transformer/rectifier sets, and heat transfer applications. FR3 fluid has excellent lubricity, an important characteristic for application in equipment with moving parts. High voltage bushing applications also appear promising due to the fluid's excellent ability to minimize insulating paper degradation and its low gassing tendency value of approximately -79 µl/min.

NOTE: *The suitability of each application of FR3 fluid is the responsibility of the user. Contact Cargill for application guidelines.*

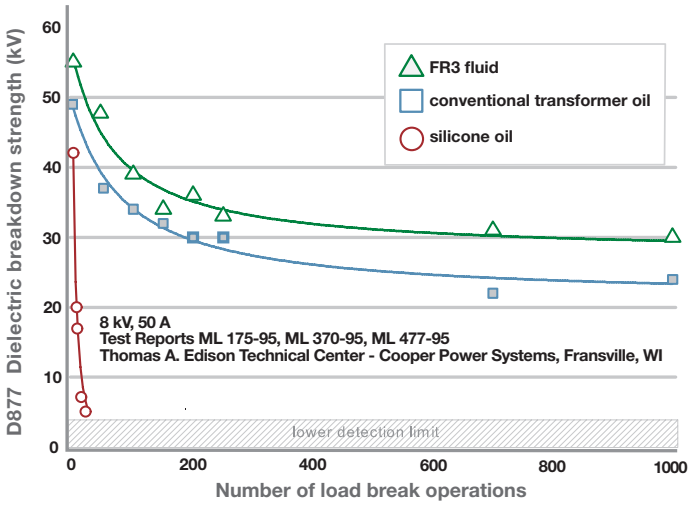


Figure 5
Fluid loadbreak dielectric strength retention comparison.

STORAGE AND HANDLING

Similar meticulous procedures for storing and handling conventional transformer mineral oil should be followed with FR3 fluid. To help maintain the extremely low percent moisture saturation at time of fluid manufacture, exposure time to air should be minimized. Drum and tote storage should be indoors or outdoors protected from the elements, including sunlight. Refer to the Cargill FR3 Fluid Storage and Handling Guide S10.

Figure 6
Prior to shipment, FR3 fluid undergoes extensive quality assurance testing. The facilities producing FR3 fluid are ISO 9001 Certified.

NOTE: *To maintain the optimal fluid properties for its intended use as an electrical insulating fluid, exposure to oxygen, moisture, and other contaminants must be minimized. Except for short storage periods, material that has been immersed in FR3 fluid should not be exposed to air. Thin films of natural esters tend to polymerize much faster than conventional transformer oil. For equipment drained of FR3 fluid, it is recommended that the equipment be placed in an inert gas environment, be re-immersed in fluid, or rinsed with mineral oil. Where the transformer power factor is a concern, hot air drying is an unacceptable process for assemblies already impregnated with a natural ester fluid. For impregnated assemblies that require additional drying, method of drying that does not expose the impregnated insulation to air is required to avoid excessive oxidation of the dielectric fluid.*

FLUID MAINTENANCE

Periodic preventive maintenance tests for FR3 fluid-filled equipment should follow the same schedule used for transformers filled with conventional transformer oil. Key tests on fluid samples include:

1. Dielectric Strength: The IEEE C57.147 minimum acceptable ASTM D1816, 2mm gap limits for continued use of service-aged FR3 fluid are 40 kV (≤ 69 kV), 47 kV (69 ≤ kV < 230), and 50 kV (≥ 230 kV).

2. Flash Point and Fire Point. Small amounts of mineral oil will not significantly reduce the fire point of FR3 fluid. Contamination above 7% may lower the fire point below 300°C. If contamination is suspected the flash and fire points should be measured.

3. Dissolved gas analysis of FR3 fluid is particularly useful for high value equipment or equipment servicing critical loads.

4. Color and appearance, dissipation factor, acid number, resistivity, viscosity, and interfacial tension are indicators of possible fluid contamination or unusual degradation.

For fluid that cannot be reconditioned, disposal options include selling to lube oil recyclers, rendering companies, or providers of fuel for industrial boilers and furnaces. Used fluid uncontaminated by controlled hazardous materials does not fall under the jurisdiction of the Federal Used Oil Regulation (CFR Title 40 Part 279).

FUNCTIONAL SPECIFICATION FOR NEW CARGILL FR3 NATURAL ESTER LESS-FLAMMABLE TRANSFORMER DIELECTRIC COOLANT

1.0 Scope

1.1. This specification describes a non-toxic (in acute aquatic[11], and oral toxicity[12] tests), biodegradable[13], fire resistant, bio-based[14] natural ester dielectric fluid. It is intended for use in electrical equipment as an environmentally preferred, less flammable insulating and cooling medium.

2.0 Requirements

2.1 Fluid Manufacturer

Fluid manufacturer shall have a minimum of ten (10) years experience producing and testing dielectric coolants. Manufacturer upon request shall provide AC withstand and impulse withstand for both gap and creep from 3mm to 150mm.

2.2 Dielectric Coolant

The dielectric coolant shall be a biobased biodegradable, be FM Global Approved, UL® Classified as a less-flammable fluid. It shall meet the property limits listed below. The base fluid shall be 100% derived from seed oils. The dielectric coolant should have undergone accelerated aging studies via sealed tube and Lockie test methods, and have published its A & B factors.

2.3 Acceptable values for receipt of shipments of new FR3 fluid are shown in Table 1.

2.4 Environmental and Health Third Party Validations

The fluid shall have a US EPA Environmental Technology Verification (ETV) Statement published. The fluid shall meet the test limits shown in Table 2.

2.5 Packaging

The electrical insulating fluid shall be furnished in sealed vessels suitable for the purpose, including 5-gallon containers, 55-gallon drums, 330-gallon totes, or in bulk. Each vessel shall have tampering indicating devices.

3.0 Recommended Customer Receiving Quality Control

3.1 Inspection

Each lot received shall be visibly inspected for container integrity. Verify that tamper proof seals are intact and no leaks are visible.

3.2 Receiving Tests

Samples shall be taken from containers per ASTM D 923 Section 2.2, as follows:

Table 5
FR3 fluid lot size and containers sampled

Lot Size (gallons)	Number of Containers Sampled
600 or less	1
601-3000	2-6
3001 or more	6 minimum (10% of quantity of containers recommended)

When material will be combined for production, samples may be mixed together in equal proportions to create a composite sample for testing. Minimum tests required are dielectric strength and visual inspection. Dissipation factor test is highly recommended, although not essential.

4.0 Important information

4.1 Storage

Avoid storing drums and totes outdoors. Extreme temperature variations can stress the integrity of container protective seals. Exposure of totes to sunlight can cause fluid discoloration.

4.2 Intended Use

The use of electrical insulating and cooling fluid is generally dictated by the engineering design of the electrical apparatus. The electrical insulating fluid covered by this specification is intended for use as an insulating and cooling medium in electrical equipment.

4.3 Fluid Transfer

When transferring electrical insulating fluid from its original container, take care to prevent contamination with moisture, dust, and foreign matter. These impurities can cause deterioration of the dielectric strength and electrical performance.

4.4 Partial Containers

Provide nitrogen blanket for partially filled containers, and properly seal to prevent contamination.

REFERENCES AND FOOTNOTES

[1] Per OPPTS 835.3110

[2] Per OECD 203, Method B

[3] Per OECD 420

[4] Less-flammable transformer fluids, Approval guide – Electrical equipment, FM Approvals, FM Global, Norwood, MA, USA

[5] EOVK.MH10678, Transformer fluids, UL Listed and Classical Products, Underwriters Laboratories, Northbrook, IL, USA EOUV.MH10678, Dielectric mediums, UL Listed and Classified Products, Underwriters Laboratories, Northbrook, IL, USA

[6] National Electric Code, NFPA 70, National Fire Protection Association, Quincy, MA, USA

[7] Transformers, 5-4, Property Loss Prevention Sheets, FM Global, Norwood, MA, USA

[8] TSR IS-PG-047-1920, “Biodegradation of FR3 Fluid”, Cargill technical report.

[9] BEES, Version 4.0e, Building and Fire Research Laboratory, National Institute of Standards and Technology, August 2007, http://www.bfrl.nist.gov/oae/software/bees/

[10] P.J. Hopkinson, L. Dix, “Tapchangers for De-energized Operation in Natural Ester Fluid, Mineral Oil, and Silicone” IEEE/PES Transmission & Distribution Conference & Exposition, July 26-30, 2009, Calgary, Canada

[11] Per OECD 203, Method B

[12] Per OECD 420

[13] Per US EPA OPPTS 835.3110 and US EPA OPPTS 835.8110 (ii)

[14] Per USDA Biopreferred minimum biobased content for Fluid-Filled Transformers - Vegetable Oil-Based

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FR3fluid.com

EXHIBIT B: FR3 OIL REMEDIATION RESOURCE

Remediation:
Oil Is Not Oil

Gene DelFiacco
Cargill, Incorporated – Envirotemp™ Dielectric Fluids

Version 1.0 | July 2012
W1030

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Reducing Costs of Spills *Through* Differentiation

While the default US environmental regulatory position treats most products equally ('oil is oil'), Envirotemp™ FR3™ fluid possesses a significantly improved environmental footprint. The greatest impact of classifying all oils as identical is higher than necessary costs incurred during construction in the form of containment (and fire mitigation systems), and more expensive remediation after spills occur. Current regulations do provide for differentiated treatment of FR3 fluid.

Compliance with the Spill Prevention, Control, and Countermeasure (SPCC) rule[1] requires thorough understanding of the US EPA regulations. To help, the US Department of Agriculture has published a step by step guide[2] to understanding and complying with these regulations at electrical substations.

Utilizing Envirotemp FR3 fluid in transformers will reduce the overall cost of complying with SPCC requirements.

Containment, when required, is as easy as building an earthen berm around the substation, eliminating the need for more expensive cement systems[3]. (Furthermore, FM Global recognizes that less flammable fluids such as FR3 fluid reduce long term liabilities, and allow its use to eliminate water deluge systems and reduce space separation distances, providing additional savings during project construction).

Remediation, the process used to repair the environment to pre-event condition, is also less expensive for FR3 fluid compared to traditional mineral oil.

For spills into waters, biological degradation (bio-remediation) is allowed[4]. FR3 fluid is proven non-toxic[5] and readily biodegradable[6] (equivalent to greater than 99% biodegradable). Implementing this solution is highly effective for FR3 fluid, and will reduce expenses when compared to any current mineral oil remediation process.

For soil spills, the transformer industry has for convenience assumed that most mineral oil spills should be remediated by excavating and incinerating (or sequestering) of the contaminated soil, replacing it with 'clean' soil, and then replanting indigenous plants.

In the case of FR3 fluid spills to soil, an equally effective remediation plan includes the use of bioremediation in lieu of the more common (and expensive) mineral oil process outlined above. Analysis of FR3 fluid confirms 100% bio-based content per ASTM D 6866.

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[1] Oil Pollution Prevention, 40CFR112

[2] Design Guide for Oil Spill Prevention and Control at Substations, Bulletin 1724E302, US Department of Agriculture, http://www.rurdev.usda.gov/SupportDocuments/UEP_Bulletin_1724E-302.pdf

[3] Bulletin 1724E302, Section 3.2.2, p.17

[4] Bulletin 1724E302, Section 8.4, p.81

[5] Fish, Acute Toxicity Test, OECD 203

[6] Ready Biodegradability, OPPTS 835.3110

Cargill recommends accelerating the bioremediation process by spreading active yeast over a spill site and adding water to activate the micro-organisms contained in the yeast. The micro-organisms will consume the FR3 fluid, thereby effectively removing it from the environment, achieving the same result as the traditional mineral oil remediation process, but at fraction of cost.

Long term risk assessment requires thorough understanding of current regulations. The use of FR3 fluid in transformers effectively mitigates long term liabilities by alleviating concerns over spill impacts, and future costs of remediation. For new construction projects, the substitution of earthen berms for cement or other costly containment methods provides immediate project savings. Spills, whether in water or on soil, should be bio-remediated, achieving results similar to more intrusive mineral oil remediation methods, but at a substantially reduced cost.

Figure1 – Aerobic Aquatic Biodegradation
EPA Test OPPTS 835.3100