Retrofilling Transformers:
A Financial Perspective

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Retrofilling mineral oil filled transformers with Envirotemp™ FR3™ fluid should deliver a positive return on investment considering:

- The costs associated with the retrofill might be capitalized instead of expensed, reducing a company's Federal tax obligation.
- Fire mitigation equipment can be removed from service, eliminating some maintenance expenses.
- Costs incurred to remediate future spills may be reduced
- Additional 21 ℃ tolerance provided without accelerating normal insulation system aging rate (achieved through additional loading)
- Reduced risk of dielectric failure caused by bubble formation during overload
- Collateral damage to other equipment by not incurring dielectric pool fire

One of the top three causes of power transformer failures is cellulose insulation failure (the others being On Load Tap Changer and bushing failures). Cellulose insulation may be the weakest link of the transformer, because aging (degradation) of the cellulose insulation is irreversible. Following robust maintenance programs can detect and address the other potential failure modes prior to failure.

Many mineral oil filled transformers are being pushed to carry load beyond nameplate rating even though the exact condition of their cellulose insulation is unknown. Such practices accelerate the aging of the paper insulation, potentially reaching end of life. Fortunately, replacing the old, outdated mineral oil (retrofilling) with new FR3 fluid is a cost effective way to slow the thermal aging rate of cellulose insulation enabling increasing load-ability of transformers. Retrofilling also upgrades the transformer's fire safety and lowers the environmental risks associated with failures of aged transformers.

Financial incentives for retrofilling transformers

To assure reliability, transformers should be regularly maintained. Because expenses associated with maintenance require spending a company's profits, many companies have transitioned from annual maintenance schedules to condition based maintenance.

FERC: On February 17, 2011, Federal Energy Regulatory Commission (FERC) ruled that utilities may capitalize all costs incurred to retrofill a transformer with bio-based Envirotemp FR3 fluid[1]. The ruling is based on FR3 fluid's ability to extend transformer insulation life and improve transformer performance.

Capitalizing costs impacts Federal tax liability; reviewing normal accounting procedures reveals:

Revenue
- Costs
Gross Profit

Gross Profit
- Depreciation expense
Earnings before Interest and Taxes

Earnings before Interest and Taxes
- Interest
Taxable Earnings

Capitalizing the costs associated with a retrofill means adding those costs to the depreciation expense instead of taking them from the maintenance budget, thus potentially reducing earnings before taxes (EBIT). Lower earnings may equate to fewer taxes owed and higher profits.

***Fire Mitigation Systems*:** Envirotemp FR3 fluid is an Approved Less Flammable fluid. FM Global designates less flammable fluids to be both an equivalent safeguard and suitable substitute for water deluge systems and fire barriers[2]. Retrofilling transformers containing

[1] Docket No. AC11-2-000, Federal Energy Regulatory Commission, February 17, 2011

[2] Transformers, Property Loss Prevention Data Sheet 5-4, FM Global

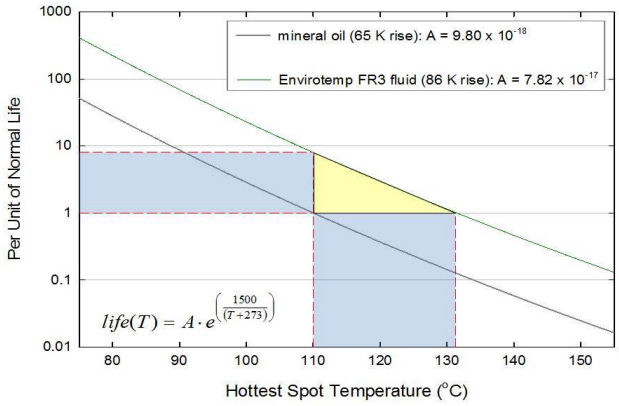
10,000 gallons or less with Envirotemp™ FR3™ fluid allows users to remove older, maintenance-intensive reactive fire safety systems, saving operating expenses while lessening long term liability. Envirotemp FR3 fluid has a flawless fire safety record, as no Envirotemp FR3 fluid-filled transformer failure has ever resulted in a dielectric coolant pool fire.

Spill Remediation: The US Department of Agriculture has published a design guide for complying with EPA regulations related to oil spills. Reviewing this design guide, bio-remediation is an effective remediation tool[3].

Envirotemp FR3 fluid is 'Ultimately biodegradable' using the EPA's test methods. As outlined by the EPA, Cargill recommends using bioremediation to remediate ground spills of Envirotemp FR3 fluid[4]. To accelerate the process, Cargill advocates adding biomass consuming mirco-organisms to the site 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 Envirotemp FR3 fluid, thereby effectively removing it from the environment.

This process will cleanse the site as effectively as the 'age old' mineral oil remediation process of excavating and disposing of soil and replacing with new uncontaminated soil, but at a much reduced cost. Additionally, in water spills, the US Department of Agriculture recognizes that biological degradation is an effective remediation tool. Since Envirotemp FR3 fluid does not create an iridescent sheen, bio-remediation may also be used in water spills.

Overload Ability: Envirotemp FR3 fluid/TUK (thermally upgraded Kraft) paper insulation systems have been proven to withstand heat better than mineral oil/TUK paper insulation systems. Retrofilling transformers with Envirotemp FR3 fluid increases overload capability without exceeding the insulation aging rate observed for mineral oil filled transformers[5]. (Refer to IEEE C57.91 for guidance before overloading power class transformers.)



Which transformers would be good candidates for retrofilling with Envirotemp FR3 fluid?

From the oldest to the newest (and including those purchased in the future), nearly all non-free breathing, non-silicone oil filled transformers are potentially good candidates for (retro) filling with Envirotemp FR3 fluid! Assessment should include a review of the maintenance records and status of the unit, and should incorporate unit proximity to environmentally sensitive areas and/or where the risk of fire is greatest.

Fiscal responsibility

Envirotemp FR3 fluid is a renewable technology that in many categories is proven to be a superior dielectric coolant to mineral oil, including automatic moisture control, dielectric strength retention, fire ignition resistance, electrical contact stability, environmental profile, carbon footprint (life cycle CO_2 generation), and many others.

Financial incentives exist that promote immediate action to take advantage of Envirotemp FR3 fluid's unique value proposition. Users will see an immediate reduction in risks when retrofilling transformers with Envirotemp FR3 fluid. Additionally, throughput of the transformer can be increased.

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[3] Design Guide for Oil Spill Prevention and Control at Substations, Bulletin 1724E302, Rural Development Utilities Programs, US Department of Agriculture

[4] EPA Bulletin EPA 542-F-96-007, April 1996

[5] Cargill paper aging studies

Envirotemp ™ FR3™ fluid is the most tested alternative dielectric coolant on the market. Over two decades of experience is validating the results. Power transformers as old as 1955 have been retrofilled with Envirotemp FR3 fluid; additionally customers around the world have already energized 245kV Envirotemp FR3 fluid filled transformers. Without exception, Envirotemp FR3 fluid filled transformers are meeting and exceeding customer expectations.

NOTE: The views expressed in this document are based on Cargill's extensive testing of Envirotemp FR3 fluid and third party validation consistent with the current regulatory, legal and compliance guidelines at the publish date. Please refer to most up to date requirements as it relates to each individual organization's programs.