

# Setting the new standard in solar power.

Get more loading capacity from your transformers and keep your solar farms operating at their full capacity with FR3 fluid's ability to easily handle difficult harmonics, high variable load conditions, and extreme heat fluctuations.







As demand for solar power continues its rapid growth and solar farms become larger and more complex in order to meet that demand, building and operating the farms is becoming more difficult. Widely varying loading conditions, difficult harmonics caused from the switching of inverters, and high heat – from both the sunny environment and in the core – are quickly exposing problems caused by mineral oil filled transformers. Mineral oil simply cannot handle the extreme conditions that come with solar power, resulting in high levels of gassing, frequent tripping, and vastly accelerated aging of the insulation system.

FR3<sup>®</sup> fluid – the original and most proven natural ester transformer insulating fluid – was specially designed and formulated to handle the difficult situations – like those experienced with solar power, keeping projects running at their full capacity while eliminating the unplanned interventions that come with mineral oil. FR3 fluid allows for up to 20% more loading capacity in the same sized transformer,\* the ability to lower costs by making transformers smaller, and significantly improved reliability thanks to the robustness of the fluid, all while also being a more sustainable, plant-based solution. FR3 fluid is becoming the new standard in insulating fluid in solar power transformers.

\*Compared to a mineral oil filled transformer.





**FR3**  
a Cargill brand





## More loading capacity in the same size package

How do you keep transformers and their skids the same size while increasing their loading capacity by up to 20%? It's simple, use FR3® fluid filled transformers instead of mineral oil. FR3 fluid's unique properties allow transformers to safely operate up to 20°C warmer than a mineral oil filled transformer - gaining up to 20% additional loading capacity, all without impacting the life or reliability of the transformer. This allows for the design of a smaller, more compact transformer with the same loading capacity, the same sized transformer with up to 20% more loading capacity, or any combination in between.\*

Utilize the extra loading capacity to connect more panels to the skid, further maximizing sized constrained applications.

# 20%

Up to 20% more  
loading capacity



## Reduce costs

Realize costs savings by specifically designing your transformers to fully utilize all of FR3 fluid's unique benefits, either by making a transformer more compact with the same amount of power or the same size with more power.\* Making the transformer smaller or increasing the loading capacity not only saves money on the insulating fluid, but also saves on other expensive materials for the transformer like copper, steel, iron, and insulating paper. Because FR3 fluid is 100% biodegradable, further cost savings are also possible through simplified spill remediation systems.

With added loading capacity available, comes the ability to connect more panels to the same size skid, reducing overall project costs and potentially also reducing the number of transformers needed.

In addition, FR3 fluid's unique moisture handling capabilities also extends paper insulation life by up to 8X longer,\* thus allowing for optimized transformer size, increased loading capacity, and extended transformer life to your specific application.

# 8x

Extended paper  
insulation life\*

\*Compared to a mineral oil filled transformer.







## More sustainable

Contribute to your company's sustainability commitments, protect the environments where your applications operate, and reduce dependency on fossil-based materials in your transformers by choosing FR3® fluid. Made from >95% vegetable oil, along with performance enhancing additives, FR3 fluid has numerous environmental benefits over mineral oil, including:

- Biodegradable in as little as 10 days
- Non-toxic in water, soil, and to wildlife and humans

# 10

Biodegradable in as little as 10 days



## Superior Fire Safety

FR3 fluid has exceptionally high flash and fire points - in fact, more than 2X higher than mineral oil. This helps reduce the risk of explosion and fire—thus reducing damage to equipment and people. It is a K-class fluid with FM Global and UL approval. Most impressively, there have been zero reported pool fires in transformers filled with FR3 fluid in over 25 years of use and over 3 million transformers filled across the globe.

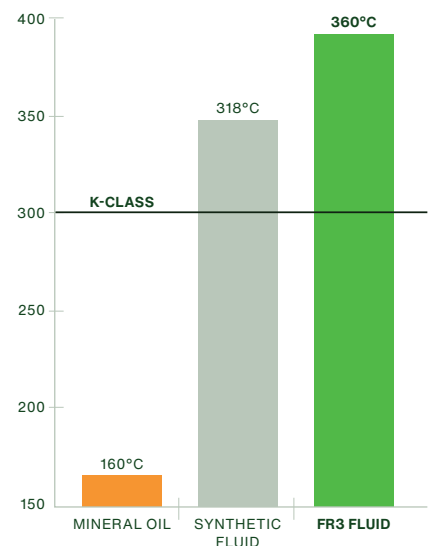
# 0

Reported fires in 25+ years

# 2x

Up to 2 times higher flash and fire points\*

Dielectric Fluid Fire Point Comparison



\*Compared to a mineral oil filled transformer.





## More reliability to maximize revenue potential

The demanding environments created by solar power farms are quickly exposing mineral oil's many shortcomings. Mineral oil simply can't handle the extreme conditions that come with solar power, which leads to high levels of gassing, frequent tripping, and vastly accelerated aging of the insulation system.

FR3® fluid is specifically formulated to handle the difficult situations created by solar power, even on the warmest of days. It's unique formulation easily handles high load fluctuations and high heat, with a top fluid temperature that can safely operate at up to 140°C,<sup>1</sup> which also makes the transformer less prone to a partial discharge. FR3 fluid continuously dries paper insulation without creating any damaging byproducts, helping make it robust enough to manage the difficult harmonics caused by the frequent switching of the inverter.

Many solar farms around the globe continue to switch from mineral oil to FR3 fluid after experiencing unplanned interventions and shutdowns. After switching to FR3 fluid, problems with gassing, overheating, and tripping disappeared almost immediately – allowing solar farms to be able to operate at full capacity, even during peak, sun-filled production times.

# 0

**No maintenance needed  
under normal operating  
conditions**

# 140°C

**Easily handles high heat  
with 140°C<sup>1</sup> top fluid  
temperature limit**

<sup>1</sup>According to IEC 60076-14, IEEE C57-154.



## Solar Power FAQs

### How can Dual Rated / Sustainable Peak Load transformers help improve my solar application?

FR3® fluid's unique formulation allows for transformers to gain up to 20% loading capacity compared to the same sized mineral oil filled transformers, allowing for more power in the same sized transformer and skid. More and more OEMs and operators are taking advantage of this benefit and specifying FR3 fluid filled transformers to better handle high peak loading conditions without needing to modify or change the design of the skid.

### Are there diagnostic tools available for FR3® fluid?

Yes. There is a complete set of standards from both the IEC and IEEE with guidelines for maintenance based on physical-chemical analysis. All the traditional DGA tools such as basic ratios, simplified ratios, and CO<sub>2</sub>/CO can be used. Specific Duval Triangles and Pentagons for FR3 fluid are also available to perform a more accurate analysis of generated gases.

### Is FR3 fluid miscible with mineral oil?

Yes, FR3® fluid is fully miscible with mineral oil. In a typical retrofit, Cargill would expect to see 3-5% residual mineral oil remaining, which does not significantly impact FR3 fluid's performance.

Cargill recommends that 7% or less of the total fluid be residual mineral oil or FR3 fluid's benefits begin to decline.

### Can I retrofit existing transformers with FR3 fluid?

Yes, FR3® fluid can be used to retrofit mineral oil filled transformers. In fact, many solar power installations have been retrofitting mineral oil filled transformers with FR3 fluid in order to improve reliability and reduce unplanned interventions.

Mineral oil has difficulty handling the harmonics and widely varying loading conditions that come with solar power generation, which causes accelerated aging of the insulating fluid.

FR3 fluid is specially formulated to handle high heat and challenging harmonics without accelerated aging of the fluid or insulation system.

### How can FR3 fluid help mitigate gassing problems?

Gassing issues in solar farms are generally related with harmonics. High-frequency voltage harmonics lead to partial discharges and generate gasses, mainly hydrogen and methane. FR3 fluid has shown an outstanding performance to withstand these harmonics due to its higher Partial Discharge Inception Voltage (PDIV) that avoids the inception of discharges and its "self-extinguish" behavior that minimizes gassing.

Additionally, its unique formulation was developed to handle high load fluctuations and high heat, with a top fluid temperature that can safely operate at up to 140°C,\* which also make the transformer less prone to form sludge due to overheating from current harmonics.

\*According to IEC 60076-14, IEEE C57-154.



**FR3**  
a Cargill brand





Learn more about how FR3<sup>®</sup> fluid can help keep your solar farm operating at full capacity at [FR3fluid.com](https://www.FR3fluid.com).