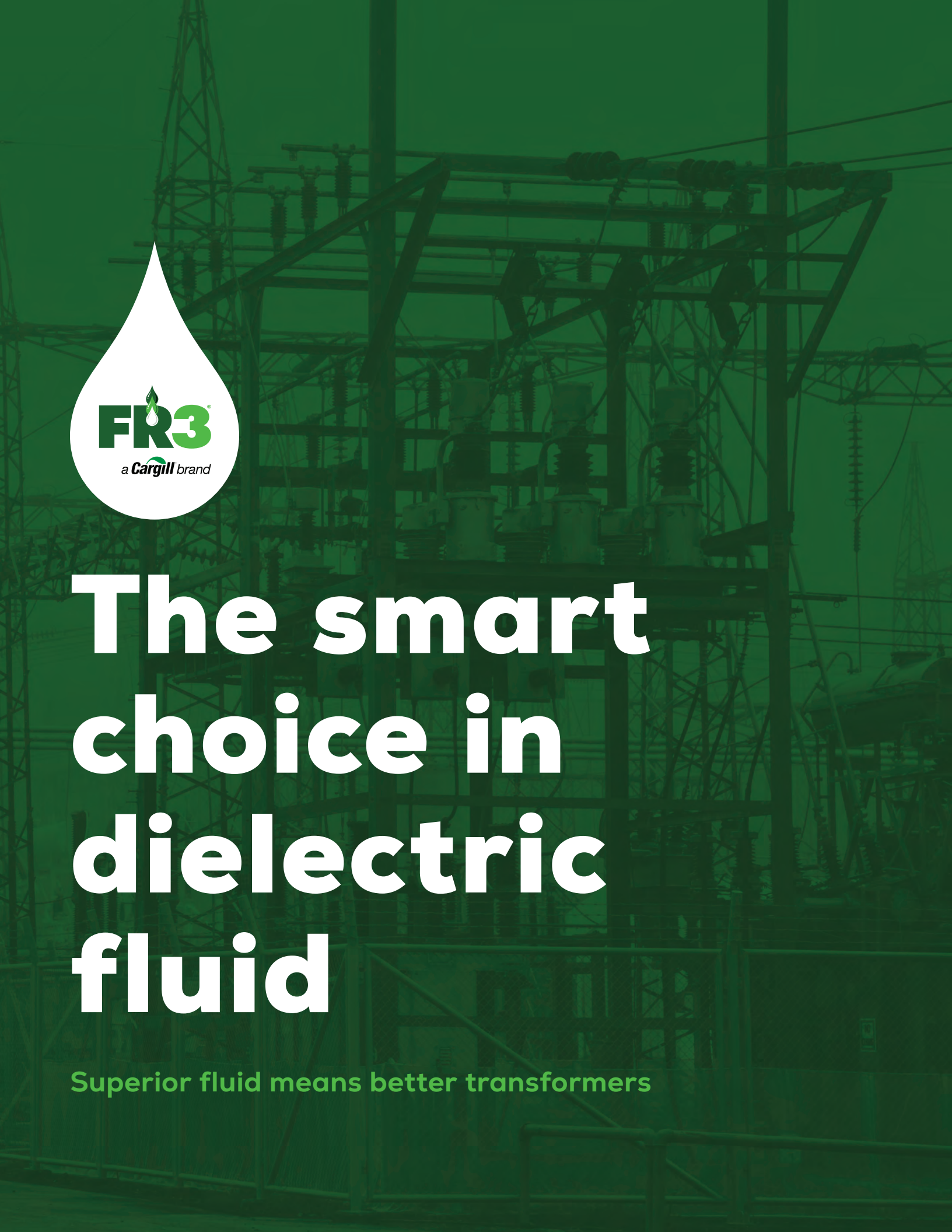
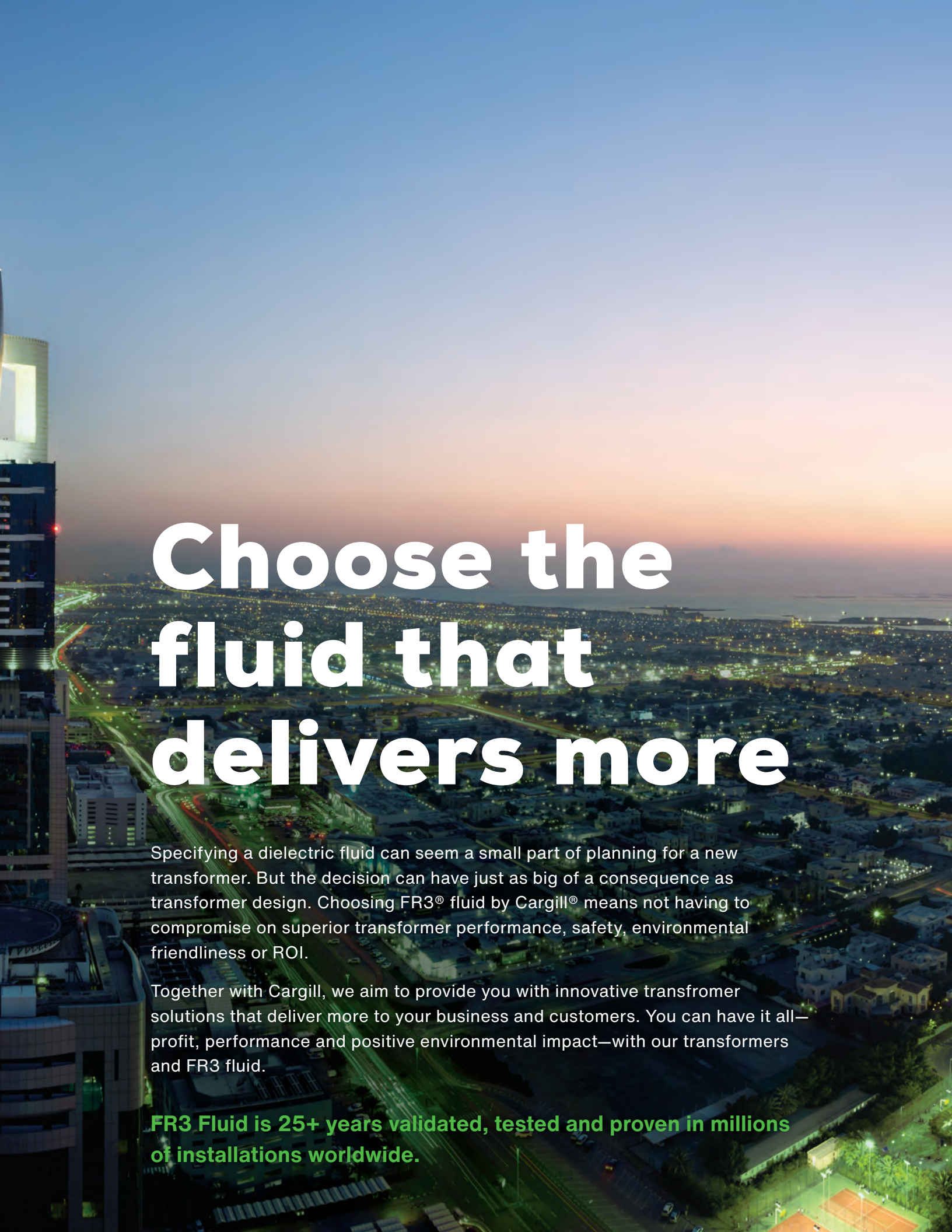


FR3®
a Cargill brand

The smart choice in dielectric fluid

Superior fluid means better transformers


FR3
a Cargill brand



Choose the fluid that delivers more

Specifying a dielectric fluid can seem a small part of planning for a new transformer. But the decision can have just as big of a consequence as transformer design. Choosing FR3® fluid by Cargill® means not having to compromise on superior transformer performance, safety, environmental friendliness or ROI.

Together with Cargill, we aim to provide you with innovative transfromer solutions that deliver more to your business and customers. You can have it all—profit, performance and positive environmental impact—with our transformers and FR3 fluid.

FR3 Fluid is 25+ years validated, tested and proven in millions of installations worldwide.

Better for business

The unique properties of FR3 fluid can dramatically improve a transformer's load capacity, insulation paper lifespan, mitigate fire risk, lessen environmental impact and more.* With FR3 fluid, you can also potentially realize:

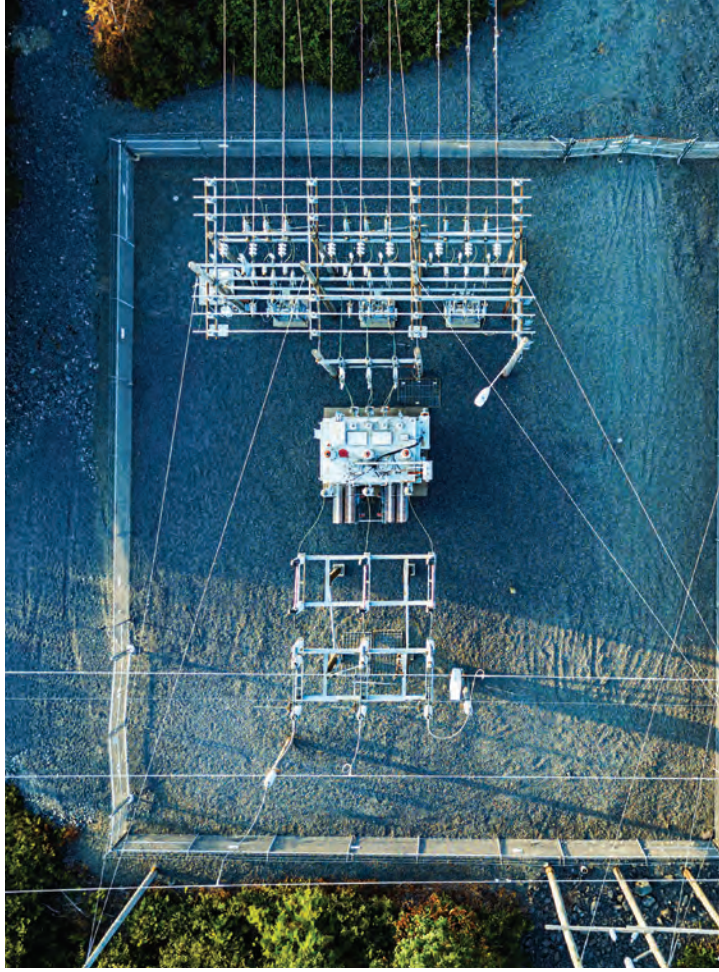
- More efficient and smaller/compact transformer design
- Minimized maintenance and spill remediation
- Fewer transformer replacements
- Streamlined asset inventory
- Sustainable supply chain

When transformers are better across the board, so is your return.

17%

Average total cost of ownership savings

*Compared to mineral oil.



Better transformer performance

With FR3 fluid in your transformers, the grid will gain flexible load capacity without sacrificing transformer life or reliability. In fact, using FR3 fluid instead of mineral oil in a transformer with thermally upgraded Kraft (TUK) lets you:

- Extend the life of the insulation paper 7.4x at 110°C hotspot
- Increase load capacity up to 20% at 130°C hotspot
- Or strike your desired balance between extended life and increased load capacity

8x

Up to 8x longer insulation life

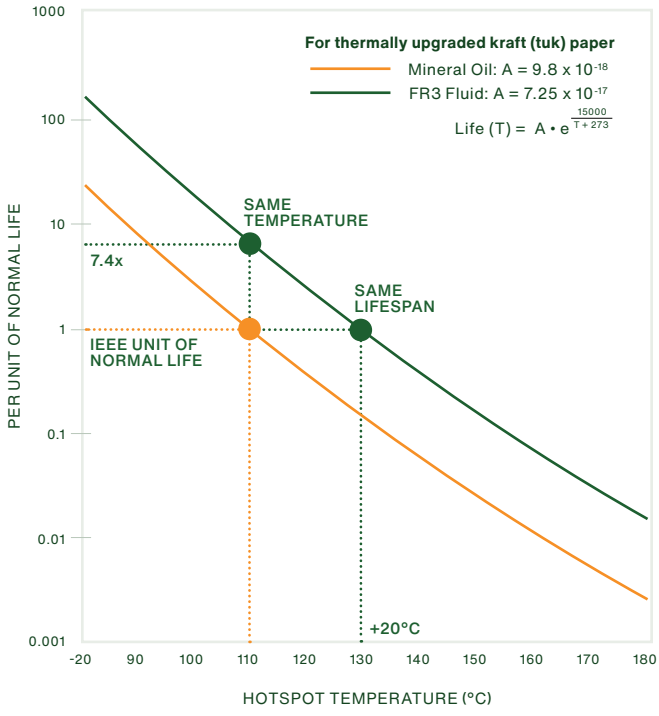
20%

Extended loading or load capacity

50%

Up to 50% extended asset life

Arrhenius Curve for Thermally Upgraded Kraft Paper Immersed in MIneral Oil and in Natural Ester Liquids



Better safety for people and the planet

FR3 fluid has exceptionally high flash and fire points. This reduces the risk of explosion and fire—and so reduces the risk of damage to equipment and people. Specifying a K-class fluid such as FR3 fluid can also:

- Eliminate the need for costly fire-mitigation systems
- Reduce clearance requirements to buildings and equipment
- Potentially reduce insurance premiums and liability service

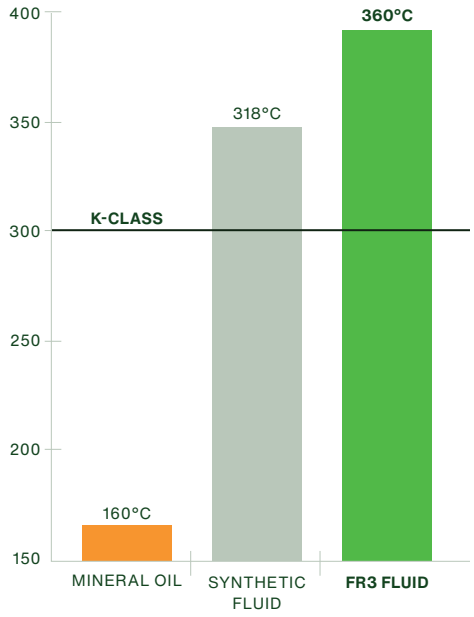
The planet benefits from your choosing biobased FR3 fluid, too. It is nonhazardous in soil and water, and its properties help prevent migration across surfaces and into subsurface soils in case of spillage. Plus, FR3 fluid requires significantly less complex and less costly spill remediation if spills occur.

0
Reported fires

2x
Mineral oil's flash and fire points

10
Biodegrades in as little as 10 days

Dielectric Fluid Fire Point Comparison



FR3® fluid properties: standard acceptance values and typical values

	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	<-1.0	≤1.0	-21
Density at 20˚C (g/cm^3)	–	ISO 3675	–	≤1.0	0.92
Relative Density (Specific Gravity) 15ºC	D1298	–	≤0.96	–	0.92
Viscosity (mm^2/sec)	D445	ISO 3104			
100˚C			≤15	≤15	7.7-8.3
40˚C			≤50	≤50	32-34
0˚C			≤500	–	190
-20ºC					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					
Dieletric Breakdown (kV)	D877	–	≥30	–	47
Dieletric Breakdown (kV)					
1mm gap	D1816	–	≥20	–	>25
2mm gap	D1816				
2.5mm gap	–	IEC 60156	–	≥35	>50
Dielectric Breakdown under Impulse (kV) 25.4mm gap	D3300		>130		140
Gassing Tendency (mm/min)	D2300	–	≤0	–	-79
Dissipation Factor					
25ºC (%)	D924	–	≤0.20	–	0.010 - 0.15
90ºC (tan d)	–	IEC 60247	–	≤0.05	0.02
100ºC (%)	D924	–	≤4.0	–	0.41 - 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	0.013 - 0.042
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 (48hrs, 120ºC)	–	IEC 61125C			
Total Acidity (mg KOG/g)	–	IEC 62621.3		≤0.6	0.1
Viscosity at 400C (mm^2/sec)	–	ISO 3104		≤30% increase over initial	17.1% increase
Dissipation Factor at 90ºC (tan d)	–	IEC 60247		≤0.5	0.1
Oxidation Induction Time 130ºC/500psi (min)	D6186**				62±2min

** 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.

FR3 fluid applications

Power Transmission and Distribution

FR3 fluid is successfully used in power generation and distribution transformers of all voltage classes. When compared to mineral oil, FR3 fluid delivers utilities superior performance and measurable cost efficiencies.

When you choose FR3 fluid for your utility, you empower a flexible and resilient grid to benefit your business, community, and the planet.

Solar Power

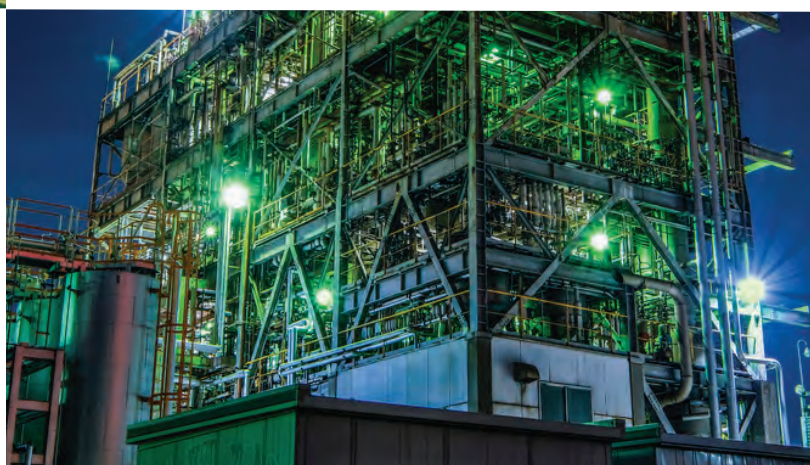
FR3 fluid is used in land-based and floating solar plants across the globe.

Solar farm transformers with FR3 fluid enjoy major performance benefits like higher flexible loading capacity and minimal maintenance. The environmental benefits allow for smaller installation footprints and improved fire safety over mineral oil.

Wind Power

Demand for wind power continues to expand and wind turbines for large-scale wind farms have grown more powerful. Now, it is essential to specify high-performing transformers that are compact, lightweight and low maintenance.

Using FR3 fluid in wind turbine transformers— for both onshore and offshore applications—easily meet these criteria with a notable impact on the bottom line.



Retrofilling

FR3-fluid-filled transformers can extend the paper insulation life up to 8X longer than mineral-oil-filled equivalents because of its superior moisture handling capabilities. You also get improved fire safety with a fire point more the 2X higher than mineral oil. As a result, when you retrofill any mineral-oil-filled transformer with FR3 fluid, you extend asset life while also lowering the risk of fire.

To learn how using FR3 fluid can be smart for your business, contact us:

AA-fr3fluid@cargill.com

Or to learn more about FR3 fluid, visit **FR3fluid.com**.