



**FR3**<sup>TM</sup>  
 ENVIROTEMP<sup>TM</sup> NATURAL ESTER FLUID

Hitesh Arora  
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# Cargill at a glance

More than 155,000  
employees

Located in 70  
countries



Speaking

**+65**

languages

**+150**

years of experience



# Cargill dielectric fluid production sites



# Fire Safety with FR3

Transformer fire causes damage to life and environment.

**14 killed in transformer explosion in Rajasthan village, Raje government orders probe**

BENGALURU

**Electricity transformer blast: injured succumbs**

SPECIAL CORRESPONDENT

BANGALORE:, APRIL 23, 2014 00:45 IST

**Surat fire: 22 killed in coaching centre blaze, horrific visuals show kids falling off burning building**

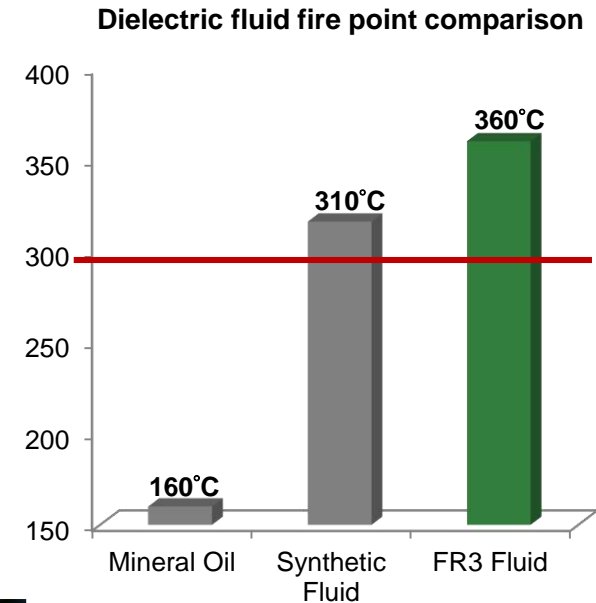
*The fire which engulfed the four-storey building started at the ground floor, forcing students to take cover at roof. At least 22 students were killed, either due to suffocation or falling off the windows in an attempt to escape fire.*

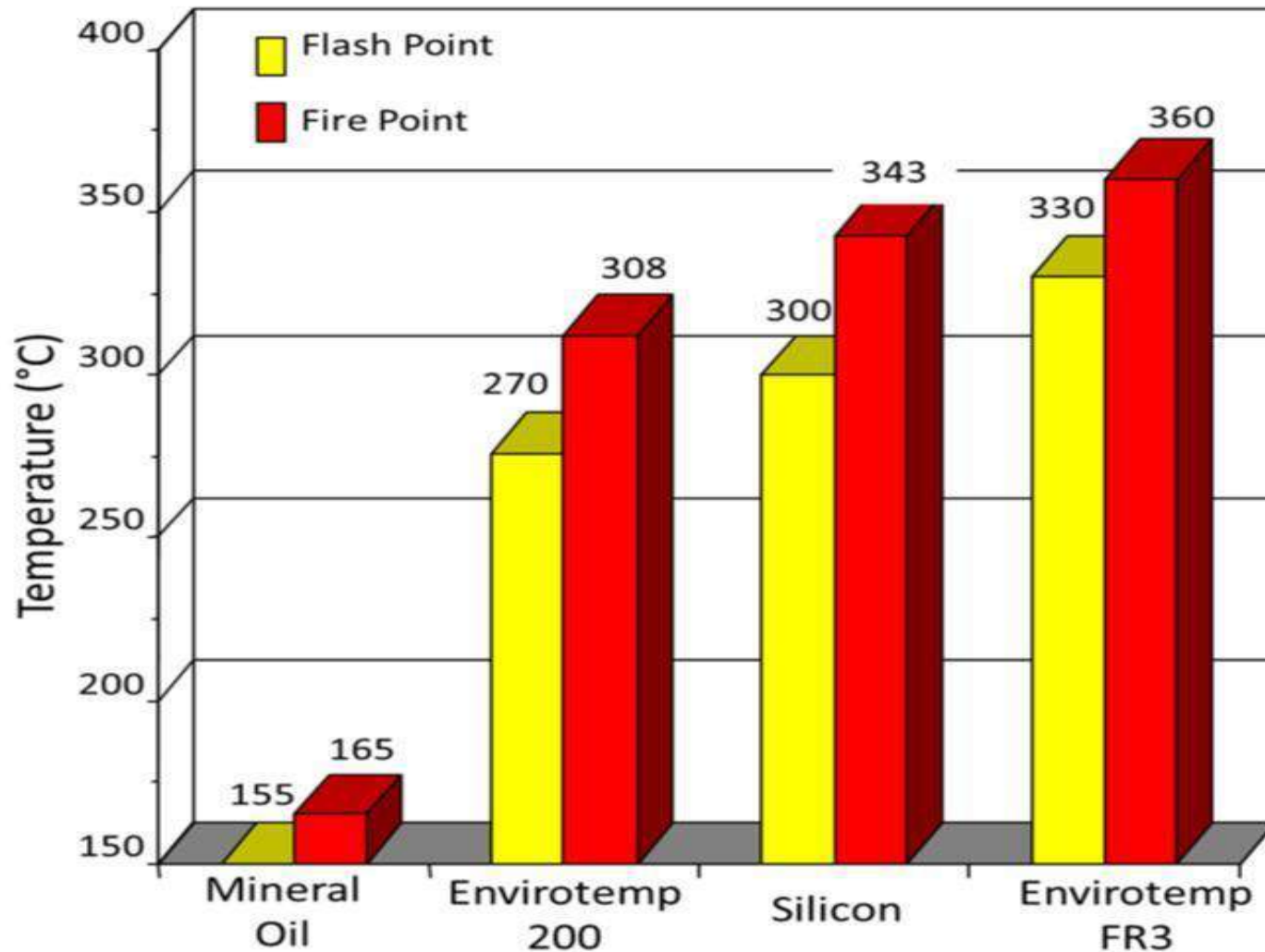
ADVERTISEMENT

Greater Noida: Three children were charred to death in a fire triggered by a blast in an electronic transformer in sector phi-III of Greater Noida on Wednesday afternoon. Victim's family members alleged laxity on part of the electricity department as they made several complaints regarding

# Fire point is most critical factor for transformer fire safety

- FR3 fluid fire point = 360°C
- Zero fire history in FR3 fluid filled transformers
- K-Class, less flammable fluid:
  - UL Classified and FM Approved
- For power transformers,
  - Eliminate deluge systems and fire walls
  - Reduce building clearances
  - Retrofill to meet fire codes versus replacing/moving unit

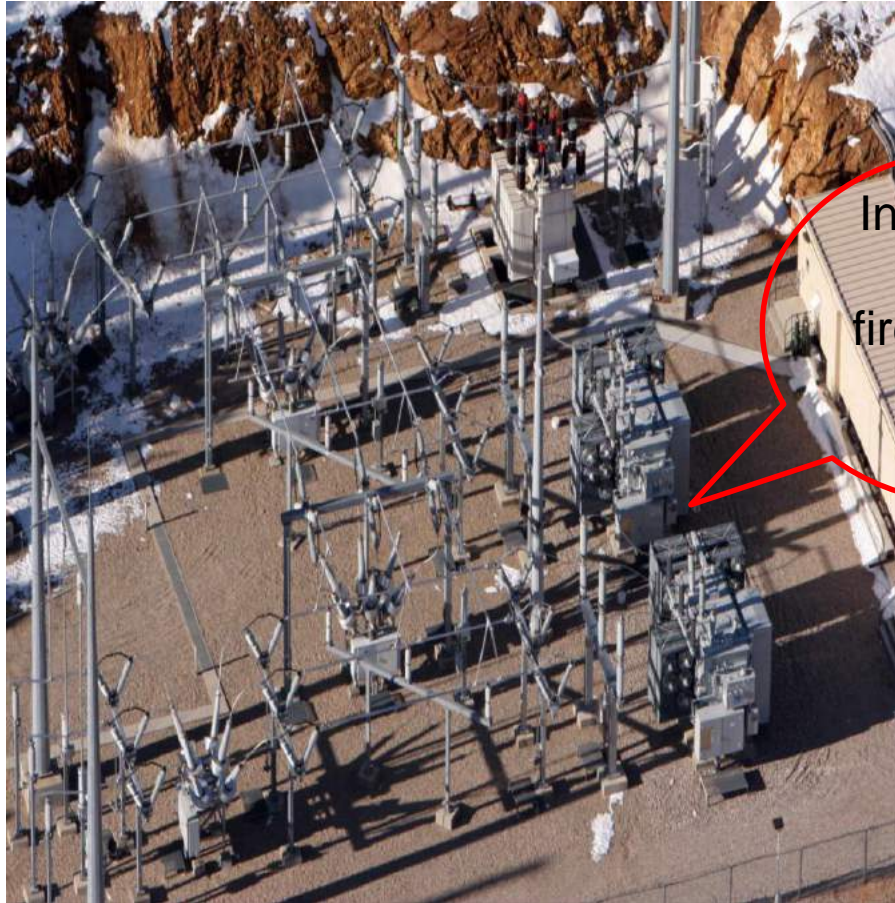




## Fire Safety: Definition of K-Class Fluids

Previously named “Fire Resistant”, K Class fluids must have Fire Point above 300° C

# Platte River Substation



Installation without firewall and deluge system

# Fenway Park Stadium Transformer



sitting area Above transformer

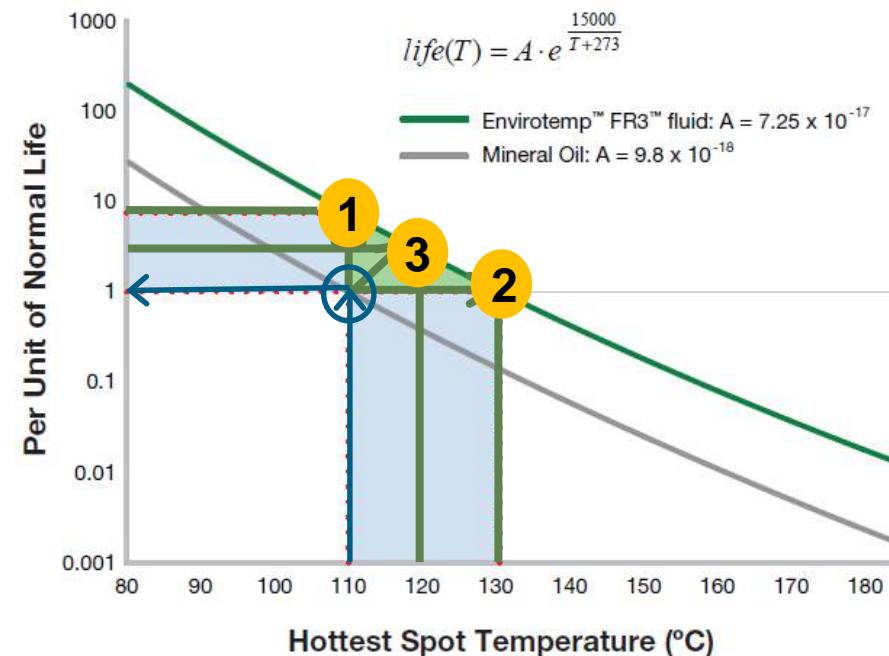


# Up gradation of insulation thermal class

# Use high temperature capability to increase load capacity extend asset life or both

- Current TUK standard 110°C hot spot with 75 AWR (IEC) or 65 AWR (IEEE) limits transformer capability
- Current Kraft 95°C hot spot with 65 AWR (IEC) or 55 AWR (IEEE) limits transformer capability
- Envirotemp™ FR3™ fluid-based insulation systems can be run 20°C warmer without degrading life
- Design new transformers smaller with same or more load capacity
- Existing transformers can be upgraded to potentially provide additional load capacity

The natural ester fluid's interaction with cellulose insulation enables transformers filled with Natural ester fluid to be designed to operate up to 20°C warmer than the mineral oil-filled alternative.



High temperature curve based on Thermally Upgraded Kraft (TUK) paper

# High Temperature Transformers Std

## IEEE C57.154 / IEEE Std 1276 / IEC 60076-14 / IS 2026-14

The standards already recognize the benefits of Natural Esters for reducing paper degradation rate



- IEEE C57.154 - at the informative Annex B - brings the table B.2 suggesting the increasing of the thermal class **when the paper is impregnated / immersed in Natural Esters.**
- Arrhenius parameters are presented (“b” =15,000, “a” from table)

IEEE Std C57.154-2012

IEEE Standard for the Design, Testing, and Application of Liquid-Immersed Distribution, Power, and Regulating Transformers Using High-Temperature Insulation Systems and Operating at Elevated Temperatures

**Table B.2—Comparison of aging results**

	Constant <i>a</i>	Temperature <i>T</i> (°C)	Thermal index	Thermal class
<b>IEEE mineral oil/thermally upgraded kraft paper</b>	$9.80 \times 10^{-18}$	110.0	110	120
<b>Natural ester liquid/thermally upgraded kraft paper</b>	$7.25 \times 10^{-17}$	130.6	130	140
IEEE mineral oil/cellulose-based paper	$2.00 \times 10^{-16}$	95.1	95	105
Natural ester liquid/cellulose-based paper	$1.06 \times 10^{-17}$	110.8	110	120

# FR3 fluid extends insulation life 5-8 times longer than mineral oil

**PROTECTING LIFE OF INSULATION PAPER IS THE NUMBER ONE FACTOR THAT DETERMINES ASSET LIFE**

FR3™ natural ester fluid vs. Mineral oil  
Sealed Tube Test – ML 152-2000

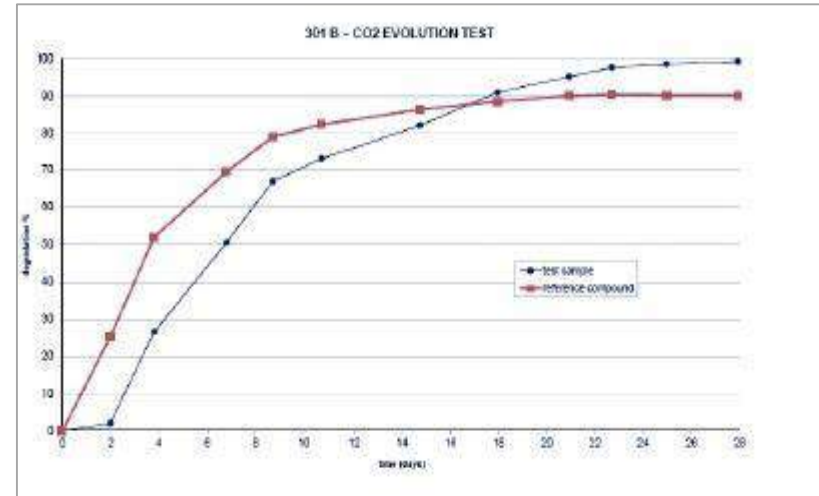


# Environment Friendly

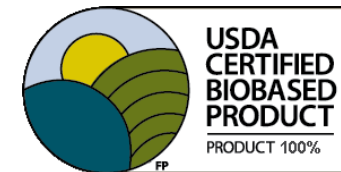
What are we doing for the planet?

# Natural ester fluid is a better choice for the communities you serve

- Made from a renewable resource
  - >98% vegetable oil
  - Carbon neutral\*
  - Contains no petroleum, halogens, silicones or sulfurs
- Non-toxic, non-hazardous in water and soil
  - OECD oral and aquatic toxicity test
- Biodegrades in less than 28 days
  - Readily biodegradable according to OECD 301 B and Environmental Protection Agency (EPA) OPPTS 835.3110 (readily) and 835.3100 (ultimately)
- Reclaimable, Recyclable, Reusable



SEA Marconi Technologies, March 15, 2017 using the OECD 301 B Ready Biodegradability CO<sub>2</sub> Evolution Method as modified for oily substances according to the American Society for Testing and Materials (ASTM D5864.05, Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or their Components).



\* According to BEES 4.0 lifecycle analysis

# Designed to deliver

## Envirotemp™ FR3 Natural Ester

### 1. Cost efficiencies, optimized transformer performance, grid reliability

- Extend insulation life
- Increase loadability
- Solid insulation is continuously dried

**5-8X**  
**LONGER**  
cellulose insulation life  
THAN MINERAL OIL

up to  
**20%**  
MORE LOAD  
CAPABILITY

### 2. Increased fire safety

- Highest fire point (>360°C) available K-class fluids

**ZERO**  
TRANSFORMER FIRES  
IMPROVED FIRE SAFETY



### 3. Improved environmental footprint with best-in-class environmental properties



**RENEWABLE**  
**BIODEGRADABLE**

### 4. Very low maintenance cost

# Safer

Zero reported fires  
with FR3 filled  
transformers



# Reliable

Robust solution  
Dielectric capacity  
preserved  
Continuous drying



# Sustainable

Biodegradable  
Non-toxic in water  
and soil  
Renewable base  
Carbon neutral



# Resilient

Flexible loading  
Life extension  
Superior peak  
capacity  
Profitable





Helping the world *thrive*