

## Advantages of K-class fluids for electrical installations.

Cargill™ FR3™ fluid has exceptionally high flash / fire points of approximately 330°C / 360°C (as per ASTM D92) - the highest values of any high fire point dielectric fluid currently available. FR3 qualifies as NEC “less-flammable”, “IEC Class K”, and NESC “non-propagating” insulating liquid for transformer application.

It is Approved by FM Global<sup>1</sup> and Classified by UL<sup>2</sup> as a Less-Flammable Dielectric Liquid for use in complying with the National Electric Code<sup>3</sup> (NEC) for indoor and outdoor applications. The guidelines presented in this document are based on UL Classification<sup>2</sup> and FM Global<sup>4</sup> requirements for less-flammable liquid, referred to as “listing” requirements in NEC 450.23.

### IEEE 979 / NFPA 70 / NEC requirements

The IEEE 979, in Section 1.3 states: *“The predominant dielectric insulating fluid for transformers is mineral oil, and mineral oil constitutes one of the primary fire hazards in the substation. Consequently, much of this guide addresses hazards and protection measures based on mineral oil fires. There are several alternative fluids with improved fire safety properties (higher flash and fire points), known as “less-flammable” dielectric fluids, which have been introduced. Many of these fluids have been recognized as reducing the hazard and the risk of a fire occurring relative to mineral oil.”*

The fire safety codes and listings are structured with alternative options to meet the requirements for fire safety. Fire safety related applications where approved and listed insulating liquids are being applied includes: indoors installations, rooftops, near buildings, bush and forest fire prone areas and in pedestrian traffic areas. In addition, substation safeguards required for mineral oil filled equipment can often be avoided, resulting in improved fire safety and significant cost savings due to: reduced separation distance between transformers and other equipment and buildings, no firewalls (which can impact natural cooling), and no need for water deluge systems.

The most relevant reference is Section 450.23 of NEC<sup>3</sup>, while the FM Global DS 5-4<sup>4</sup> is the internationally accepted reference for listing requirements.

### Indoor Installations

Table 1 is an adaptation of the requirements for indoor installations using less-flammable liquid filled transformers from FM Global DS5-4<sup>4</sup>. The link to this document is provided by in the NEC 450.23 (A), given the indoor installed transformer is rated 35kV or less, in item “d”: *The installation complies with all the restrictions provided for in the listing of the liquid.* The referred document is a widely accepted reference, internationally used.

Table 1 – Recommended Construction for Transformer Buildings and Rooms – adapted from FM Global DS5-4<sup>4</sup>.

Transformer Type	Fluid Type	Volume in Largest Transformer	Building Fire Rating	Fire Protection for Transformer Liquids
FM Approved or equivalent <sup>c</sup>	FM Approved liquids	Any <sup>d</sup>	Non-combustible	None <sup>b</sup>
Non- Approved Transformer	FM Approved liquids	Any <sup>d</sup>	One-hour fire-rated	None <sup>b</sup>
			Non-combustible	Per Section 2.2.3 <sup>e</sup>

b - See also Section 2.2.3.4 for protection of combustibles other than transformer liquids.

c - Section 3.3 describes FM Approved and equivalent transformers.

d - Provide liquid spill containment in accordance with Section 2.2.1.5

e - Automatic sprinklers, foam-water sprinklers or water mist.

Also provide emergency drainage for sprinkler discharge per Section 2.2.1.6

### Outdoor Installations

NEC 450.23 (B) provides that for buildings Type I (fire resistive) or Type II (non-combustible), the installation shall comply with all the restrictions provided for in the listing of the liquid. This links to FM Global DS 5-4<sup>4</sup>, as a widely accepted global reference for “listing requirements”.

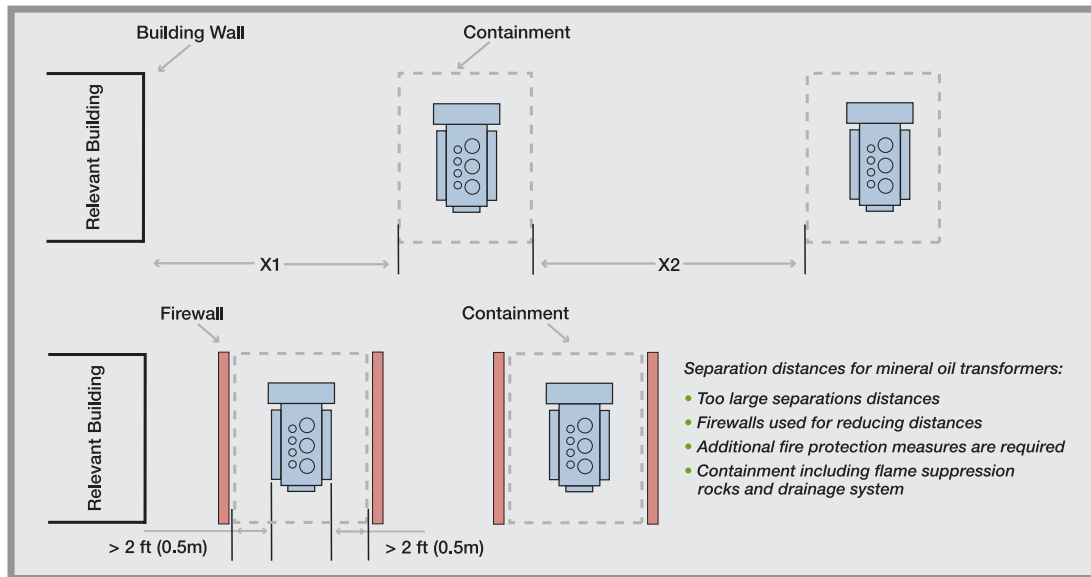
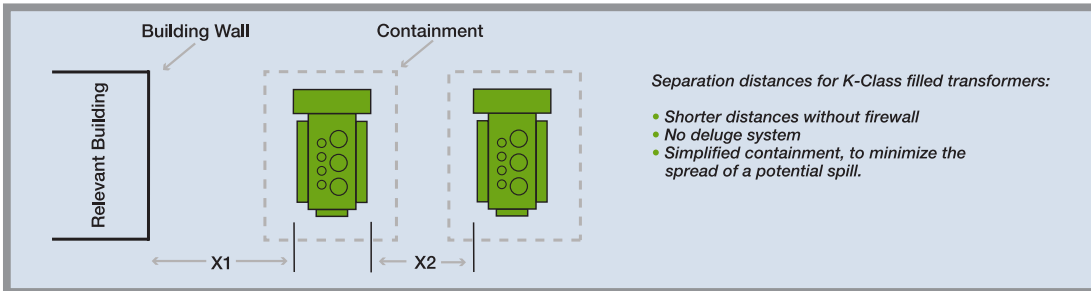
For mineral-oil-filled equipment fires the separation distances are measured at the flame front limit, which is the containment perimeter. For less-flammable fluids, where the risk of a pool fire is mitigated, the flame front limit would be the transformer itself. Providing the prescriptive space separation distances, no additional measures are required. Additional dimensions for height and wide coverage for protection of exposed main building walls can be found in FM Global DS5-4<sup>4</sup>.

### Containment and Drainage Systems

Most of the containment features, required due to the pool fire risk in the case of mineral oil, can be simplified when using k-class liquids. As per item 6.6.12 of IEEE 979<sup>5</sup>, the fluid may be retained in the containment area of the equipment when it is a less flammable fluid.

**Table 2 – Recommended Construction for Transformer Buildings and Rooms**  
 – adapted from FM Global DS5-4<sup>4</sup>.

Insulating Fluid Type	Total Volume of Fluid	Minimum Separation Distances from Transformers to Buildings - X1		Minimum Separation Distances Between Adjacent Transformers -X2
		Non-combustible buildings	Two hours fire-rated buildings	
Mineral Oil	>500 gal (1.9m <sup>3</sup> )	15 ft (4.6 m)	5 ft (1.5 m)	5 ft (1.5 m)
	≤5,000 gal (1.9-19m <sup>3</sup> )	25 ft (7.6 m)	15 ft (4.6 m)	25 ft (7.6 m)
	>5,000 gal (19m <sup>3</sup> )	50 ft (15.2 m)	25 ft (7.6 m)	50 ft (15.2 m)
K-Class Fluid (FR3™ fluid)	>10,000 gal (38m <sup>3</sup> )	5 ft (1.5 m)		5 ft (1.5 m)
	≤10,000 gal (38m <sup>3</sup> )	15 ft (4.6 m)		25 ft (7.6 m)



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