2017 NEC Requirement Guidelines for the Installation of Listed Less-Flammable Liquid-Filled Transformers

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These guidelines represent Eaton's understanding and interpretation of the National Electrical Code®. UL® Classification of Envirotemp® FR3™ Fluid and FM Global Property Loss Prevention Data Sheets 5-4 - Transformers, Approved Transformer Fluids Standard 6933, FM Approved Transformer Standard 3990 and IEEE standards in effect at the time of this publication. It does not necessarily represent the position of Eaton on the protection and installation of less-flammable transformers.
General requirements

NEC (NFPA 70) Recognition: These guidelines focus on the requirements of Section 450.23 of the 2017 National Electrical Code (NEC) for the installation of Less-Flammable Liquid-Insulated Transformers. Less-flammable liquids are used in transformers where an extra margin of fire safety is important. Typical applications include installations indoors, on rooftops, near buildings, bush and forest fire prone areas and in pedestrian traffic areas.

Less-flammable liquids, also known as high fire point liquids, are transformer dielectric coolants that have a minimum fire point of 300°C. Commonly used fire resistant coolants include high molecular weight hydrocarbons (HMWH), dimethysiloxane, synthetic esters (Envirotemp 200 fluid), and natural esters (Envirotemp FR3 fluid). Two Nationally Recognized Testing Laboratories (NRTL)* Underwriters Laboratories (UL) and FM Global (FM) currently list less-flammable liquids. They also list less-flammable liquid-filled transformers.

Less-flammable liquid-filled transformers were formally recognized by the NEC for indoor installations in 1978. In 1990, the NEC integrated specific less-flammable transformer requirements for outdoor installations into Section 450.23, in effect recognizing less-flammable transformers as inherently safer than conventional oil-filled transformers. Less-flammable transformers, long recognized as an additional safeguard for indoor installations, are becoming increasingly recognized for outdoor installations as well.

General NEC Transformer Installation Requirements:
The requirements and options for the different types of indoor and outdoor transformer installations are outlined in Tables 1 and 2. These guidelines also summarize the UL Classification and FM Global Approved installation requirements for less-flammable liquid referred to as “listing” requirements in NEC 450.23.

NEC Section 450.28, Modification of Transformers, requires that when modifications are made to transformers in existing installations that change the transformer type, the transformers must be marked to show the type of insulating liquid installed and the installations must comply with current requirements of the NEC. Examples of changes include replacing a complete transformer (retrofitting) or replacement of the fluid only (retrofilling). Askarel (PCB) and conventional mineral oil-filled transformers can be retrofitted or retrofilled using some types of less-flammable liquids like natural esters. Section 110.34 sets minimum clear work space dimensions around transformers.

Note:
The intention of this guide is focused on the NEC requirements for the installation of transformers. However, the user of the Guide should be aware that not all transformer installations are under the jurisdiction to require compliance to NEC, such as the NESC, the National Electrical Safety Code. Transformer owned and operated by electric Utilities typically follow the NESC guidelines.

NESC (ANSI C2) Recognition: Utility-owned transformer installations are typically subject to the requirements of the National Electrical Safety Code (NESC), ANSI C2, in lieu of the NEC. Since 1993, the NESC has also recognized the use of less-flammable transformer liquid as an optional fire safeguard for indoor and outdoor transformer installations in Section 152. Other optional fire safeguard methods that may be applied, depending on the degree of fire hazard present in the installation, are separation from combustible materials or structures, liquid confinement, fire resistant barriers or enclosures, or extinguishing systems.

Note: Envirotemp™ and FR3™ are licensed trademarks of Cargill, Incorporated.

*Refer to Occupational Safety & Health Administration (OSHA) for complete listing of NRTLs.
Indoor installation options
(Refer to Appendices 1 and 4)

450.23 Less-Flammable Liquid-Insulated Transformers.
Transformers insulated with less-flammable liquids that have a fire point of not less than 300°C shall be permitted to be installed in accordance with 450.23(A) or 450.23(B). ***

Table 1. NEC Section 450.23 Requirements – (A) Indoor installation. Indoor installations shall be permitted in accordance with one of the following:

1. In Type I or Type II buildings*, in areas where all of the following requirements are met:
   a. The transformer is rated 35,000 volts or less.
   b. No combustible materials are stored.
   c. A liquid confinement area is provided.
   d. The installation complies with all the restrictions provided for in the listing of the liquid.

Informational note: Such restrictions may include, but are not limited to: maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types and proper sizing of overcurrent protection.

2. With an automatic fire extinguishing system and a liquid confinement area, provided the transformer is rated 35,000 volts or less.

3. In accordance with 450.26**

Type I and Type II building definition

Type I – Fire-resistive
This concrete and steel structure, called fire resistive when first built at the turn of the century, is supposed to confine a fire by its construction. This type of construction in which the building elements are of non-combustible materials, such as concrete and steel. The roof is also of non-combustible material, such as concrete or steel.

Type II – Non-combustible
This type of building has steel or concrete walls, floors, and structural framework similar to type I construction; however, the roof covering material is combustible. The roof covering of a type II building can be a layer of asphalt waterproofing, with a combustible felt paper covering. Another layer of asphalt may be mopped over the felt paper.

NFPA 450.26 information
450.26 Oil-insulated transformers installed indoors.

Oil insulated transformers installed indoors shall be installed in a vault constructed as specified in Part III of this article.

Exception No. 1: Where the total capacity does not exceed 112½ kVA, the vault specified in Part III of this article shall be permitted to be constructed of reinforced concrete that is less than 100 mm (4 in.) thick.

Exception No. 2: Where the nominal voltage does not exceed 1000 volts, a vault shall not be required if suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 3: Electric furnace transformers that have a total rating not exceeding 75 kVA shall be permitted to be installed without a vault in a building or room of fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 4: A transformer that has a total rating not exceeding 75 kVA and a supply voltage of 1000 volts or less that is an integral part of charged-particle-accelerating equipment shall be permitted to be install without a vault in a building or room of non-combustible or fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 5: Transformers shall be permitted to be installed in a detached building that does not comply with Part III of this article if neither the building nor its content present a fire hazard to any other building or property, and if the building is used only in supplying electric service and the interior is accessible only to qualified persons.

Exception No. 6: Oil insulated transformers shall be permitted to be used without a vault in portable or mobile surface mining equipment (such as electric excavator) if each of the following conditions are met:

- Provisions are made for draining leaking fluid to the ground
- Safe egress is provided for personnel
- A minimum of 6 mm (1/4 in) steel barrier is provided for personnel protection

* Refer to NFPA 220 for definition of non-combustible or limited combustible Type I and II building construction.

** No additional NEC article 450.23 safeguards are required if one or more of Exceptions 1 - 6 of Section 450.26, Oil-Insulated Transformers Installed Indoors apply.

*** Section 450.23 (A) published in the 2017 NEC by NFPA included an editorial error in the numbering. This error was corrected by Errata No. 70-17-6 dated July 5, 2018. The strikethroughs shown reflect the corrections NFPA issued with Errata 70-17-6. There were no requirement changes intended to this Section in the 2017 NEC from the 2014 NEC.
Example – Option (A)(1), indoor installation rated ≤ 35 kV

Without a vault in Type I or II building*, non-combustible materials with liquid containment pan.

*Refer to NFPA 220 for more information about Type I and Type II building construction.
**Outdoor installation options**  
*(Refer to Appendices 2 and 5)*

Outdoor installations using less-flammable liquid-insulated transformers must comply with NEC section 450.23, which defines the requirements for the two installations options as detailed in Table 2:

<table>
<thead>
<tr>
<th>Class of Transformer</th>
<th>Installation Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I and Type II buildings*</td>
<td>Installation shall comply with all the restrictions provided for in the listing of the liquid.</td>
</tr>
<tr>
<td></td>
<td>Informational note No. 1: Installations adjacent to combustible material, fire escapes or door and window openings may require additional safeguards such as those listed in 450.27.</td>
</tr>
<tr>
<td></td>
<td>Informational note No. 2: Such restrictions may include, but are not limited to: maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types and proper sizing of overcurrent protection.</td>
</tr>
<tr>
<td><strong>Or</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Informational note No. 1: As used in this section, Type I and Type II buildings refers to Type I and Type II building construction as defined in NFPA 220-2015, Standard on Types of Building Construction. Combustible materials refers to those materials not classified as non-combustible or limited-combustible as defined in NFPA 220-2015, Standard on Types of Building Construction.</td>
</tr>
<tr>
<td></td>
<td>Informational note No. 2: See definition of Listed in Article 100.</td>
</tr>
</tbody>
</table>

**450.27 Oil-insulated transformers installed outdoors.**

Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on roofs, attached to or adjacent to a building or combustible material.

In case where the transformer installation presents a fire hazard, one or more of the following safeguards shall be applied according to the degree of hazard involved:

- Space separation
- Fire resistant barriers
- Automatic fire suppression systems
- Enclosures that confine the oil of a rupture transformer tank

Oil enclosures shall be permitted to consist of fire-resistant dikes, curved areas or basins, or trenches filled with coarse, crushed stone. Oil enclosures shall be provided with trapped drains where the exposure and the quantity of oil involved are such that removal of oil is important.

Informational Note: For additional information on transformers installed on poles or structures or underground, see ANSI C2-2007, National Electrical Safety Code.

*Refer to NFPA 220 for more information about Type I and Type II building construction.*

As in indoor installations, less-flammable liquid-insulated transformers are increasingly recognized as an additional safeguard by insurance underwriters and specifiers for outdoor applications. The degree of fire safety will be significantly increased when a transformer is filled with less-flammable liquid instead of conventional mineral oil. Transformers installed according to the listing requirements of less-flammable liquids will provide an even greater margin of safety.

**Outdoor Installations Using Conventional Mineral Oil, per IEEE 979**

Spatial separation of outdoor mineral-oil-insulated equipment

Electrical equipment installed outdoors and containing mineral oil should be separated from other equipment, buildings, and the adjacent property line to minimize the impact of a major fire. Spatial separation is an effective method for reducing fire spread or damage from mineral-oil-filled equipment fires.

There are two methods for determining acceptable minimum separation distances. Prescriptive guidelines are presented in 7.2 followed by a performance-based alternative discussed in 7.3. The prescriptive method is most commonly used, but this method may not provide adequate protection for all site conditions. The performance-based method indicates a level of protection that more accurately models the specific site conditions.

Per Section 1.3 General: 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. Use of a “less flammable” fluid is one means to reduce the risk of fire at a substation. See 8.4.2 and A.21 for additional information on these fluids.

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* Refer to NFPA 220 for definition of non-combustible or limited combustible Type I and II building construction.

** Per NFPA 220, the definition of combustible material refers to material not classified as non-combustible or limited-combustible.
NEC Options for Transformer Listing **
Indoor installation

At the time of the publication of this Guide, two nationally recognized testing entities list less-flammable insulating liquids and publish their respective listing requirements:

A. Underwriters Laboratories classifications
B. FM Global Approvals

It is optional which of the listings are used to comply with 450.23.

For indoor installations, if the transformers are provided with less-flammable liquid insulation and are installed without a vault in a Type I or Type II non-combustible building* where no combustible material is stored, it requires:

1) A liquid confinement area be provided.
   Liquid containment may include:
   - Containment pan
   - Curbing
   - Room containment (e.g. door sill)
2) The transformer be filled with a listed less-flammable insulating liquid with a minimum of 300°C fire point.
3) The installation complies with all restrictions provided for in the listing of the liquid.

Or

A liquid confinement area, as indicated above and an automatic fire extinguishing system.

If the transformer has a non-listed insulating liquid, provide individual containment for the content of the transformer to prevent spills from flowing to another transformers or important equipment in the room.

Or

It must be installed in a vault complying with the NEC 450 Part III, Transformer vaults.

Section 450.26 may be followed in lieu of any requirements listed in Section 450.23. Exceptions to vault requirements are listed.

Points in Section 450.26 are also valid for less-flammable liquid-filled installations. Construction requirements for vaults are detailed in Part Ill of Article 450.

Section 450.42 in Part III, Transformer Vaults, allows an exception to the 3-hour vault requirement permitting a 1-hour rated fire resistant rated room if equipped with an automatic extinguishing system.

*Refer to NFPA 220 for more information about Type I and Type II building construction.

**No additional NEC article 450.23 safeguards are required if one or more of exceptions 1-6 of Section 450.26, Oil-insulated transformers installed indoors apply.
Listing option – A
Underwriters Laboratories Requirements*

The UL Classification of less-flammable liquids per the NEC Section 450.23 for 3-Phase 45-10,000 kVA transformers requires:

- Transformers be equipped with tanks capable of withstanding 12 psig without rupture.
- Transformers be equipped with pressure relief devices with minimum pressure relief capacity per the UL Classification Marking.
- Transformer primaries be protected with overcurrent protection options per the UL Classification Marking.

Overcurrent Protection Option I, available exclusively with Envirotex FR3 Fluid’s UL Classification, allows internal expulsion fuses (e.g., bay-o-net fuses) only if in series with current limiting fuses. Overcurrent Protection Option II allows stand-alone expulsion fuses, but they must be located outside the transformer tank.

To specify a UL Classified Envirotex FR3 fluid-filled transformer for a specific kVA rating, refer to the UL Classification Marking for the fluid shown in Table 3.

<table>
<thead>
<tr>
<th>Transformer Rating kVA</th>
<th>Required Current Limiting Fusing (+)</th>
<th>Or Required Overcurrent Protection (+)</th>
<th>Required Pressure Relief Capacity, (+++) SCFM at 15 psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>500,000</td>
<td>700,000</td>
<td>35</td>
</tr>
<tr>
<td>75</td>
<td>500,000</td>
<td>800,000</td>
<td>35</td>
</tr>
<tr>
<td>112.5</td>
<td>550,000</td>
<td>900,000</td>
<td>35</td>
</tr>
<tr>
<td>150</td>
<td>600,000</td>
<td>1,000,000</td>
<td>50</td>
</tr>
<tr>
<td>225</td>
<td>650,000</td>
<td>1,200,000</td>
<td>100</td>
</tr>
<tr>
<td>300</td>
<td>750,000</td>
<td>1,400,000</td>
<td>100</td>
</tr>
<tr>
<td>500</td>
<td>900,000</td>
<td>1,900,000</td>
<td>350</td>
</tr>
<tr>
<td>750</td>
<td>1,100,000</td>
<td>2,200,000</td>
<td>350</td>
</tr>
<tr>
<td>1,000</td>
<td>1,250,000</td>
<td>3,400,000</td>
<td>350</td>
</tr>
<tr>
<td>1,500</td>
<td>1,500,000</td>
<td>4,500,000</td>
<td>700</td>
</tr>
<tr>
<td>2,000</td>
<td>1,750,000</td>
<td>6,000,000</td>
<td>700</td>
</tr>
<tr>
<td>2,500</td>
<td>2,000,000</td>
<td>7,500,000</td>
<td>5,000</td>
</tr>
<tr>
<td>3,000</td>
<td>2,250,000</td>
<td>9,000,000</td>
<td>5,000</td>
</tr>
<tr>
<td>3,750</td>
<td>2,500,000</td>
<td>11,000,000</td>
<td>5,000</td>
</tr>
<tr>
<td>5,000</td>
<td>3,000,000</td>
<td>14,000,000</td>
<td>5,000</td>
</tr>
<tr>
<td>7,500</td>
<td>3,000,000</td>
<td>14,000,000</td>
<td>5,000</td>
</tr>
<tr>
<td>10,000</td>
<td>3,000,000</td>
<td>14,000,000</td>
<td>5,000</td>
</tr>
</tbody>
</table>

* UL EOVK - Transformer Fluids
Fire protection for indoor transformers (FM requirement)

If transformers cannot be located outdoors in accordance with section 2.3 of the FM DS 5-4, provide a detached dedicated building or room with location and construction safeguards as described in Fig. 1 and Table 1 (Reference to Fig. 2a and Table 4 of the FM DS 5-4). This applies to dry or liquid filled insulated transformers.

![Diagram of transformer locations](image)

**Fig 1. Locations from Transformer buildings and rooms**

**Table 4. Recommended construction for transformer buildings and rooms**

<table>
<thead>
<tr>
<th>Transformer type</th>
<th>Fluid type</th>
<th>Fluid volume in largest transformer</th>
<th>Room or building fire rating</th>
<th>Fire protection for transformer liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry or gas insulated</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Non combustible</td>
<td>None</td>
</tr>
<tr>
<td>FM approved or equivalent</td>
<td>FM approved liquid</td>
<td>Any</td>
<td>Non combustible</td>
<td>None</td>
</tr>
<tr>
<td>FM approved liquids</td>
<td>Any</td>
<td>One-hour fire-rated</td>
<td>Non combustible</td>
<td>Per section 2.2.3e</td>
</tr>
<tr>
<td>Non approved liquids</td>
<td>Less than 100 gal</td>
<td>One-hour fire-rated</td>
<td>None</td>
<td>Per section 2.2.3e</td>
</tr>
<tr>
<td></td>
<td>(380 L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>More than 100 gal</td>
<td>Three-hour fire-rated with subdivisions if multiple transformers</td>
<td>None</td>
<td>Per section 2.2.3e</td>
</tr>
<tr>
<td></td>
<td>(380 L)</td>
<td>Three-hour fire-rated with multiple transformers and no subdivision</td>
<td>None</td>
<td>Per section 2.2.3e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One-hour fire-rated with single transformer</td>
<td>None</td>
<td>Per section 2.2.3e</td>
</tr>
</tbody>
</table>

*a* With no oil-filled bushings, oil-filled tap changer or other oil-filled accessories that could increase the fire hazard

*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 sprinklers discharge per Section 2.2.1.6

*f* Subdivide room or building with three-hour fire-rated construction for each transformer if multiple transformers are present

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*a* Fig. 1 is based on the information provided on Fig. 2a of the FM document DS 5-4 dated 10-2017.

**Table 4 is based on the information provided on Table 4 of the FM document DS 5-4 dated 10-2017.
**Listing option - B**

**FM Global Requirements**

The FM indoor installation requirements for all transformer and fluid types are given in FM Global Property Loss Prevention Data Sheets 5-4 - Transformers (LPD). Specific requirements for less-flammable liquid-insulated transformers are included. Refer to Section 2.2.1.2 of FM LPD for special installation requirements for network transformers.

General transformer requirements are as follows:

- Minimum 3 ft. clear from building walls, **and**
- Liquid containment provisions, **and**
- Room fire resistance rating based on fluid and transformer type, **and**
- Room ventilation, if necessary, to prevent non-thermal damage, **and**
- Smoke detection with alarm in the electrical room.

Less-flammable liquid-filled transformers must comply with one of the following:

- Be FM Approved or equivalent, **or**
- Be located in a room with a one hour fire resistance rating, **or**
- Have automatic sprinklers above the transformer and 20 ft. beyond with a discharge density of 0.20 gpm/sq. ft.

**FM Approved Transformer:**

Less-flammable liquid-filled transformers rated 5 through 10,000 kVA must be equipped with specific design and protection features to be FM Approved or equivalent. Key characteristics of this protection system are fire properties of the liquid, the ability to mechanically withstand pressure generated by a low level electrical fault and the ability of electrical protection to clear a fault before tank rupture.

According to FM Global Standard 3990 dated 1-2018, the key protection features are as listed below. Refer to the FM standard for complete requirements:

- The transformer tank rupture strength shall be a minimum of 15 psig for rectangular and 20 psig for cylindrical tanks. All transformer tanks shall be designed to withstand a pressure of 7 psig without permanent distortion, **and**
- The transformer tank shall be provided with a pressure relief device to vent internal overpressures. The device must be capable of venting a minimum specified flow rate, based on the kVA as noted in Table 4 and Section 3.2.3 of the FM Global Standard 3990. Proper pressure venting coordinated with proper tank pressure withstand rating has proven highly effective in preventing tank rupture from overpressure due to internal fault currents below the trip rating of primary circuit current limiting fuses, **and**
- The transformer tank shall have over-current protection which limits the let-through current (I^2t) to a specified maximum value as listed in Table 5 and in Section 3.2.5 of the FM Global Standard 3990. Current-limiting fusing and its functional equivalents are designed to interrupt a high current internal fault before the tank withstand pressure level is reached. If protection is designed to vent gas during operation, such as with expulsion fuses, this protection shall be located outside the transformer tank. Exception: Envirotemp FR3 fluid-immersed expulsion fusing (e.g. bay-o-net) may be mounted in the transformer tank if in series and properly coordinated with current limiting fusing, **and**
- The unit is filled with an FM Global Less-Flammable liquid* to reduce the probability of ignition of the liquid. Less-Flammable liquids, also known as high fire point or fire resistant liquids, are dielectric coolants that have a minimum fire point of 300 °C per the ASTM D92 Open Cup Test Method, **and**
- The primary circuit shall have over-current protection which limits the let-through current (I^2t) to a specified maximum value as listed in Table 5 and in Section 3.2.5 of the FM Global Standard 3990. Current-limiting fusing and its functional equivalents are designed to interrupt a high current internal fault before the tank withstand pressure level is reached. If protection is designed to vent gas during operation, such as with expulsion fuses, this protection shall be located outside the transformer tank. Exception: Envirotemp FR3 fluid-immersed expulsion fusing (e.g. bay-o-net) may be mounted in the transformer tank if in series and properly coordinated with current limiting fusing, **and**

* For a listing of FM Global Less-Flammable liquids, refer to the Less Flammable Fluids section of the FM Global Approval Guide - Electrical Equipment.
Listing option - B
FM Global Requirements (continued)

- For grounded wye secondary windings of 150 volts or more and rated at 1,000 or more nominal amperes, a notification tag shall be provided by the manufacturer, secured to the low voltage neutral bushing, advising that the transformer installation requires ground fault relay protection prior to energization (if not installed at time of manufacturing), Indoor units greater than 500 kVA should be provided with alarm contacts on the pressure relief device and units greater than 2500 kVA, in all locations shall be equipped with alarm contacts on the pressure relief device and a rapid-rise relay, And

- Three-phase pad-mounted and substation transformers shall be equipped with an oil level gauge. Additionally, all transformers rated 750 kVA or higher shall be equipped with a liquid temperature indicator and pressure-vacuum gauge, And

- Transformers shall be capable of passing Basic Lightning Impulse Insulation Level (BIL) testing at a minimum tilt of 15° from vertical.

Table 5: FM Pressure Relief Device Required Ratings

<table>
<thead>
<tr>
<th>kVA Rating 3-Phase (1-Phase)</th>
<th>Flow Rate SCFM @ 15psi (103 pKa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>112.5 (37.5)</td>
<td>35</td>
</tr>
<tr>
<td>150 (50)</td>
<td>50</td>
</tr>
<tr>
<td>300 (100)</td>
<td>100</td>
</tr>
<tr>
<td>1,000 (333)</td>
<td>350</td>
</tr>
<tr>
<td>2,000 (667)</td>
<td>700</td>
</tr>
<tr>
<td>10,000 (3,333)</td>
<td>5,000</td>
</tr>
<tr>
<td>Over 10000 KVA (3333 10)</td>
<td>12600</td>
</tr>
</tbody>
</table>

Note: For kVA ratings not listed use next highest rating in table.

Table 6: FM Maximum I²t Let Through Required Ratings

<table>
<thead>
<tr>
<th>kVA Rating 3-Phase (1-Phase)</th>
<th>Current Limiting Fusing</th>
<th>Other Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 (15)</td>
<td>500,000</td>
<td>700,000</td>
</tr>
<tr>
<td>75 (25)</td>
<td>500,000</td>
<td>800,000</td>
</tr>
<tr>
<td>112.5 (37.5)</td>
<td>550,000</td>
<td>900,000</td>
</tr>
<tr>
<td>150 (50)</td>
<td>600,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>225 (75)</td>
<td>650,000</td>
<td>1,200,000</td>
</tr>
<tr>
<td>300 (100)</td>
<td>750,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td>500 (167)</td>
<td>900,000</td>
<td>1,900,000</td>
</tr>
<tr>
<td>750 (250)</td>
<td>1,100,000</td>
<td>2,200,000</td>
</tr>
<tr>
<td>1,000 (333)</td>
<td>1,250,000</td>
<td>3,400,000</td>
</tr>
<tr>
<td>1,500 (500)</td>
<td>1,500,000</td>
<td>4,500,000</td>
</tr>
<tr>
<td>2,000 (667)</td>
<td>1,750,000</td>
<td>6,000,000</td>
</tr>
<tr>
<td>2,500 (833)</td>
<td>2,000,000</td>
<td>7,500,000</td>
</tr>
<tr>
<td>3,000 (1,000)</td>
<td>2,250,000</td>
<td>9,000,000</td>
</tr>
<tr>
<td>3,750 (1,250)</td>
<td>2,500,000</td>
<td>11,000,000</td>
</tr>
<tr>
<td>5,000 (1,667)</td>
<td>3,000,000</td>
<td>14,000,000</td>
</tr>
<tr>
<td>7,500 (2,500)</td>
<td>3,000,000</td>
<td>14,000,000</td>
</tr>
<tr>
<td>10,000 (3,333) and over</td>
<td>3,000,000</td>
<td>14,000,000</td>
</tr>
</tbody>
</table>

Note: For kVA ratings not listed use next lowest rating in table.
NEC Options for Transformer Listing - Outdoor installations

The NEC allows two different options for the listing of the installed liquid transformers:

(A) Underwriters Laboratories; or

(B) FM Global

For outdoor installations, the FM approval indicates that the Spill containment requirements for environmental protection and related regulations are outside the scope of the DS 5-4. Some considerations can still be consider for spillage.

1. If an accidental release of transformer fluid could expose a main building or adjacent equipment or storage, provide the liquid filled transformer with a spill containment

2. Design the spill containment system in accordance with Chapter 7 of IEEE STD 980.

Or

It must be installed in accordance with NEC section 450.27, oil insulated transformers installed outdoors, i.e. space separation, fire barriers or water spray systems

Less-flammable liquid-insulated transformers are permitted to be installed outdoors, attached to, on, or adjacent to non-combustible* buildings. The installation must comply with the requirements of a recognized listing of the fluid.

A fine print note states that combustible material**, combustible buildings, fire escapes and door and window openings may require additional safeguarding, as describe in Section 450.27. Fine Print Notes (FNP) are defined in Section 90.5 as informational only and are not enforceable as code requirements

*Refer to NFPA 220 for definition of non-combustible or limited combustible Type I and II building construction.

**Per NFPA 220, the definition of combustible material refers to material not classified as non-combustible or limited-combustible.
Listing option - A
Underwriters Laboratories Requirements

The same UL Classification of less-flammable liquids per the NEC Section 450.23 for 3-Phase 45-10,000 kVA transformers applies to both indoor and outdoor applications and requires:

- Transformers be equipped with tanks capable of withstanding 12 psig without rupture, \textit{And}
- Transformers be equipped with pressure relief devices with minimum pressure relief capacity per the UL Classification Marking, \textit{And}
- Transformer primaries be protected with overcurrent protection options per the UL Classification Marking.

Overcurrent Protection Option I, available exclusively with Envirotemp FR3 Fluid’s UL Classification, allows internal expulsion fuses (e.g. bay-o-net fuses) in series with current limiting fuses. Overcurrent Protection Option II allows stand-alone expulsion fuses, but they must be located outside the transformer tank.

To specify a UL Classified Envirotemp FR3 fluid-filled transformer for a specific kVA rating, refer to the UL Classification Marking for the fluid shown in Table 3.

Listing option - B
FM Global Requirements

The outdoor installation requirements according to FM Global Property Loss Prevention Data Sheets 5-4 - Transformers consist of requirements for transformer and fluid types. Specific requirements for less-flammable liquid-insulated transformers are included.

FM outdoor installation requirements are based on the FM Approval Status of the transformer and both the volume and FM Approval Status of the fluid. If transformers filled with conventional mineral oil or non-approved fluids would expose buildings and equipment to a release of oil, the transformer must comply with FM LPD requirements. This may include containment, separation distances, fire barriers, or water spray systems. Installation of FM Approved transformers or transformers with FM Approved less-flammable liquids must comply with FM LPD requirements for containment and separation distances. The FM LPD provides detailed requirements for fire barriers in Section 2.3.1.1.1 and water spray exposure protection in Section 2.3.2.1.

Fluid containment requirements as detailed in Section 2.3.1.4 of the FM LPD are:

- Provide a liquid containment when accidental release of fluid could expose the main building, adjacent equipment or storage
- Design the containment per IEEE 980
- Where water spray is provided, install additional containment or direct discharge water, this per DS 7-83
- Provide system for removal of rainwater from the containment area
- Extend containment perimeter at least 5 ft for transformers with up to 1000 gal and 8 ft for transformers with more than 1000 gal
- Provide containment system for roof-mounted liquid-filled transformer
Listing option - B
FM Global Requirements (continued)

Separation Distance: Separation distance requirements are based on whether the transformer is FM Approved or equivalent, or the volume of fluid, and if the fluid is FM Approved. For FM listed less-flammable liquid as well as the non-approved FM transformer, the horizontal distance is measured from closest inside edge of the spill containment barrier area and the 2 hour fire barrier.

Per Approval standard 3990 dated 1-2018, the transformer must be located 5 ft (1.5 m) from doors, fire escapes and windows.

Table 7. Separation for exposure protection of main building walls (see Fig. 2) **

<table>
<thead>
<tr>
<th>Fluid or transformer type</th>
<th>Fluid volume, gal (m³)</th>
<th>2-hour fire-rated wall ft (m)</th>
<th>Non-combustible wall ¹ ft (m)</th>
<th>Combustible wall ¹ ft (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM approved transformer or equivalent</td>
<td>Per approval listing</td>
<td>3 (0.9)</td>
<td>3 (0.9)</td>
<td>3 (0.9)</td>
</tr>
<tr>
<td>FM approved liquid in non-approved transformer</td>
<td>&lt; 10,000 (38)</td>
<td>5 (1.5)</td>
<td>5 (1.5)</td>
<td>25 (7.6)</td>
</tr>
<tr>
<td></td>
<td>&gt;10,000 (3.8)</td>
<td>5 (1.5)</td>
<td>5 (1.5)</td>
<td>50 (15.2)</td>
</tr>
<tr>
<td>Non-approved transformer liquid</td>
<td>≤5000 (1.9 – 19)</td>
<td>15 (4.6)</td>
<td>25 (7.6)</td>
<td>50 (15.2)</td>
</tr>
<tr>
<td></td>
<td>&gt;5000 (19)</td>
<td>25 (7.6)</td>
<td>50 (15.2)</td>
<td>100 (30.5)</td>
</tr>
</tbody>
</table>

¹ For definition of combustible and non-combustible construction material, see Appendix A of DS 1-1. Fire safe building construction and materials

* Figure 2 is based on the information provided on Fig. 2b of the FM document DS 5-4 dated 10-2017.

** Table 7 is based on the information provided on Table 5 of the FM document DS 5-4 dated 10-2017.
**Listing option - B**  
FM Global Requirements (continued)

Fig 3. Use of 2-hour fire barriers and separation distances for protection of exposed main building walls*

**Table 8. Separation and extent of 2-hour fire barrier for protection of Main building walls (for dimensions refer to fig. 3) **

<table>
<thead>
<tr>
<th>Fluid type</th>
<th>Fluid volume, gal (m³)</th>
<th>Separation and extent of 2-hour fire barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dimensions 1,2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(See fig. 3)</td>
</tr>
<tr>
<td>FM approved transformer fluid</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>&lt; 10,000 (38)</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td>&gt;10,000 (3.8)</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
</tr>
<tr>
<td>Non-approved transformer liquid</td>
<td>&lt;500 (1.9)</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td>≤5000 (1.9 – 19)</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td>&gt;5000 (19)</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
</tr>
</tbody>
</table>

1 For definition of combustible and non-combustible construction material, see Appendix A of DS 1-1. Fire safe building construction and materials
2 Barrier vertical extent is dimension Z in the Table of the building height plus 30 in. (0.75 m) parapet, whichever is less.
3 For definitions of combustible and non-combustible construction material, see Appendix A of DS 1-1, *Fire Building Construction and Materials*

* Figure 3 is based on the information provided on Fig. 2c of the FM document DS 5-4 dated 10-2017.
** Table 8 is based on the information provided on Table 6 of the FM document DS 5-4 dated 10-2017.
Listing option - B
FM Global Requirements (continued)

![Diagram of transformer fire exposure and separation distances]

* Figure 4 is based on the information provided on Fig. 2d of the FM document DS 5-4 dated 10-2017.

** Table 9 is based on the information provided on Table 7 of the FM document DS 5-4 dated 10-2017.

---

### Table 9. Transformer fire exposure to non-combustible building roof where separation from wall is based on 3-hour fire barrier or water spray protection **

<table>
<thead>
<tr>
<th>Liquid type</th>
<th>Maximum liquid volume Gal (m³)</th>
<th>Building height ft (m)</th>
<th>W (see fig. 4) ft (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-approved transformer fluid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;1000 (3.8)</td>
<td>Any</td>
<td>Not exposed</td>
</tr>
<tr>
<td></td>
<td>Any</td>
<td>≥50 (15)</td>
<td>Not exposed</td>
</tr>
<tr>
<td></td>
<td>1000 – 5000 (3.8 – 19)</td>
<td>≥25 (7.5)</td>
<td>Not exposed</td>
</tr>
<tr>
<td></td>
<td>1000 – 5000 (3.8 – 19)</td>
<td>&lt;25 (7.5)</td>
<td>15 (4.5)</td>
</tr>
<tr>
<td></td>
<td>&gt;5000 (19)</td>
<td>&lt;50 (15)</td>
<td>25 (7.5)</td>
</tr>
</tbody>
</table>

---

### Table 10. Minimum separation distance between adjacent transformers

<table>
<thead>
<tr>
<th>Liquid type</th>
<th>FM Approved transformer or Equivalent</th>
<th>Liquid Volume gal (m³)</th>
<th>Distance ft (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM approved transformer fluid</td>
<td>Yes</td>
<td>N/A</td>
<td>3 (0.9)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>≤10000 (38)</td>
<td>5 (1.5)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>&gt;10000 (38)</td>
<td>25 (7.6)</td>
</tr>
<tr>
<td>Non-approved transformer fluid</td>
<td>N/A</td>
<td>≤500 (1.9)</td>
<td>5 (1.5)</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>500 - &lt;5000 (19)</td>
<td>25 (7.6)</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>≥5000 (19)</td>
<td>50 (15.2)</td>
</tr>
</tbody>
</table>
Outdoors on or adjacent to combustible buildings or combustible materials

Installation type
For installations other than Type I and Type II* buildings or for installations that do not comply with all the restrictions provided for in the listing of the liquid.

NEC requirement
- Per NEC Section 450.27, Oil-Insulated Transformers Installed Outdoors.

Section 450.23 refers to Section 450.27, Oil Insulated Transformers Outdoors, for installation requirements when less-flammable liquid-filled transformers are installed on or adjacent to combustible buildings or near combustible materials. As for conventional oil-filled transformers, it requires the safeguarding of combustible material, combustible buildings, fire escapes and door and window openings. Recognized safeguards include space separation, fire barriers, spray extinguishing systems and confinement areas for spilled fluid. The NEC requires that one or more of the above safeguards be applied according to the degree of fire hazard present in cases where the installation presents a fire hazard. Obviously, less-flammable liquid-filled transformers significantly reduce the possibility that the installation presents a fire hazard compared to conventional mineral oil.

*Refer to NFPA 220 for definition of non-combustible or limited combustible Type I and II building construction.
Appendix 1 - Indoor installations per UL listing requirements

Less-Flammable Liquid-Insulated Transformers
Compliance to NEC Section 450.23 per UL Listing

Requirement Highlights

- Transformer ≤ 35 kV and Liquid Confinement Area Available
- Non-Combustible Building (Type I or Type II)* and No Combustibles in the Area
- UL Classified Transformer Fluid**
- Installation Incorporates UL Classification** Marking Requirements

UL OPTION I
- Pressure Relief Device
- Minimum 12 psig Tank Pressure Rupture Withstand
- Primary Current Limiting Fusing Per UL Classification Marking.**

UL OPTION II
- Pressure Relief Device
- Minimum 12 psig Tank Pressure Rupture Withstand
- Overcurrent Protection Per UL Classification Marking.**

NOTE: Devices that vent during operation such as bay-o-net fuses may not be liquid-immersed.

COMPLIANCE WITH NEC 450.23

UL Classified Transformer Fluids:**
Cargill Envirotemp FR3 Fluid (natural ester), Option I or Option II
Dow Corning® 561 (silicone), Option II only

* Refer to NFPA 220 for definition of non-combustible Type I and II building construction
** Transformer Fluids (EOVK), Underwriters Laboratories Certifications Directory

Note: UL Classification Dielectric Mediums (EOUV) states that “Liquids intended for use as dielectric and cooling mediums in electrical transformers are covered under Transformer Fluids (EOVK).”
Appendix 2 - Outdoor installations per UL listing requirements

Less-Flammable Liquid-Insulated Transformers
Compliance to NEC Section 450.23 per UL Listing

Requirement Highlights

UL Classified Transformer Fluids:*  
Cargill Envirotemp FR3 Fluid (natural ester), Option I or Option II  
Dow Corning® 561 (silicone), Option II only

* Refer to NFPA 220 for definition of non-combustible Type I and II building construction  
** Transformer Fluids (EOVK), Underwriters Laboratories Certifications Directory  

Note: UL Classification Dielectric Mediums (EOUV) states that "Liquids intended for use as dielectric and cooling mediums in electrical transformers are covered under Transformer Fluids (EOVK)."
Appendix 3

UL Classified Less-Flammable Liquids & UL Listed & Classified Transformers

Important Information to Assure Code Compliance Part A: Dielectric liquids

Not all UL Classified dielectric liquids applied in transformers meet NEC Section 450.23 requirements. Simply specifying that a transformer be filled with a UL Classified dielectric liquid is not sufficient to assure the transformer meets NEC Section 450.23 listing requirements.

UL has two classification categories for dielectric liquids:

- EOUV: Dielectric Mediums (See page 24 for EOUV guideinfo)
- EOVK: Transformer Fluids (See page 26 for EOVK guideinfo)

To assure compliance with NEC Section 450.23 listing requirements of UL, the dielectric liquid must be Classified as an EOVK Transformer Fluid as detailed in Part A2 of this appendix.

Part A1: UL Classification EOUV Dielectric Mediums

This category is a fire hazard rating only. All Classified Dielectric Mediums have the same fire hazard ratings, “Classed 4 to 5 less hazardous paraffin oil in respect to fire hazard.” Included in the EOUV Classification are requirements for minimum ignition temperature, fire point, and closed cup flash point. This Classification makes no reference to NEC 450.23, and does not classify the fluid as a “less-flammable liquid” in accordance with Section 450.23.

Table A1 - UL Classified EOUV Dielectric Mediums‡

<table>
<thead>
<tr>
<th>EOUV Dielectric Medium</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargill Incorporated Envirotemp FR3</td>
<td>natural ester</td>
</tr>
<tr>
<td>Momentive Performance Materials SF97-50</td>
<td>silicone</td>
</tr>
<tr>
<td>Sopus Products Diala® HFX</td>
<td>HMWH</td>
</tr>
<tr>
<td>DSI Ventures Beta®</td>
<td>HMWH</td>
</tr>
<tr>
<td>Dielectricos Vegatales SAS</td>
<td>Natural Ester</td>
</tr>
<tr>
<td>Dong Nam Petroleum Ind. Co Ltd</td>
<td>Natural Ester</td>
</tr>
<tr>
<td>Dow Silicone Co Ltd</td>
<td>silicone</td>
</tr>
<tr>
<td>Dow Silicone Corp</td>
<td>silicone</td>
</tr>
<tr>
<td>M&amp;I Materials Ltd</td>
<td>Synthetic Ester</td>
</tr>
<tr>
<td>Prolec GE International SRL de CV</td>
<td>Natural Ester</td>
</tr>
<tr>
<td>Savita Polymer Limited</td>
<td>Natural Ester</td>
</tr>
<tr>
<td>Yi Chiu Chemical &amp; Technical Co Ltd</td>
<td>Insulating Oil</td>
</tr>
</tbody>
</table>

This category covers liquids intended for use as dielectric and cooling mediums. Liquids intended for use as dielectric and cooling mediums in electrical transformers are covered under Transformer Fluids (EOVK).

Part A2: UL Classification EOVK Transformer Fluids

In addition to giving the requirements for minimum ignition temperature, fire point, and closed cup flash point, this category gives the UL Use Restrictions required for compliance with NEC 450.23 for the listed less flammable fluids.

Table A2 gives the fluids listed in the UL Directory having EOVK Classification.

Table A2 - UL Classified EOVK Transformer Fluids‡

<table>
<thead>
<tr>
<th>EOVK Transformer Fluids</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargill Incorporated Envirotemp FR3 fluid</td>
<td>natural ester</td>
</tr>
<tr>
<td>Dow Corning 561</td>
<td>silicone</td>
</tr>
</tbody>
</table>

This category covers liquids intended for use as dielectric and cooling mediums in electrical transformers.

‡ This list includes all the insulating liquid manufacturers listed by UL and FM Global as of the date of this publication. Refer to UL and FM Global for the latest lists.
Appendix 3 (continued)

UL Classified Less-Flammable Liquids &
UL Listed & Classified Transformers

Important Information to Assure Code Compliance
Part B: UL Listed Transformers

Not all UL Listed and classified transformers meet NEC Section 450.23 requirements.

Simply specifying that a transformer be UL Listed is not sufficient to assure the transformers meet NEC Section 450-23 listing requirements.

To assure UL Listed transformers meet NEC Section 450-23 requirements, the transformer must use an EOVK Transformer Fluid or EOUV dielectric medium and meet its Use Restrictions (see Part A2).

Part B1: XPLH Transformers, Distribution, Liquid-filled Type, Over 600 Volts

UL transformer listing requirements, detailed in UL Guideline XPLH, allow the use of mineral oil and other transformer coolants regardless of Classification status. These transformers are required to comply with various IEEE C57.12.00 standards listed in the XPLH.GuideInfo sheet. This guide states that transformers with the UL Listing mark are: “intended for installations with the requirements of NFPA 70, National Electrical Code.” Table B1 shows the manufacturers of UL Listed liquid-insulated transformers.

Table B1 - UL XPLH Listed Transformers‡

<table>
<thead>
<tr>
<th>XPLH Transformer Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>EATON Cooper Power Series</td>
</tr>
<tr>
<td>ABB Inc, South Boston VA</td>
</tr>
<tr>
<td>ABB Inc, Jefferson City MO</td>
</tr>
<tr>
<td>GE Co., Shreveport LA</td>
</tr>
<tr>
<td>Howard Industries Inc, Laurel, MS</td>
</tr>
<tr>
<td>Prolec GE, Monterrey MX</td>
</tr>
<tr>
<td>Virginia Transformer Corp, Roanoke VA</td>
</tr>
<tr>
<td>ERMCO, Dyersburg, TN</td>
</tr>
<tr>
<td>Maddox Industrial Transformer LLC, Mauldin, SC</td>
</tr>
<tr>
<td>Niagara Transformer Corp., Buffalo, NY</td>
</tr>
<tr>
<td>Schneider Electric USA, Nashville, TN</td>
</tr>
<tr>
<td>Siemens Energy INC, Richland, MS</td>
</tr>
<tr>
<td>Solomon Corporation, Solomon, KS</td>
</tr>
<tr>
<td>Southwest Electric, Oklahoma City, OK</td>
</tr>
<tr>
<td>Sunbelt Transformer INC, Temple, TX</td>
</tr>
<tr>
<td>Vantran Industries INC, Waco, TX</td>
</tr>
<tr>
<td>HC Transformer and Switchgear, Torrance, CA</td>
</tr>
<tr>
<td>WEG Transformers USA, Washington, MO</td>
</tr>
</tbody>
</table>

These transformers will display a single UL Listing Mark, the UL symbol, together with the word “LISTED,” a control number, and the product name “Liquid-Filled Distribution Transformer” as in Figure B1.

Figure B1 – Example transformer mark for a UL Listed ANSI-compliant transformer.

‡ This list includes all the insulating liquid manufacturers listed by UL and FM Global as of the date of this publication. Refer to UL and FM Global for the latest lists.
Appendix 3 (continued)

UL Classified Less-Flammable Liquids & UL Listed & Classified Transformers

Important Information to Assure Code Compliance
Part A: Dielectric Coolants

Part B2: UL Listed and Classified Transformers for use as Less-Flammable Liquid-Insulated Transformer In Accordance With Sec. 450.23 of the NEC **

UL uses the same XPLH GuideInfo sheet noted above for transformers intended to meet the requirements of NEC section 450.23. However, the sub-header “USE AND INSTALLATION” adds the following requirements:

• Transformer must be provided with UL Classified “Less-Flammable Liquid, having a fire point of not less than 300°C”
• Transformer must be Marked to:
  • identify the product name and flammability rating of the liquid
  • indicate whether the liquid may evolve flammable gases when decomposed by an electric arc (as applicable)
  • list all the use restrictions provided for in the UL Classification of the liquid.

A UL Listed and Classified Transformer must display both a Listing mark and a Classification mark. See Figure B2.

Figure B2 Example transformer mark for a UL Listed and Classified transformer filled with an UL EOVK Transformer Fluid and complying with its Use Requirements.

Eaton manufacturers UL Listed and Classified Transformers for use as less-flammable liquid-insulated transformers in accordance with NEC Section 450.23. UL does not currently publish which transformer manufacturers offer the dual marking. Purchasers and users should confirm their UL Listed transformers also are UL Classified and the units have both respective UL logos for units that are intended for use in complying with NEC Section 450.23.

The transformer listing by UL should be referred to as an “UL Listed And Classified Transformer for Use as Less-Flammable Liquid-Insulated Transformer in Accordance with Sec. 450.23 of The National Electric Code (NEC)”.

** The source of the information of this section is the UL online certification Directory, XPHL.GuideInfo -Transformers, Distribution, Liquid-filled Type, Over 600 Volts on October 18, 2016. Copyright © Underwriters Laboratories Inc®.
Appendix 3 (continued)

UL Classified Less-Flammable Liquids &
UL Listed & Classified Transformers

Important Information to Assure Code Compliance
EOUV.GuidelInfo
Dielectric Mediums
USE

This category covers liquids intended for use as dielectric and cooling mediums. The liquids are not intended to replace mineral oil unless equipment is also designed for the specific liquid.

These products have been Certified as to their fire hazard only, using Underwriters Laboratories’ method for Classification of the fire hazard of liquids. They have been rated on a numerical scale of hazard ranging from 0 to 100 as indicated in the table below:

<table>
<thead>
<tr>
<th>General classification</th>
<th>Numerical classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diethyl ether</td>
<td>100</td>
</tr>
<tr>
<td>Gasoline</td>
<td>90 to 100</td>
</tr>
<tr>
<td>Between gasoline and ethyl alcohol</td>
<td>80 to 90</td>
</tr>
<tr>
<td>Between ethyl alcohol and gasoline</td>
<td>70 to 80</td>
</tr>
<tr>
<td>Ethyl alcohol</td>
<td>60 to 70</td>
</tr>
<tr>
<td>Between ethyl alcohol and kerosene</td>
<td>50 to 60</td>
</tr>
<tr>
<td>Between kerosene and ethyl alcohol</td>
<td>40 to 50</td>
</tr>
<tr>
<td>Kerosene</td>
<td>30 to 40</td>
</tr>
<tr>
<td>Between kerosene and paraffin oil</td>
<td>20 to 30</td>
</tr>
<tr>
<td>Paraffin oil</td>
<td>10 to 20</td>
</tr>
<tr>
<td>Less hazardous than paraffin oil</td>
<td>0 to 10</td>
</tr>
<tr>
<td>Water or nonflammable</td>
<td>0 or nonflammable</td>
</tr>
</tbody>
</table>

Note: Dielectric media/transformer fluids including mineral oil, natural and synthetic esters, silicone oil and refined petroleum oil exhibiting flammability temperature limits > 464°F (240°C) may be assigned a Numerical Fire Hazard Rating of “4-5 Less Hazardous than paraffin oil.”

Related products
Liquids intended for use as dielectric and cooling mediums in electrical transformers are covered under Transformer Fluids (EOVK).

Additional information
For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ) and Flammable and Combustible Liquids and Gases Equipment (AAPQ).

Requirements
The basic standard used to investigate products in this category is ANSI/UL 940 “Tests for Comparative Flammability of Liquids.”

UL Mark
The Certification Mark of Underwriters Laboratories Inc. on the product container is the only method provided by UL to identify products manufactured under its Classification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the word “CERTIFIED” and “SAFETY”, the geographical identifier(s) and the file number.

Additional Certification Markings
Products covered under this category are additionally marked with the following information:

AS TO FIRE HAZARD ONLY

These products may also be marked with the following statement:

MAY EVOLVE FLAMMABLE GASES
WHEN DECOMPOSED BY AN ELECTRIC ARC

Alternate UL Mark
The Classification Mark of UL on the product container is the only method provided by UL to identify products manufactured under its Classification and Follow-Up Service. The Classification Mark for these products includes the UL symbol, the word “CLASSIFIED” above the UL symbol (as illustrated in the Introduction of this Directory), and the following additional information:

[PRODUCT IDENTITY]
CLASSED
AS TO FIRE HAZARD ONLY
Control No.
Appendix 3 (continued)

UL Classified Less-Flammable Liquids &
UL Listed & Classified Transformers

Important Information to Assure Code Compliance
EOUV.GuidelInfo
Dielectric Mediums
USE

The Classification Mark may also include the following statement as appropriate:

MAY EVOLVE FLAMMABLE GASES WHEN DECOMPOSED
BY AN ELECTRIC ARC

UL, in performing its function in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. UL shall not incur any obligation or liability for any loss, expense or damages, including incidental or consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Guide information.

Last Updated on 2017-08-28

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Appendix 3 (continued)

UL Classified Less-Flammable Liquids &
UL Listed & Classified Transformers

Important Information to Assure Code Compliance
EOVK.Guideline
Transformer Fluids
(Dielectric Mediums) Transformer Fluids
USE

This category covers liquids intended for use as dielectric and cooling mediums in electrical transformers.

These products have been Certified as to their fire hazard only, using Underwriters Laboratories' method for Classification of the fire hazard of liquids. They have been rated on a numerical scale of hazard ranging from 0 to 100 as indicated in the table below:

<table>
<thead>
<tr>
<th>General classification</th>
<th>Numerical classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diethyl ether</td>
<td>100</td>
</tr>
<tr>
<td>Gasoline</td>
<td>90 to 100</td>
</tr>
<tr>
<td>Between gasoline and ethyl alcohol</td>
<td>80 to 90</td>
</tr>
<tr>
<td>Between ethyl alcohol and gasoline</td>
<td>70 to 80</td>
</tr>
<tr>
<td>Ethyl alcohol</td>
<td>60 to 70</td>
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<tr>
<td>Between ethyl alcohol and kerosene</td>
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</tr>
<tr>
<td>Between kerosene and ethyl alcohol</td>
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<td>Kerosene</td>
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<tr>
<td>Less hazardous than paraffin oil</td>
<td>0 to 10</td>
</tr>
<tr>
<td>Water or nonflammable</td>
<td>0 or nonflammable</td>
</tr>
</tbody>
</table>

Note: Dielectric media/transformer fluids including mineral oil, natural and synthetic esters, silicone oil and refined petroleum oil exhibiting flammability temperature limits > 464°F (240°C) may be assigned a Numerical Fire Hazard Rating of "4-5 Less Hazardous than paraffin oil."

Related products
Liquids intended for use as dielectric and cooling mediums are covered under Dielectric Mediums (EOUV).

Use restrictions
Products Classified as 'less-flammable liquid' may have use restrictions on the product container. Certain fluids have fuse use restrictions which require that the fuse must be either a type which does not vent under normal operation, or it must be installed external to the transformer tank.

Additional information
For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ) and Flammable and Combustible Liquids and Gases Equipment (AAPQ).

Requirements
The basic standard used to investigate products in this category is ANSI/UL 340 "Tests for Comparative Flammability of Liquids."

These products are also certified as a "less-flammable liquid" or "nonflammable liquid" in accordance with Sections 450.23 or 450.24 of ANSI/NFPA 70, "National Electrical Code."

UL mark
The Certification Mark of Underwriters Laboratories Inc. on the product container is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the word "CERTIFIED" and "SAFETY", the geographical identifier(s) and a file number.

Additional Certification Markings
Products covered under this category are additionally marked with the following information:

AS TO FIRE HAZARD ONLY

These products may also be marked with one or more of the following statements:

MAY EVOLVE FLAMMABLE GASES WHEN DECOMPOSED BY AN ELECTRIC ARC

ALSO CERTIFIED AS A "LESS-FLAMMABLE LIQUID" IN COMPLIANCE WITH THE NATIONAL ELECTRICAL CODE WITH "USE RESTRICTIONS"

ALSO CERTIFIED AS A "NONFLAMMABLE LIQUID" IN COMPLIANCE WITH THE NATIONAL ELECTRICAL CODE WITH "USE RESTRICTIONS"

Alternate UL Mark
The Classification Mark of UL on the product container is the only method provided by UL to identify products manufactured under its Classification and Follow-Up Service. The Classification Mark for these products includes the UL symbol, the word "CLASSIFIED" above the UL symbol (as illustrated in the Introduction of this Directory), and the following additional information:

For the original info see the following link http://productspec.ul.com/document.php?id=EOvk.Guideline

[PRODUCT IDENTITY]
CLASSED
AS TO FIRE HAZARD ONLY
Control No.
Appendix 3 (continued)

UL Classified Less-Flammable Liquids &
UL Listed & Classified Transformers

Important Information to Assure Code Compliance
EOVK.GuideInfo
Transformer Fluids
(Dielectric Mediums) Transformer Fluids
USE

The Classification Mark may also include the following statement as appropriate:

MAY EVOLVE FLAMMABLE GASES WHEN DECOMPOSED
BY AN ELECTRIC ARC
Also classified as a "less-flammable liquid"
In compliance with the national electrical code
With the following "use restrictions"
Also classified as a "nonflammable liquid"
In compliance with the national electrical code
With the following "use restrictions"

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Appendix 4 - Indoor installations per FM listing requirements

Less-Flammable Liquid-Insulated Transformers
Compliance to NEC Section 450.23 per FM Listing

Requirement Highlights

Transformer ≤ 35 kV and Liquid Confinement Area Available

Yes

Non-Combustible Building (Type I or Type II)* and No Combustibles in the Area

Yes

FM Approved Less-Flammable Liquid**

Yes

Installation Incorporates FM LPD Sheet*** Requirements

Yes

FM Approved Transformer** or Equivalent includes:
- a) Tank Rupture Strength
- b) Tank Pressure Relief
- c) Low Current Fault Protection
- d) High Current Fault Protection
- e) Approved Less-Flammable Liquid

Yes

Automatic Fire Extinguishing System Available

No

In Accordance With One Or More of the Exceptions of NEC 450.26

No

Vault Requirements per NEC 450, Part III

Yes

COMPLIANCE WITH NEC 450.23


FM Approved Fluids include: ‡
- Cargill Envirotect FR3 Fluid (natural ester)
- M&I Materials MIDEL® 7131 (synthetic ester)
- Shell Diala® HFX (fire resistant hydrocarbon)
- Dow Chemical L305, Y-7582 (silicone)
- DSI Alpha-1™, Beta® (hydrocarbon)
- Dow Corning® 561 (silicone)
- Momentive Performance Mat SF97-50
- Prolec GE Int’l VG-100

* Refer to NFPA 220 for definition of non-combustible Type I and II building construction.
** FM Global Approval Guide.
*** FM Global Property Loss Prevention Data Sheets 5-4 — Transformers.

FM Approved Transformers include: ‡
- EATON Cooper Power Series
- ABB
- Siemens
- Eaton Cutler-Hammer
- GE Energy
- Square-D
- Prolec GE Int’l
- Wilson Transformer

‡ This list includes all the insulating liquid manufacturers listed by UL and FM Global as of the date of this publication. Refer to UL and FM Global for the latest lists.
Appendix 5 - Outdoor installations per FM listing requirements

Less-Flammable Liquid-Insulated Transformers
Compliance to NEC Section 450.23 per FM*** Listing

Requirement Highlights

Non-Combustible Building
(Type I or Type II)** and
No Combustibles in the Area

Yes

Yes

FM Approved Less-Flammable Liquid**

No

Yes

Installation Incorporates
FM LPD Sheet*** Requirements

No

Yes

Requirements per Liquid Listing

See Page 19 for FM Requirements Detail

Compliance
WITH
NEC 450.23

Yes

Yes

Requirements Per NEC 450.27
If installation presents fire hazard
one or more of the following
safeguards shall be applied:
• Space Separation
• Fire Barriers
• Automatic Water Spray
• Enclosure

FM Approved Fluids include: **
Cargill Envirotex FR3 Fluid (natural ester)
M&I Materials MIDE® 7131 (synthetic ester)
Shell Diala® HFX (fire resistant hydrocarbon)
Dow Chemical L305, Y-7582 (silicone)
DSI Alpha-1™, Beta® (hydrocarbon)
Dow Corning® 561 (silicone)
Momentive Performance Mat SF97-50
Prolec GE Int'l VG-100

FM Approved Transformers include: **
EATON Cooper Power Series
ABB
Siemens
Eaton Cutler-Hammer

Note: NEC Section 110.3 (b) applies if the listing chosen for compliance specifically addresses outdoor application.
Appendix 5 - Outdoor installations per FM listing requirements (continued)

Less-Flammable Liquid-Insulated Transformers
Compliance to NEC Section 450.23 per FM Listing

FM Requirements Detail for outdoor installations

* FM Global Approval Guide.
** Environmental Technology Verification Program, U.S. Environmental Protection Agency (Envirotex FR3 fluid and BIOTEMP® fluid have ETV status for Ready Biodegradation).
*** FM Global Property Loss Prevention Data Sheets 5-4 — Transformers.