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MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2

1 MVA Pad Mount Transformer - 12470Y/7200 Grounded Wye Primary, 208Y/120 Wye Secondary - KNAN/Bell Green

Product ID: 295904



Larson Electronics LLC manufactures a wide variety of products, including custom built to spec designs. The pictures displayed for this unit are a general representation of form factor for the product line and may not accurately represent this exact configuration in every detail due to custom builds and changes between similar products in our standard catalog. The specifics for this configuration are listed in the specification table and supporting documentation (CAD files, Dimensional Drawing, Name Plate Diagram, Wiring Diagram, etc.). This means that specific details (receptacles, plugs, wires, connections, mounting brackets, external finishes, etc.) may not be accurately represented in images vs specifications. Please review specifications and do not order based solely on images.

MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2 Pad Mount Transformer

Transformer Type: Pad Mounted, Compartmental-Type
Transformer Configuration: Liquid Filled Pad Mounted
Transformer Feed Type: Loop Feed
Operation: Step-Down Operation (Not Approved for Step-Up)
Phase: Three Phase
Capacity: 1 MVA (1000 KVA)
Vector Group: YnYn0
Primary Voltage: 12470GrdY/7200
Primary Voltage Switch: N/A
Primary Voltage Class: 15 kV Class
Primary Phasor: Grounded Wye
Primary BIL: 95 KV
Secondary Voltage: 208Y/120
Secondary Voltage Class: 1.2 kV Class
Secondary Phasor: Wye-N
Secondary BIL: 30 KV
Frequency: 60 Hz
Temperature Rise: 65°C
Insulation Rating: Class E Insulation - 120°C, 248°F
Cooling Class: KNAN; Self-Cooled
Forced Air (Fans): None
Tap Changer: 5-position Tap Changer
Tap Qty: (2) FCAN Above Taps, (2) FCBN Below Taps
Tap %: 2.5%
Tap Changer Switch Rating: 300-Amp, 15 kV
Tap Changer Switch Location: High Voltage (HV) [Left Side] Front Compartment
Impedance: 5.0-7.5% Typical, Target 5.75%
Primary Connection Type: Dead Front

Ratings

Meets/Exceeds DOE 2016 Efficiency Ratings
Meets/Exceeds CSA Efficiency Ratings
Complies with ANSI / IEEE C57.12.00
Complies with ANSI / IEEE C57 12.28
Complies with ANSI / IEEE C57 12.29
Complies with ANSI / IEEE C57 12.34
Complies with ANSI / IEEE C57 12.35
Complies with ANSI / IEEE C57.12.70
Complies with ANSI / IEEE C57.12.110
Complies with ANSI / IEEE C57.12.131
Complies with ANSI / IEEE C62.11
Complies with ANSI / IEEE C62.22
Complies with ANSI / IEEE 386
Complies with ANSI / IEEE C2
Complies with ANSI / IEEE C37.47
Complies with ANSI Z535.4
Complies with ASTM D3487
Complies with ASTM D6871
Complies with NEMA 260-1996
Complies with 10 CFR Part 431
Complies with CSA C2.1-06
Complies with CSA C50
Complies with CSA C88
Complies with CSA C88.1
Complies with CSA C88-16
Complies with CSA C227.4
Complies with CSA C227.5
Complies with CSA C802-3

Primary Termination Arrangement: V Terminal Arrangement
Primary Termination: Externally Clamped Well Bushings w/ Removable Studs, 200A Load Break Elbows w/ Inserts
Primary Connection Qty: (6) Primary Connections for use w/ Elbow Connectors
Primary Parking Stand Qty: (6) Welded Brackets for Installing Accessory Parking Stand Bushings
Primary Bushing Rating: 15 kV Class, 95 kV BIL, 200A, Load Break, IEEE 386 Color Red
Primary Neutral Connection: Primary HO Neutral Internally Bonded to Tank
Primary Surge Arrestors: (3) High Voltage Elbow Surge Arrestors, Included
Primary Surge Arrestor Voltage Rating: 10 kV Class Elbow Arrestor
Primary Surge Arrestor MCOV Rating: 8.4 kVrms
Primary Over Current Protection (OCP): Bayonet Expulsion Fuse in series w/ Partial-Range Current-Limiting Fuse
Primary Over Current Protection Method: Fused, Oil-Immersed
Primary Over Current Protection Holder: Bayonet Fuse Holder w/ Flapper Valve and External Drip Shield
Primary Grounding Provisions: (1) NEMA Ground Bar attached to tank via (2) Welded Ground Bungs in HV Cabinet
Secondary Connection Type: Live Front
Secondary Termination Arrangement: Staggered Terminal Arrangement
Secondary Connections: NEMA Spade Terminals, 10-Hole Spade, Externally Clamped, Accepts up to (10) Double Lug connections with (5) cables per side of Spade connector
Secondary Connection Qty: (4) Externally Clamped One-Piece Epoxy Bushings Copper Threaded Studs
Secondary Connection Supports: N/A
Secondary Over Current Protection (OCP): N/A
Secondary Neutral Connection: Secondary X2 Neutral Grounded to Tank via 1/2"-13 UNC Tapped Hole, 7/16" Deep Bung & Copper Ground Strap
Secondary Grounding Provisions: (1) NEMA Ground Bar attached to tank via (2) Welded Ground Bungs in LV Cabinet
Metering Current Transformer (CT): N/A
Metering Panel: N/A
Auxiliary Control Panel : N/A
Load Break Switch: 4-Position Load Break Switch
Load Break Switch Qty: (1)
Load Break Switch Rating: 300-Amp, 15 kV
Load Break Switch Location: High Voltage (HV) Front Compartment
Efficiency Standard(s): Meets DOE 2016 Standards, Meets CSA Standards Meets ANSI/IEEE Standards
K-Factor Rating (Harmonic Mitigation): K-1 (Standard)
Pulse Drive Rating: N/A
Insulation Fluid: Cargill FR-3 Biodegradable Natural Vegetable Oil Ester Insulating Fluid - Non-PCB Fluid
Fluid (Oil) Capacity*: 212 Gallons
Fluid (Oil) Weight*: 1,631 lb
Liquid Level Indicator: Analog Dial Gauge
Temperature Indicator: Analog Dial Gauge
Pressure/Vacuum Indicator: Analog Dial Gauge
Pressure Relief Device: Included, Automatic Action
Fault Indicator: N/A
Gas Sampler Valve: Included, Schrader Valve
Fill Valve: 1" NPT Port w/ Removable Bolt Plug
Fill Valve Location: Front Compartment
Drain Valve: 1" NPT Port w/ 5/8" NPT Sampler Valve
Drain Valve Location: Front Compartment
Winding Material: Copper
Ambient Temperature Rating: 40°C
Ambient Operating Temperature Range: -40°C to +40°C (-50°F to +104°F)
Sound Level: 58 dBA
Elevation (Altitude): 3300ft (1000 meters) Above Sea Level
Core Material: Grain Oriented Steel
Tank Material: Coated Steel
Cabinet Material: Coated Steel
Base Platform Material: Coated Steel
Portability: Lifting lugs, provisions for jacking under base, w/ base construction suitable for using rollers or skidding
Housing Type: Compartmental Air-Filled Cabinet w/ Locking Doors, HV Compartment Left, LV Compartment Right, Steel Barrier Separation, HV Door Spring-Loaded Release Pin in LV Compartment
Enclosure Rating: NEMA 3R Weatherproof Wiring Cabinet, Sealed Tank
Seismic Rating: Yes

Complies with CSA C802.1

Features

Pentahead Bolt Entry Assembly
High-Fire Point Insulating Fluid
Non-PCB Insulating Fluid
Tamper Proof Housing
Hinged Front Compartment Doors, Pad Lockable
NEMA 3R Wiring Compartment
Hot Stick Included, HV Door Mount

Efficiency %: 99.20%

Based on transformer operating at 50% of nameplate base kVA.

Load Losses Based on 85°C Reference Temp.

No Load Loss (in watts): +/- 1,300W

Full Load Loss (in watts) at 100%: +/- 8,500W

Total Load Loss (in watts) at 100%: +/- 9,800W

Total Losses at 55°C LL Temp.& 20°C NL Temp.

Total Load Loss (in watts) at 50%: +/- 3,221W

Note: Losses offered are typical only, not guaranteed

Labeling:

Externally Stencilled (Painted) KVA Rating
Externally Stencilled (Painted) Voltage Rating
External Non-PCB Label
External Warning & Danger Label
External Barcode Label
Internal Busing & Accessory Labeling
Stainless Steel Riveted Nameplate

Factory Tests:

Winding Resistance Test
Insulation Resistance Test
Voltage Ratio Error Test
Short-circuit Impedance Test
No-load Loss (Wattage) Test
Load Loss (Wattage) Test
Induced Voltage Withstand Test
Separate Source Voltage Withstand Test
Pressure Integrity Test Test

Shipping:

Shipped on pallet on open flatbed
Palletized on Wooden Pallet w/ Skid Pockets
Pallet Skid Facing Outward Sides of Truck
Note: Crated shipping in lieu of palletizing can be done upon request for an additional fee

Paint Type: Weatherproof and UV Resistant Epoxy Coating and Undercoating
Finish Color: Munsell™ 7.0 GY 3.29/1.5 Bell Green
Mounting: Pad Mounted
Conduit Opening: Bottom Feed Underground Entry/Exit
HV Compartment Base Wireway Dimensions*: 20"-W x 5"-D
LV Compartment Base Wireway Dimensions*: 20"-W x 5"-D
MV/LV Compartment Cabinet Depth*: 24"-D
Tank Cover Access Handhole: N/A
Dimensions*: 73"-W x 69"-D x 73"-H
Dry Weight (w/o Oil)*: 3,216 lb
Total Weight (Liquid Filled)*: 6,834 lb
*Please note that numbers are approximate and subject to change

Special Orders - Requirements
Contact us for special requirements

Toll Free: 1-800-369-6671
Intl: 1-214-616-6180
Fax: 1-903-498-3364
E-mail: sales@larsonelectronics.com

The MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2 from Larson Electronics is an Industrial Pad Mount Transformer that offers powerful, reliable, and efficient power distribution in indoor, outdoor, and public locations. The low operating costs, low heat emissions, and low cost of ownership makes this transformer ideal for a wide range of applications and businesses. An enclosed design caters to installations on concrete pads without protective fencing.

PLEASE NOTE: ANY FREE SHIPPING OFFERS DO NOT APPLY TO POWER DISTRIBUTION PANELS, TRANSFORMERS, OR SUBSTATIONS*

Transformer Features: With a transformer rating of 1000 KVA (1 MVA), the industrial transformer features a dual rated primary voltage of three-phase 12470Y/7200 grounded Wye and a secondary voltage of three-phase 208Y/120 V Wye. An input voltage switch allows the transformer to be switched between primary voltages. The unit has a primary loop feed for single installations and dead-front primary connections. This transformer features a 5-position tap changer with two, +/- 2.5% taps above and two, +/- 2.5% taps below to allow small changes for voltage.

copper transformer winding material helps improve performance, reduce weight and lower cost. Compared to copper, copper windings have lower eddy losses due to higher resistivity. This transformer consists of rectangular coil and five-legged wound core design with three coils and four core loops (this is for three-phase transformers only; single-phase units have one coil and two core loops).

The MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2 is air cooled and does not have fans or mounting provision for fans.

Enclosure Design: This pad mounted transformer is a compartmental design. The tank and housing are fabricated from steel. The front electrical enclosure carries a NEMA 3R rating. The high voltage and low voltage compartments are located in front of the transformer tank, with the high voltage compartment on the left side and low voltage compartment on the right side. The HV and LV compartments are air filled and separated by a full length steel barrier between the compartments. A removable steel plate at the base of the HV and LV compartments prevents rodents and other intrusions from entering the enclosure once installed. This steel plate allows for underground conduit entry into the enclosure compartments. Two hinged exterior doors allows for access into the compartments. A single pad lockable handle on the low voltage compartment door allows for securing the transformer. A spring loaded pin within the low voltage compartment prevents the high voltage door from being opened without pulling the safety pin. A hot stick is included in the high voltage compartment, mounted to the HV door.

Temperature Rise: This unit features 65°C temperature rise for reduced heat waste, increased reliability and longer life. At 65°C temperature rise, the transformer offers 1000 KVA (1 MVA). The transformer meets standard efficiency requirements. The combination of low temperature rise and high efficiency makes this unit suitable for use in electrical rooms, air conditioned spaces in buildings, underground vaults and similar locations, in addition to outdoor areas.

Insulation Fluid: The MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2 features brand name biodegradable ester oil Cargill Envirotemp FR3® fluid

(KNAN) with a capacity of 212 gallons. We offer transformers with FR-3 oil fluid, if needed.

Biodegradable Fluid: Biodegradable cooling fluid (vegetable oil) has a higher heat capacity compared to mineral oil, making the liquid safer to use and more reliable during operations. Vegetable oil has a higher flash point and fire point than mineral oil, hydrocarbon oil, silicone oil and synthetic ester. This cooling fluid is also non-toxic and can tolerate higher breakdown voltages than mineral oil. When operating at high temperatures, biodegradable cooling liquid sustains up to 120% loan conditions, which helps preserve the transformer's lifespan and performance.

Gauges: The following gauges are included with the system: liquid level, temperature and pressure/vacuum gauges. Standard liquid level, temperature and pressure/vacuum gauges are analog, manual reading types. These gauges do not have auxiliary contacts.

Fault Pressure Devices: This transformer features an automatic action fault pressure device. Fault pressure devices are used to detect high rates of pressure rise within the tank.

Rapid Rise Relay: There are no rapid rise relays on the unit. This safety component is designed for protection when a rapid increase in tank pressure occurs. The relay is suitable for detecting sudden pressure fluctuations above predetermined safe limits.

Surge Arrestors: This system comes with high elbow surge arrestors on the primary side. Designed for over-voltage and transient voltage protection, the components prevent damage caused by lightning, internal switching or voltage surges. We can offer models without high elbow surge arrestors that have mounting provisions for customer-provided surge arrestors.

Valves: The MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2 is equipped with a pressure relief valve, fill valve, and drain valve with sampler port.

Protection Fuses: This transformer contains bayonet protection fuses on the primary side. For units without protection fuses, up stream protection is provided. We recommend provisions for protection fuses when possible, as blown fuses may require more frequent oil changes.

Mount: The heavy-duty enclosure makes the unit suitable for both indoor and outdoor applications. This power distribution system can be pad mounted on concrete pads.

Benefits: The MT-PML-R7-3P-GMR-1MVA-YT-LT-DF-A6-BF-CZ-2B4-M2 pad mount transformer offers many benefits to consumers. This transformer provides owners with significant energy savings, as well as offering environmental benefits. Higher efficiency not only extends the life of the transformer, but also turns into cost savings for owners in the form of lower energy bills and decreased cost of ownership.

Applications: General purposes, industrial sites, electrical rooms, underground vaults, manufacturing facilities, steel plants, offshore, commercial, military, processing plants, electric power distribution, utilities, public locations, and more. Larson Electronics is a manufacturer and as such can build stationary and portable transformer systems to your specifications. Although we carry several models of power distribution transformer systems, we can deliver custom ordered units almost as quickly as our prebuilt units. If this model does not meet your needs, please contact us at 1-800-369-6671 or sales@larsonelectronics.com to discuss your specific requirements.


CAUTION
CAUTION


CAUTION
CAUTION







RAPO® VEGETABLE INSULATING OIL CHARACTERS

Environmental Character

Environmental friendly

- Based on natural plants
- Almost 100% biodegradation
- Non oral toxicity
- Non toxicity for aquatic animals
- None halogen, polycyclic aromatic hydrocarbons
- Petroleum independency



Transformer oil biodegradability comparison

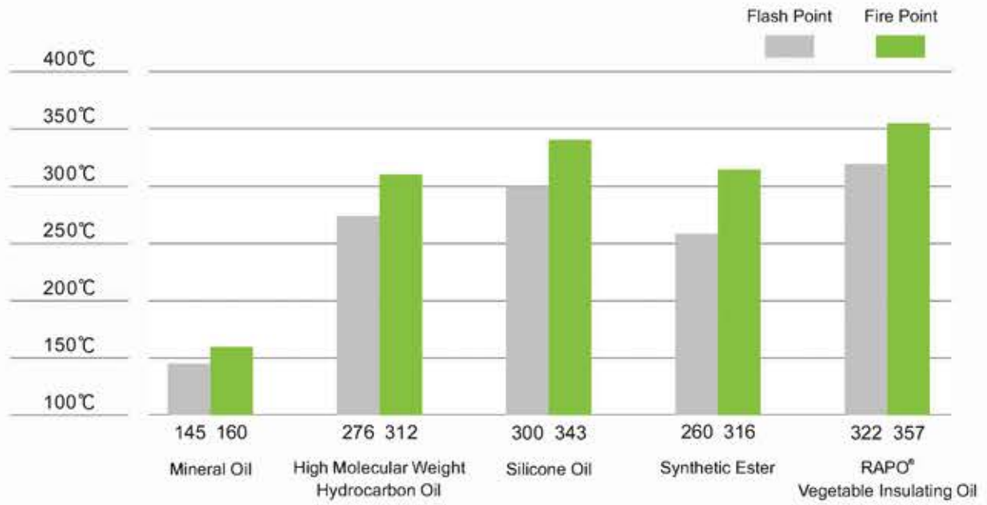


- If RAPO® spillover, it can be cleaned by normal means, instead of the way to deal with toxic waste.
- RAPO® is real green insulating oil which can avoid punishment by government regulations and eliminate the cleanup process.

Less-flammable Character

Mineral oil's fire point is in the range of 147-165ºC (296.6-329ºF). The relatively lower fire point might result in transformers' fire and explosion. The fire point of RAPO® vegetable insulating oil is up to 350ºC, higher than most of fire-resistant oil and other insulating oil in use, greatly improved the safety and reliability of transformers and grid system.

Fireproof performance comparison of various types of transformer oil

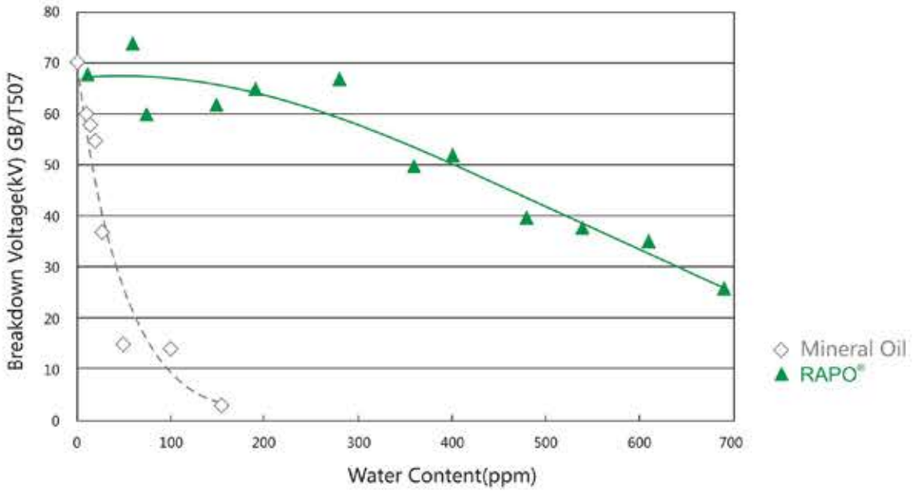


- RAPO® vegetable insulating oil can effectively save equipment maintenance, replacement and other costs, and avoid the economic losses caused by the transformer fire.
- RAPO® can be used indoors or in the compact space.
- RAPO® can help to reduce the use of fire-fighting equipment (sprinkler) and firewalls if space is limited.
- RAPO® can reduce insurance costs.

Excellent Electrical Character

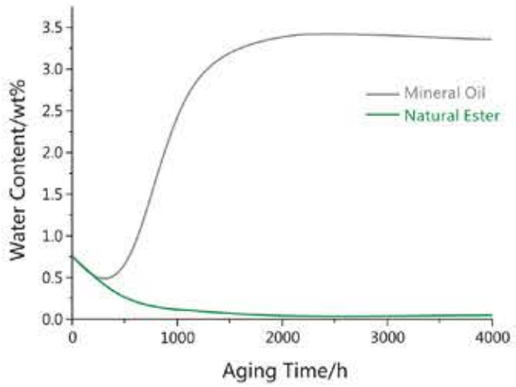
RAPO® vegetable insulating oil has a higher breakdown voltage than mineral insulating oil.

	Dielectric Breakdown (kV)	Standards Request (kV)
RAPO® Vegetable Insulating Oil	72	⩾35
Mineral Oil (typical)	65	⩾30

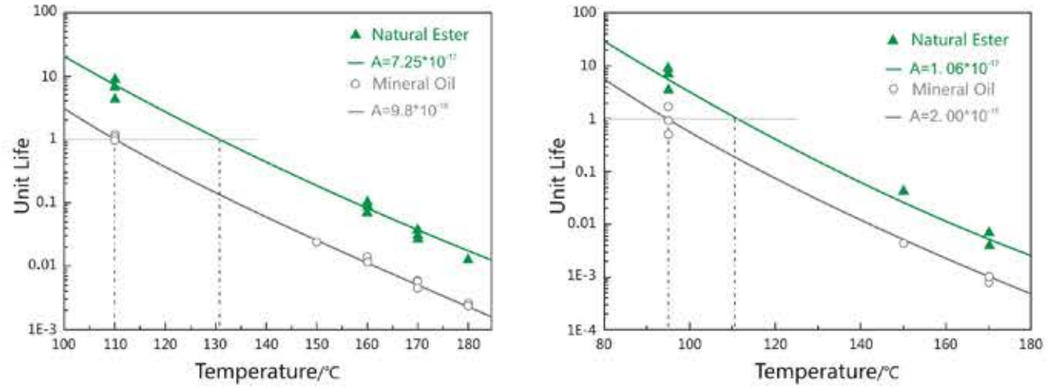


Ester chain in natural ester can make it have "polar" region, the region covered by ester chain effects like a magnetic fields which has a special attraction to water molecule and can absorb the water which exists in insulation cellulose paper material. So RAPO® has extremely high water saturation at various temperatures compared to mineral oil. Under normal operating environment, water saturation of RAPO® is 5-8 times than mineral oil.

Due to the higher water saturation of RAPO®, RAPO® vegetable insulating oil can keep the breakdown voltage to be over 60kV even if the water content exceeds over 300ppm. In contrast, the breakdown voltage decreases dramatically under 35kV when mineral oil contains a little amount of water such as 55ppm.



During thermal aging, RAPO® can absorb the water in insulation paper or pressboard which can accelerate the aging progress of insulation paper and pressboard. So RAPO® can prolong the insulation paper and pressboard aging process and improve the life span of the transformer.



Experimental data shows that insulation paper infiltrated by RAPO® can work with a long time in the environment whose temperature is 10-15℃ higher than the maximum allowable one and has same life expectancy with the insulation paper infiltrated by mineral oil, can well prevent the production of precipitates, so that can increase the overload of the transformers. Transformers using RAPO® as filled oil can work in a long term with up to 120% load conditions and without affecting transformer's life and performance.

Insulating Oil Type	Top Liquid Temperature Rise	Average Winding Temperature Rise	Hottest Spot Temperature
Mineral Oil	60℃	65℃	78℃
RAPO® Vegetable Insulating Oil	80℃	115℃	160℃





RAPO® VEGETABLE INSULATING OIL PARAMETERS

Test Items		RAPO® Insulating Oil	Test Methods	ASTM D6871
Electrical Properties				
Breakdown voltage (kV/2.5mm)		72	IEC 156	≥35
Dissipation factor (%)	25℃	0.06	ASTM D924	≤0.2
	100℃	1.37	ASTM D924	≤4
Volume resistivity (Ω•cm @25℃)		6.9×10^{13}	DL/T 421	—
Physical and Chemical Properties				
Relative density ($g\cdot cm^{-3}$ @15℃)		0.919	ASTM D1298	≤0.96
Color		L0.5	ASTM D1500	≤1.0
Total acid number (mgKOH/g)		0.024	ASTM D974	≤0.06
Viscosity(mm^2/s)	40℃	36.07	GB/T 265	≤50
	100℃	8.263	GB/T 265	≤15
Thermal Properties				
Flash point(open cup)/℃		322	GB/T 3536	≥275
Fire point/℃		357	GB/T 3536	≥300
Pour point/℃		-27	GB/T 3535	≤-10

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CERTIFICATE OF COMPLIANCE

Certificate Number	MH63693
Report Reference	MH63693-20200528
Issue Date	2020-JUNE-05
Issued to:	GUANG DONG JOOYN NEW MATERIAL TECHNOLOGY CO.,LTD. No.17, Guinan Industrial Park, Wuguishan Town Zhongshan, Guangdong 528458 CHINA
This certificate confirms that representative samples of	DIELECTRIC MEDIUMS Dielectric Medium, "RAPO Natural Ester".
	Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.
Standard(s) for Safety:	UL 340, Comparative Flammability of Liquids
Additional Information:	See the UL Online Certifications Directory at https://iq.ulprospector.com for additional information.

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Bruce Mahrenholz, Director North American Certification Program

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Dielectric Fluids

Cargill®

Electrical Apparatus

R2000

Envirotemp™ FR3™ Fluid

DESCRIPTION

Envirotemp™ FR3™ fluid is a renewable, bio-based natural ester dielectric coolant for use in distribution and power class transformers where its unique fire safety, environmental, electrical, and chemical properties are advantageous. Acceptance limits for new fluid are shown in Table 1. More than 20 years of field experience (with over one million transformers in service) confirms excellent performance.

Envirotemp FR3 fluid is formulated from seed oils and performance enhancing additives. It does **not** contain petroleum, halogens, silicones or corrosive sulfur. It quickly and thoroughly biodegrades[1] in the environment. The fluid is non-toxic in acute aquatic[2] and oral toxicity tests[3]. The Color Green tint reflects its favorable environmental profile (See Table 2) and readily distinguishes it from petroleum based oils.

Envirotemp FR3 fluid has exceptionally high flash/fire points of approximately 330/360 °C - the highest ignition resistance of any high fire point dielectric fluid currently available. It qualifies as a "high-fire-point", "less-flammable", "IEC Class K", and "non-propagating" fluid. Envirotemp FR3 fluid is Approved[4] by FM Global and Classified[5] by Underwriters Laboratories as a Less-Flammable Dielectric Liquid for use in complying with the National Electric Code[6] (NEC) and insurance listing requirements[7].

Envirotemp FR3 fluid is compatible with standard transformer construction materials and components. Envirotemp FR3 fluid should be stored, handled, and processed in a similar meticulous manner as transformer mineral oil. See Cargill's Envirotemp FR3 Fluid Storage and Handling Guide, S10, for additional information.

A transformer filled with FR3 fluid complies with the transformer temperature operating range requirements defined in IEEE C57.12.00 and IEC 60076-1.

TABLE 1

Acceptable values for receipt of shipments of new FR3 fluid

	Standard test methods		ASTM D6871	IEC 62770
PROPERTY	**ASTM**	**ISO/IEC**	**As-received new fluid property requirements**	**Unused new fluid property requirements**
Physical				
Color	D1500	ISO 2211	≤1.0	
Flash Point PMCC (˚C)	D93	ISO 2719		≥250
Flash Point COC (˚C)	D92	ISO 2592	≥275	
Fire Point (˚C)	D92	ISO 2592	≥300	>300
Pour Point (˚C)	D97	ISO 3016	<-10	≤-10
Density at 20˚C (g/cm³)		ISO 3675		
Relative Density (Specific Gravity) 15˚C	D1298		≤0.96	≤0.96
Viscosity (mm²/sec)	D445	ISO 3104		
100 ˚C			≤15	≤15
40 ˚C			≤50	≤50
0 ˚C			≤500	
Visual Examination	D1524	IEC 61099 9.2	bright and clear	clear, free from sediment and suspended matter
Biodegradation		OECD 301	readily biodegradable	readily biodegradable
Electrical				
Dielectric Breakdown (kV)	D877		≥30	
Dielectric Breakdown (kV)				
1mm gap	D1816		≥20	
2mm gap	D1816		≥35	
2.5mm gap		IEC 60156		≥35
Gassing Tendency (mm/min)	D2300		≤0	
Dissipation Factor				
25˚C (%)	D924		≤0.20	
90˚C (tan δ)		IEC 60247		≤0.05
100˚C (%)	D924		≤4.0	
Chemical				
Corrosive Sulfur	D1275	IEC 62697	non-corrosive	non-corrosive
Water Content (mg/kg)	D1533	IEC 60814	≤200	≤200
Acid Number (mg KOH/g)	D974	IEC 62021.3	≤0.06	≤0.06
PCB Content (mg/kg)	D4059		not detectable	free from PCBs
Oxidation Stability (48 hrs, 120˚C)		IEC 61125C		
Total Acidity (mg KOH/g)		IEC 62621.3		≤0.6
Viscosity at 40°C (mm²/sec)		ISO 3104		≤ 30% increase over initial
Dissipation Factor at 90°C (tan δ)		IEC 60247		≤ 0.5

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.

1 Per OPPTS 835.3110
2 Per OECD 203, Method B
3 Per OECD 420
4 Less-Flammable Transformer Fluids, Approval Guide – Electrical Equipment, FM Approvals, FM Global, Norwood, MA, USA
5 EOVK.MH10678, Transformer Fluids, UL Listed and Classified Products, Underwriters Laboratories, Northbrook, IL, USA
EOUV.MH10678, Dielectric Mediums, UL Listed and Classified Products, Underwriters Laboratories, Northbrook, IL, USA;
6 National Electrical Code, NFPA 70, National Fire Protection Association, Quincy, MA, USA
7 Transformers, 5-4, Property Loss Prevention Sheets, FM Global, Norwood, MA, USA

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In addition to new distribution and power class transformers, a variety of other equipment, including voltage regulators, sectionalizing switches, transformer rectifiers, and electromagnets use Envirotemp FR3 fluid. The fluid is also used in retrofill applications for transformers and other fluid-filled distribution and power equipment.

ENVIRONMENTAL AND HEALTH

Envirotemp FR3 fluid is specifically formulated to help minimize health and environmental risks. The base oils come from renewable resources - commodity seeds - and are recyclable and reusable.

The US and California Environmental Protection Agencies published Envirotemp FR3 fluid's Environmental Technology Verification Report in 2003. The verification process includes biodegradation and toxicity testing. Results from the aquatic biodegradation test confirm that Envirotemp FR3 fluid's rate of biodegradation is the same as that of the standard reference material. Envirotemp FR3 fluid meets the "ultimately biodegradable" criteria (Figure 1). When tested for acute oral toxicity, Envirotemp FR3 fluid is not toxic.

The Edible Oil Regulatory Reform Act (US Public Law 104-55, 1995) makes Envirotemp FR3 fluid eligible for current and future regulatory relief. The options of alternative spill response procedures, such as bio-based remediation, are now available. The fluid's inherent viscosity and tendency of thin layers to polymerize help prevent migration along the surface and into subsurface soils.

The EPA, Occupational Safety & Health Administration (OSHA), and the Department of Transportation (DOT) do not list Envirotemp FR3 fluid as hazardous. Its Hazardous Material Information System (HMIS) rating is 1 for both health and reactivity. Envirotemp FR3 fluid is not classified as bio-accumulating or mutagenic. It is not listed as a carcinogen by National Toxicology Program (NTP), in International Agency for Research on Cancer (IARC) monographs, or by OSHA Regulation. The products of complete combustion of Envirotemp FR3 fluid are essentially carbon dioxide and water.

TABLE 2
Envirotemp™ FR3™ fluid's Environmental Attributes

Attribute	Results	Method
Aquatic Biodegradation [%]	>99	EPA OPPTS 835.3100
Ready Biodegradation [%]	>99	EPA OPPTS 835.3110
Acute Aquatic Toxicity	Non-toxic	OECD 203
Acute Oral Toxicity	Non-toxic	OECD 420
Biobased Material Content	>95%	USDA Biopreferred Program
Total Life Cycle Carbon Footprint	Carbon Neutral	Department of Commerce NIST BEES V4.0
Overall Environmental impact	1/4th impact of mineral oil	Department of Commerce NIST BEES V4.0

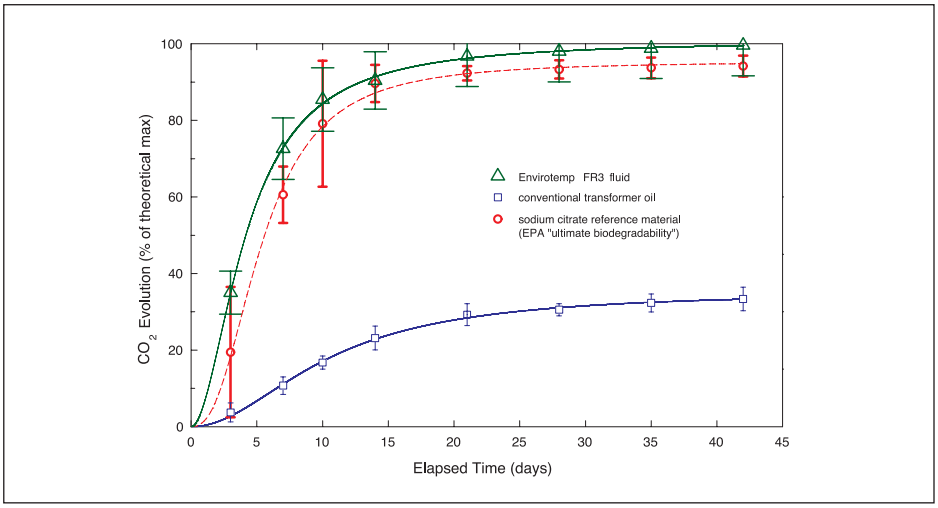


Figure 1.
Aerobic Aquatic Biodegradation Graph EPA Test OPPTS 835.3100

TABLE 3
Greenhouse gases[a] attributed to transformer fluid for its complete life cycle.

	Grams Per Unit[b]		Tons Per 1000 Gallons	
Catagory	Mineral Oil	Envirotemp FR3 Fluid	Mineral Oil	Envirotemp FR3 Fluid
Raw Materials	1,048,184	-381,590	2.306	-0.839
Manufacturing	544,363	160,212	1.198	0.352
Transportation	122,478	71,498	0.269	0.157
Use	154,124	153,450	0.339	0.338
End of Life	30,825	30,690	0.068	0.068
Total	1,899,973	34,260	4.180	0.075

a carbon dioxide equivalents
b In BEES 4.0e, one unit is a 1000 kVA transformer containing 500 gallons of fluid

SUSTAINABILITY

Building for Environmental and Economic Sustainability (BEES) software[8], available from the National Institute of Standards and Technology, uses a life-cycle assessment approach, analyzing raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management, to determine a product's global warming potential.

Table 3 shows the BEES amounts of greenhouse gas generated from raw materials through end of life for mineral oil and Envirotemp FR3 fluid. The cost of mineral oil, in terms of carbon

[8] BEES, Version 4.0e, Building and Fire Research Laboratory, National Institute of Standards and Technology, August 2007, http://www.bfrl.nist.gov/oae/software/bees/

emissions, is expensive. Meanwhile, Envirotemp FR3 fluid is relatively inexpensive, about 8.2 lb/gal less green house gas emitted to produce it. Additionally, the study reports that Envirotemp FR3 fluid's overall environmental performance impact score is 1/4th that reported for mineral oil (and that's without consideration for Envirotemp FR3 fluid's transformer insulation life extending properties). This cumulative score results from adding the impacts of water intake, smog, ozone depletion, indoor air, human health, habitat alteration, global warming, fossil fuel depletion, eutrophication, ecological toxicity, critical air pollutants, and acidification.

Envirotemp FR3 fluid, and transformers filled with Envirotemp FR3 fluid are listed in the US Federal BioPreferred℠ Products Program, making them readily identifiable as BioPreferred to all applicable Federal agencies. Envirotemp FR3 fluid is an excellent option for ISO 14000, Green Build, and other similar environmental programs that promote the use of alternative, environmentally preferable and sustainable materials and procedures.

FIRE SAFETY

Envirotemp FR3 fluid has a fire point of approximately 360°C, well above the minimum of 300°C required for high fire point fluid classifications. Its flash point (approximately 330°C) is higher than the fire point of most other ignition resistant dielectric fluids in use today (Figure 2).

In laboratory and full-scale ignition tests, Envirotemp FR3 fluid has demonstrated greater fire resistance than other dielectric fluid types. Based on large-scale arc ignition testing, FM Global concluded that the probability of a pool fire evolving from Envirotemp Envirotemp FR3 fluid was so low that a heat release rate need not be determined or considered for FM Global approval.

Based on large-scale arc ignition and hot metal ignition tests, FM Global recognizes Envirotemp FR3 fluid as an equivalent safeguard to space separation, fire barriers, and fire suppression systems for most installations.

FM Global recognizes Envirotemp FR3 fluid as a component of Approved transformers per FM Global Standard 3990. When used in transformers containing 10,000 gallons of fluid or less, transformers' separation distance to buildings and other equipment may be up to 1/10th the distance required for mineral oil filled transformers, without fire walls or deluge systems.

OSHA recognizes this FM Global standard as fitting the definition of a Listed and Labeled Product per NEC Section 110-3(b). The standard permits Envirotemp FR3 fluid-filled transformers to be installed indoors, typically without sprinklers or vaults, with a minimum clearance to walls of just 3 feet (0.9M).

UL Standard 340 compares the fire hazard ratings of various fluids. Figure 3 shows the favorable rating assigned to Envirotemp FR3 fluid.

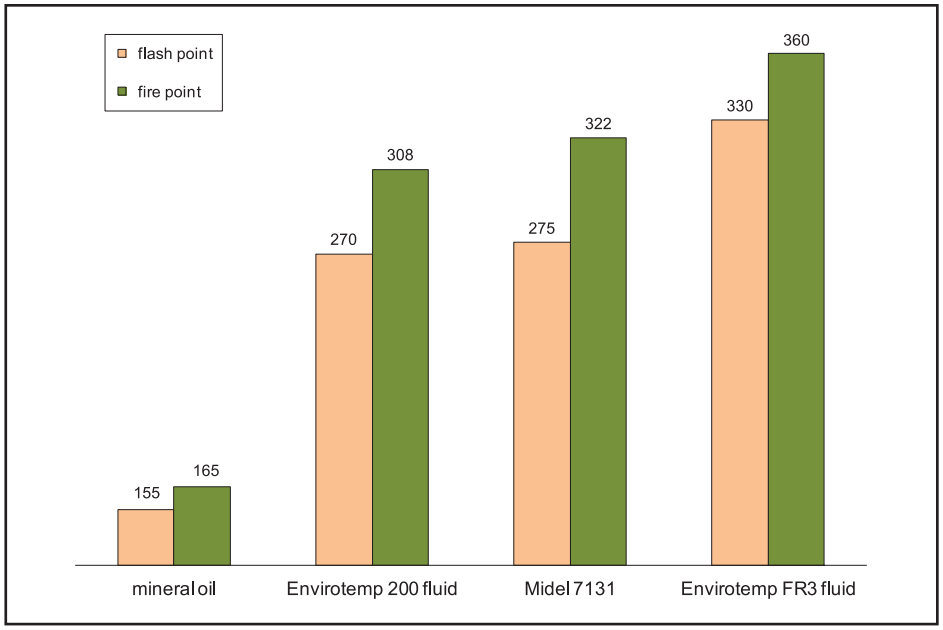


Figure 2.
Flash & Fire Point of Dielectric Fluids (°C).

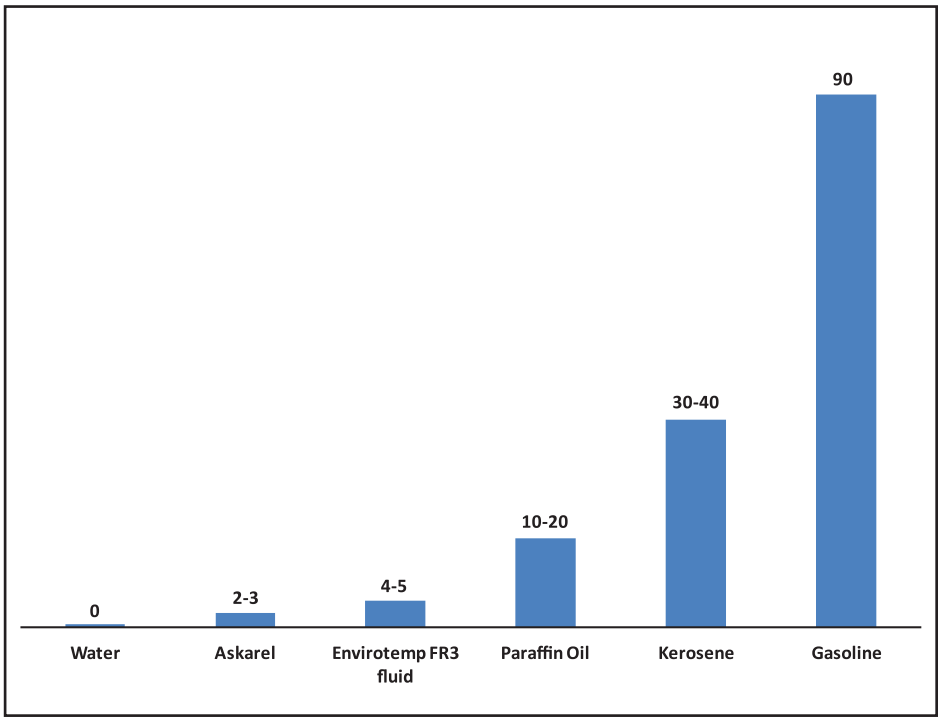


Figure 3.
Fire Hazard Rating UL Standard 340.

TABLE 4
Transformer Insulating Paper End-of-Life (Hours)

End-of-Life Basis	150°C Mineral Oil	150°C Envirotemp FR3 Fluid	150°C IEEE Basis	170°C Mineral Oil	170°C Envirotemp FR3 Fluid	170°C IEEE Basis
Retained Tensile Strength						
50%	3100	>4000*	1602	240	1300	323
25%	4000	>4000*	3327	490	4000	671
Degree of Polymerization						
200	3200	>4000*	3697	480	3400	746

* Paper did not reach end-of-life over the duration of the test. To be conservative, extrapolation was not employed.

There are no known reports of dielectric pool fires involving Envirotemp FR3 fluid filled transformers.

MEETING THE CODES

Less-Flammable fluids are recognized as a fire safeguard in Section 15 of the National Electrical Safety Code (Accredited Standards Committee C2) for generation and distribution substations. Envirotemp FR3 fluid meets the National Electrical Code Section 450-23 requirements as a listed less-flammable liquid. It is covered by OSHA Article §1910.305, Section 5(v).

Envirotemp FR3 fluid is FM Global Approved and Underwriters Laboratories Classified "Less-Flammable" per NEC Article 450-23, fitting the definition of a Listed Product per NEC. For additional information, request Cargill's NEC Requirement Guidelines 2008 Code Options for the Installation of Listed Less-Flammable Liquid Filled Transformers.

FLUID/PAPER INSULATION SYSTEM

The unique chemical structure of Envirotemp FR3 fluid provides superior insulation system performance compared to other types of dielectric fluids. The thermal properties of Envirotemp FR3 fluid make it a more efficient coolant than higher molecular weight silicone and hydrocarbon dielectric coolants.

Envirotemp FR3 fluid has an exceptional ability to remove water generated by aging paper. This enables the fluid to significantly reduce the aging rate of transformer insulating paper. Per IEEE C57.100, accelerated aging tests show that Thermally Upgraded Paper (TUK) paper insulation aged in Envirotemp FR3 fluid takes 5-8 times longer to reach the same end-of-life points as TUK paper insulation aged in conventional mineral oil.

Table 4 compares the time to reach insulation end-of-life for TUK paper aged in Envirotemp FR3 fluid and conventional transformer oil. The time to insulation end-of-life calculated using the IEEE C57.91 loading guide is included for comparison. Accelerated aging tests show similar thermal aging improvement for non-thermally upgraded Kraft paper.

APPLICATIONS

NOTE: The suitability of each application of Envirotemp FR3 fluid is the responsibility of the user. Contact Cargill Envirotemp FR3 Fluids group for application guidelines.

New Transformers

Distribution and Power class transformers filled with Envirotemp FR3 fluid for indoor, submersible and outdoor applications are available from manufacturers worldwide.

For indoor applications, Envirotemp FR3 fluid-filled transformers provide the proven technical and performance advantages of liquid-filled designs over dry types as well as a lower total life cycle cost when compared to all other transformer types.

Many types of Envirotemp FR3 fluid-filled transformers are in service: pole-mounted, pad-mounted, networks, reactors, small, medium and large substations, transmission substations, and generator step-ups. Envirotemp FR3 fluid-filled transformers are accepted in both industry and government. Contact Cargill Envirotemp FR3 Fluids group for a copy of the Envirotemp FR3 Fluid User's List, Bulletin B110.

Retrofilling Transformers

Envirotemp FR3 fluid is especially suited for upgrading the environmental and fire safety of mineral oil-filled transformers. It is miscible with mineral oil, high molecular weight hydrocarbons and other ester fluids. FR3 fluid is not miscible with silicone and should not be applied in transformers previously containing silicone. FR3 fluid can also be used in PCB (Askarel) replacement initiatives.

Unlike most other fluid types, the residual transformer oil in a properly retrofilled transformer should not reduce the fire point of Envirotemp FR3 fluid below the NEC minimum of 300°C (Figure 4). This is true even after full equilibrium has been achieved between the replacement fluid and the residual mineral oil in the paper.

Additional advantages of retrofilling with Envirotemp FR3 fluid include high dielectric strength, better match of dielectric constant to Kraft paper insulation, excellent lubricity, material compatibility, and a coefficient of expansion similar to conventional transformer oil. Envirotemp FR3 fluid has superior resistance to coking and sludge formation when compared to conventional transformer oil. In addition to passing the Power Factor Valued Oxidation (PFVO) test, Doble Laboratories' Sludge-Free Life tests resulted in no measurable sludge. The fluid also acts as a drying agent for transformer insulation that has become wet from aging, extending the useful life of the transformer insulation system.

Switching Devices

With excellent dielectric strength retention (Figure 5), lubricity, and gassing tendencies, Envirotemp FR3 fluid is an excellent switching medium at normal operating temperatures. Proven applications include new and retrofilled sectionalizing switches and transformers with load break accessories such as Bay-O-Net and current-limiting fusing, on-off and four position switches, and Vacuum Fault Interruption protection devices.

[9] P.J. Hopkinson, L. Dix, "Tapchangers for De-energized Operation in Natural Ester Fluid, Mineral Oil, and Silicone" IEEE/PES Transmission & Distribution Conference & Exposition, July 26-30, 2009, Calgary Canada

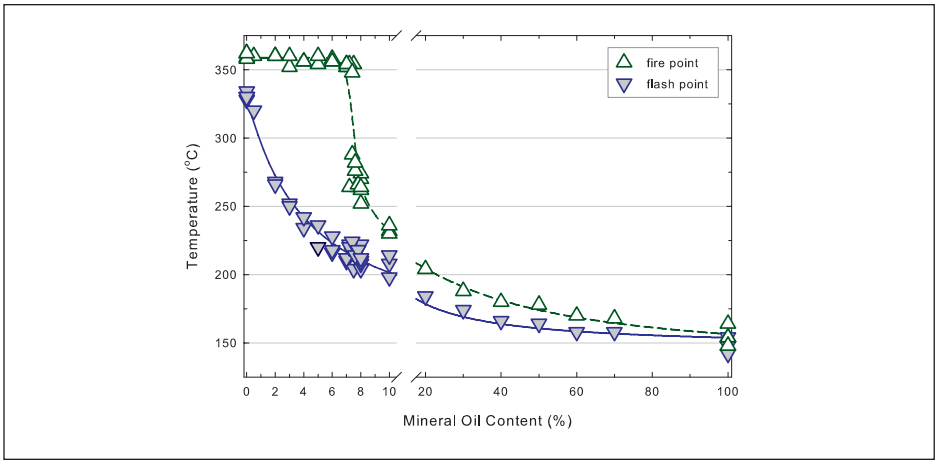


Figure 4.
Envirotemp™ FR3™ fluid Flash & Fire Point Variation with Conventional Transformer Oil Content.

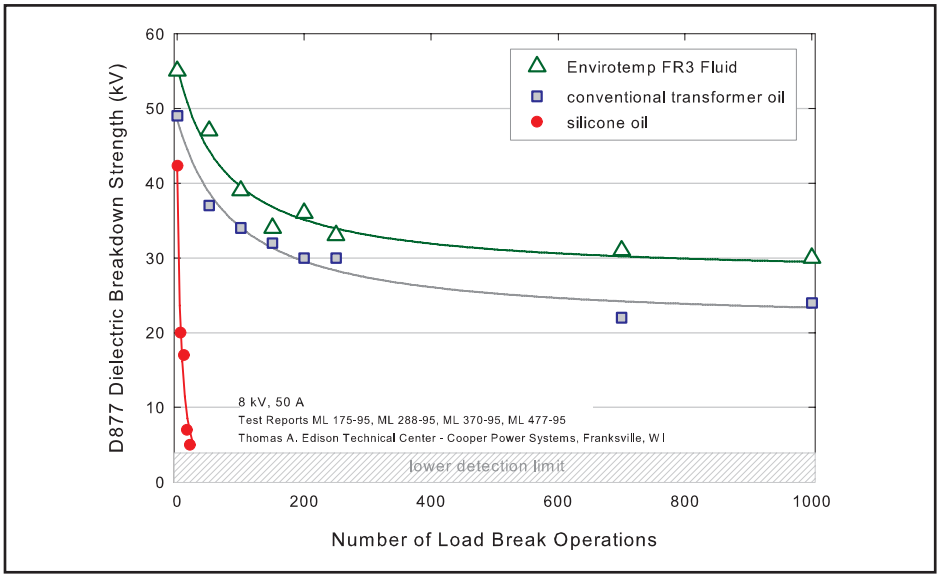


Figure 5.
Fluid loadbreak dielectric strength retention comparison.

Accelerated life tests confirm stationary contacts are most stable in Envirotemp FR3 fluid[9]. In coking tests, Envirotemp FR3 fluid produced less than 1/20th of the deposits that were produced in conventional mineral oil.

Due to the low temperature viscosity difference of Envirotemp FR3 fluid compared to conventional transformer oil, the equipment manufacturer should verify applications at low ambient temperatures.

Other Applications

The inherent safety and performance properties of Envirotemp FR3 fluid have led to its application in electrical equipment other than transformers, including industrial electromagnets, superconducting motors, klystron modulators, transformer/rectifier sets, and heat transfer applications. Envirotemp FR3 fluid has excellent lubricity, an important characteristic for application in equipment with moving parts. High voltage bushing applications also appear promising due to the fluid's excellent ability to minimize insulating paper degradation and its low gassing tendency value of approximately -79 µl/min.

STORAGE AND HANDLING

Similar meticulous procedures for storing and handling conventional transformer mineral oil should be followed with Envirotemp FR3 fluid. To help maintain the extremely low percent moisture saturation at time of fluid manufacture, exposure time to air should be minimized. Drum and tote storage should be indoors or outdoors protected from the elements, including sunlight. Refer to the Cargill Envirotemp FR3 Fluid Storage and Handling Guide S10.

Note: To maintain the optimal fluid properties for its intended use as an electrical insulating fluid, exposure to oxygen, moisture, and other contaminants must be minimized. Except for short storage periods, material that has been immersed in Envirotemp FR3 fluid should not be exposed to air. Thin films of natural esters tend to polymerize much faster than conventional transformer oil. For equipment drained of Envirotemp FR3 fluid, it is recommended that the equipment be placed in an inert gas environment, be re-immersed in fluid, or rinsed with mineral oil. Where the transformer power factor is a concern, hot air drying is an unacceptable process for assemblies already impregnated with a natural ester fluid. For impregnated assemblies that require additional drying, a method of drying that does not expose the impregnated insulation to air is required to avoid excessive oxidation of the dielectric fluid.

FLUID MAINTENANCE

Periodic preventive maintenance tests for Envirotemp FR3 fluid-filled equipment should follow the same schedule used for transformers filled with conventional transformer oil. Key tests on fluid samples include:

1. Dielectric Strength: The IEEE C57.147 minimum acceptable ASTM D1816, 2mm gap limits for continued use of service-aged Envirotemp FR3 fluid are 40 kV (≤ 69 kV), 47 kV (69 ≤ kV < 230), and 50 kV (≥ 230 kV).
2. Flash Point and Fire Point. Small amounts of mineral oil will not significantly reduce the fire point of Envirotemp FR3 fluid. Contamination above 7% may lower the fire point below 300°C. If contamination is suspected, the flash and fire points should be measured.



Figure 6.
Prior to shipment, Envirotemp™ FR3™ fluid undergoes extensive quality assurance testing. The facility where Envirotemp FR3 fluid is produced is ISO 9001 Certified.

3. Dissolved gas analysis of Envirotemp FR3 fluid is particularly useful for high value equipment or equipment servicing critical loads.
4. Color and appearance, dissipation factor, acid number, resistivity, viscosity, and interfacial tension are indicators of possible fluid contamination or unusual degradation.

For fluid that cannot be reconditioned, disposal options include selling to lube oil recyclers, rendering companies, or providers of fuel for industrial boilers and furnaces. Used fluid uncontaminated by controlled hazardous materials does not fall under the jurisdiction of the Federal Used Oil Regulation (CFR Title 40 Part 279).

FUNCTIONAL SPECIFICATION FOR NEW ENVIROTEMP FR3 NATURAL ESTER LESS-FLAMMABLE TRANSFORMER DIELECTRIC COOLANT

1.0 Scope

1.1. This specification describes a non-toxic (in acute aquatic[10], and oral toxicity[11] tests), biodegradable[12], fire resistant, bio-based[13] natural ester dielectric fluid. It is intended for use in electrical equipment as an environmentally preferred, less-flammable insulating and cooling medium.

2.0 Requirements

2.1 Fluid Manufacturer

Fluid manufacturer shall have a minimum of ten (10) years experience producing and testing dielectric coolants. Manufacturer upon request shall provide AC withstand and impulse withstand for both gap and creep from 3mm to 150mm.

2.2 Dielectric Coolant

The dielectric coolant shall be a biobased biodegradable, be FM Global Approved, UL® Classified as a less-flammable fluid. It shall meet the property limits listed below. The base fluid shall be 100% derived from seed oils.

2.3 Acceptable values for receipt of shipments of new Enviotemp FR3 fluid are shown in Table 1

2.4 Environmental and Health Third Party Validations

The fluid shall have a US EPA Environmental Technology Verification (ETV) Statement published. The fluid shall meet the test limits shown in Table 2

2.5 Packaging

The electrical insulating fluid shall be furnished in sealed vessels suitable for the purpose, including 5-gallon containers, 55-gallon drums, 330-gallon totes, or in bulk. Each vessel shall have tampering indicating devices.

3.0 Recommended Customer Receiving Quality Control

3.1 Inspection

Each lot received shall be visibly inspected for container integrity. Verify that tamper proof seals are intact and no leaks are visible.

3.2 Receiving Tests

Samples shall be taken from containers per ASTM D 923 Section 2.2, as follows:

Lot Size (gallons)	Number of Containers Sampled
600 or less	1
601 - 3000	2-6
3001 or more	6 minimum (10% of quantity of containers recommended)

When material will be combined for production, samples may be mixed together in equal proportions to create a composite sample for testing. Minimum tests required are dielectric strength and visual inspection. Dissipation factor test is highly recommended, although not essential.

4.0 Important information

4.1 Storage

Avoid storing drums and totes outdoors. Extreme temperature variations can stress the integrity of container protective seals. Exposure of totes to sunlight can cause fluid discoloration

4.2 Intended Use

The use of electrical insulating and cooling fluid is generally dictated by the engineering design of the electrical apparatus. The electrical insulating fluid covered by this specification is intended for use as an insulating and cooling medium in electrical equipment.

[10] Per OECD 203, Method B
[11] Per OECD 420
[12] Per US EPA OPPTS 835.3100 and US EPA OPPTS 835.8110 (ii)
[13] Per USDA Biopreferred minimum biobased content for Fluid-Filled Transformers - Vegetable Oil-Based

4.3 Fluid Transfer

When transferring electrical insulating fluid from its original container, take care to prevent contamination with moisture, dust, and foreign matter. These impurities can cause deterioration of the dielectric strength and electrical performance.

4.4 Partial Containers

Provide nitrogen blanket for partially filled containers, and properly seal to prevent contamination.

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Cargill Industrial Specialties
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envirotempfluids.com

Certification

Manufacturer: Larson Electronics LLC
Address: 9419 US-HWY 175
Kemp, Texas 75143

Declare the following equipment conforms to the standard(s) as listed:

Model: MT-PML & MT-UPM Series
Description: Overhead & Pad Mounted Distribution Transformers

The MT-PML & MT-UPM series complies with the below standards set forth by the listed Association's requirements. Purchased and manufactured components are evaluated to Larson Electronics LLC Quality Control Management system per ISO 9001:2015. This certification applies to all specimens manufactured in accordance to the manufacture's drawings and options configured per the specification data sheet.

Evaluated Standards:

- **ASTM A240/A240M (2020a):** Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- **ASTM D117 (2018)**: Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
- **ASTM D1535 (2014; R2018):** Standard Practice for Specifying Color by the Munsell System
- **ASTM D3487 (2016; E2017):** Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
- **ASTM D6871 (2017):** Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus
- **ASTM D877/D877M (2019):** Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- **ASTM D92 (2012a):** Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- **ASTM D97 (2017b):** Standard Test Method for Pour Point of Petroleum Products
- **D4059-00 (2018):** Standard Specifications for Analysis of Polychlorinated Biphenyls in Mineral Insulating Oils By Gas Chromatography.
- **EPA 712-C-98-075 (1998):** Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
- **EPA 821-R-02-012 (2002):** Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms

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- **ANSI / IEEE C2:** National Electric Safety Code
- **ANSI / IEEE C12.1 (2014; E2016)**: Electric Meters - Code for Electricity Metering
- **ANSI / IEEE C12.10 (2011):** Physical Aspects of Watthour Meters - Safety Standards
- **ANSI / IEEE C12.7 (2014):** Requirements for Watthour Meter Sockets
- **ANSI / IEEE C57.106-1991 (R1998):** Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
- **ANSI / IEEE C2 (2017; E2017; INT 2017):** National Electrical Safety Code
  ANSI / IEEE C37.47 (2011): Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches
- **ANSI / IEEE C57.12.00 (2015):** General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- **ANSI / IEEE C57.12.20 (2017):** Overhead-Type Distribution Transformers 500 kVA and Smaller; High Voltage, 34 500 V and Below; Low Voltage, 7970/13 800Y V and Below
- **ANSI / IEEE C57.12.21 (2000):** Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers With High-Voltage Bushings: High Voltage (34 500 GrdY/19 920 V and Below) and Low Voltage (240/120 V, 167 kVA and Smaller)
- **ANSI / IEEE C57.12.25 (1990):** Requirements for Pad-Mounted Compartmental-Type Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors, High-Voltage, 34500 Grd. Y/19920 Volts and Below; Low Voltage, 240/120; 167 KVA and Smaller.
- **ANSI / IEEE C57.12.28 (2014):** Standard for Pad-Mounted Equipment - Enclosure Integrity
- **ANSI / IEEE C57.12.29 (2014):** Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
- **ANSI / IEEE C57.12.31 (2010):** Standard for Pole-Mounted Equipment - Enclosure Integrity
- **ANSI / IEEE C57.12.34 (2015):** Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
- **ANSI / IEEE C57.12.35 (2013):** Standard Bar Coding for Distribution Transformers and Step-Voltage Regulators
- **ANSI / IEEE C57.12.38 (2014):** Standard for Pad-Mounted-Type, Self-Cooled, Single-Phase Distribution Transformers; High Voltage, 34 500 GrdY/19 920 V and Below, Low Voltage, 240/120 V; 167 kVA and Smaller
- **ANSI / IEEE C57.12.70 (2020):** Terminal Markings And Connections For Distribution And Power Transformers
- **ANSI / IEEE C57.12.80 (2010):** Standard Terminology for Power and Distribution Transformers
- **ANSI / IEEE C57.12.90 (2015; C2017):** Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
- **ANSI / IEEE C57.12.110 (2018):** Recommended Practice for Establishing Liquid Immersed and Dry-Type Power and Distribution Transformer Capability when Supplying Nonsinusoidal Load Currents
- **ANSI / IEEE C57.13 (2016):** Requirements for Instrument Transformers
- **ANSI / IEEE C57.91 (2011):** Guide for Loading Mineral-Oil-Immersed Transformers
- **ANSI / IEEE C57.98 (2011):** Guide for Transformer Impulse Tests
- **ANSI / IEEE C57.106 (2015):** Guide for Acceptance and Maintenance of Insulating Oil in Equipment
- **ANSI / IEEE C57.109 (2018):** Guide for Liquid-Immersed Transformer Through-Fault-Current Duration
- **ANSI / IEEE C57.147 (2018):** Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers
- **ANSI / IEEE C57.154 (2012):** 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
- **ANSI / IEEE C62.11 (2020):** Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

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- **ANSI / IEEE C62.22 (2009):** Guide For The Application Of Metal-Oxide Surge Arresters For Alternating-Current Systems
- **ANSI / IEEE 386 (2016):** Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
- **CSA C2.1:06 (R2022):** Standard for Single-phase and three-phase liquid-filled distribution transformers
- **CAN / CSA C50-14 (R2018):** Mineral insulating oil, electrical, for transformers and switches
- **CSA C88:1 (R2018):** Power Transformer And Reactor Bushings
- **CSA C88:16 (R2021):** Power transformers and reactors
- **CSA C227.1:** Single Phase Pad Mounted Distribution Transformers
- **CAN / CSA C227.2:** Three-Phase, Live-Front, Pad-Mounted Distribution Transformers
- **CSA C227.3:06 (R2022):** Low-profile, single-phase, pad-mounted distribution transformers with separable insulated high-voltage connectors
- **CSA C227.4 (R2021):** Three-phase, pad-mounted distribution transformers with separable insulated high-voltage connectors
- **CSA C227.5-08 (R2018):** Three-Phase Live-Front Pad-Mounted Distribution Transformers
- **CSA C301.2:06 (R2022):** Standard for Three-phase submersible distribution transformers
- **CAN / CSA C802.1-13 (R2018):** Minimum efficiency values for liquid-filled distribution transformers
- **CSA C802.3-15 (R2020):** Minimum efficiency values for power transformers
- **NARA 10 CFR Part 431:** Energy Efficiency Program for Certain Commercial and Industrial Equipment
- **NEMA 260-1996 (R2019):** Safety Labels For Pad-Mounted Switchgear And Transformers Sited In Public Areas
- **NEMA C12.10 (2011):** Physical Aspects of Watthour Meters - Safety Standards
- **ANSI / NEMA Z535 (2011):** Safety color chart
- **ANSI / NEMA Z535.1 (2022):** Safety colors
- **ANSI / NEMA Z535.2 (2011):** Environmental and facility safety signs
- **ANSI / NEMA Z535.3 (2022):** Criteria for safety symbols
- **ANSI / NEMA Z535.4 (2011, R2017):** Product safety signs and labels
- **ANSI / NEMA Z535.5 (2022):** Safety tags and barricade tapes (for temporary hazards)
- **ANSI / NEMA Z535.6 (2011, R2017):** Product safety information in product manuals, instructions, and other collateral materials
- **NETA ATS (2021):** Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
- **TR-1 (2013):** Transformers, Regulators and Reactors

Signed for and on behalf of: Larson Electronics, LLC
Place of issue: Kemp, TX

Signature: James Thomas

Name: James Thomas
Position: Operations Manager

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Concrete Pad Construction Details

MT-PML-RX-3P-XX-R1 Series

Three Phase Pad Mounted Transformers

Purpose and Scope

This document shows construction details for concrete pads for three-phase, pad-mounted transformers.

General Information

1. When a pad is installed by the customer, that customer shall provide all materials. In areas of known unusually soft soil conditions, AHJ may require special treatment. Before pouring or setting the pad, the customer or contractor may be required to request an inspection by AHJ to approve the installation. AHJ shall determine the acceptability of each pad installation.

2. The installation of the pad includes the two ground rods and the interconnecting ground wire.

Application

3. If a pad-mounted transformer cannot be located away from vehicular traffic, the customer shall provide suitable barriers for the protection of the transformer. AHJ shall determine the protection requirements.

4. If the customer is to use bus duct, the secondary opening is not needed. Grout in the window of precast pads.

5. The pad sizes are based on maximum dimensions, including cooling radiators, of the various configured transformers.

Construction Notes

6. In general, all equipment pads should be installed as level as practical. Pads supporting oil-filled equipment must be leveled to within 1 inch in 8 feet in all directions.

7. In general, all equipment pads should be installed as level as practical. Pads supporting oil-filled equipment must be leveled to within 1 inch in 8 feet in all directions.

8. An equipment pad SHALL NOT be placed on an elevated berm, mound or structure either earthen or otherwise when placed in a Flood Plain. If local knowledge of the area in which the equipment is to be placed identifies a high likelihood that uninsulated terminals of the equipment will come in contact with floodwater and the location cannot be moved to a location less likely to have flood levels come in contact with the exposed terminals, a Subsurface Fully Insulated Device should be installed in lieu of the pad mount design. In some cases such as transformers, because of capacity limits of subsurface material coded equipment it may not be possible to provide a transformer of sufficient capacity to seNe loads in excess of the capabilities of a 1000 kVA UCO.

9. The transformer pad shall be placed on firm, compacted native material or on engineered fill which has been compacted at least to the requirements this document

10. The area under the pad shall be excavated to the required grade, or to a depth necessary to reach firm, undisturbed material, whichever is deeper. The material can be considered firm if it cannot be penetrated by thumb except with moderate effort.

11. If firm material has not been reached within a depth of 3 feet, excavate 3 feet beyond the perimeter of the pad and backfill the entire excavated area to the required grade and to the requirements of Note 12.

12. In case it has been necessary to excavate deeper than the required grade to reach firm material, backfill to the required grade in one of the following ways:

A. Backfill with clean, non-expansive soil compacted to 90% of maximum density. Soil shall be placed in layers not more than 8 inches thick before compaction. Maximum density and in-place density is to be determined by by ASTM D-1556 and ASTM D-1557 respectively. A copy of the test results may be required by AHJ.

B. Backfill with soil-cement slurry consisting of one sack of Portland cement per cubic yard and clean native soil or sand. When slurry is used as a backfill material, the customer will not be required to use a poured-in-place pad.

13. In areas of known soft soil conditions, trenches within the pad excavation area for the installation of conduits shall be backfilled in one of the ways specified in Note 12.

14. In addition to the above, precast pads shall be placed on a 3-inch layer of slurry backfill or sand screeded level to provide uniform bearing.

15. Conduit windows shall be grouted with non-shrink grout (asphalt or blacktop is not approved for grouting).

16. Concrete shall be designed to attain a strength of 2,500 pounds per square inch (psi) at 28 days. Slump for concrete placement shall not exceed 3 inches. Reinforcing steel shall be per ASTM A615, Grade 40 minimum.

17. A minimum distance of 6 feet shall be maintained between ground rods.

18. Wood-float or light broom finish the top of the slab. Finish all exposed edges with a finishing tool. Vertical edges shall have a 3/4-inch chamfer. Slope exposed horizontal surfaces slightly for drainage. Moist-cure concrete for at least 7 days after pouring. Do not install transformer until 14 days after pouring concrete. See Note 19 for exceptions to this requirement.

19. The transformer may be installed earlier than the 14 days specified above, provided the concrete has attained a compressive strength of at least 1,500 psi obtained as follows (this procedure is permitted only for urgent cases where earlier pouring of pad is not practical):

A. For a six-sack mix using normal Portland cement, the transformer may be installed after 7 days; or for a six-sack mix using high early-strength cement, the transformer may be installed after 72 hours.

B. All concrete must be moist-cured to the minimum period specified above before installing the transformer.

C. Verify the required strength by either concrete cylinder test or Schmidt hammer test.

20. Belled ends of conduits should be placed approximately 1 inch above the concrete pad surface. If belled ends are removed, install end bell fittings. Temporarily plug or cap all conduits.

21. Only AHJ-approved utility electric-service-related equipment and structures may be installed in the area beneath the transformer pad. The area 6 feet deep and 12 inches horizontally around the pad shall be free of all foreign substructures.

Construction Notes for Precast Pads

22. Concrete shall be designed to attain a strength of 2,500 psi in 28 days.

23. Inserts and securing of inserts shall be of sufficient strength to lift the pad. A minimum of three inserts with 7/8- inch diameter, UNC thread and 2-1/4 inch inside depth, steel, galvanized with temporary plugs shall be provided.

24. Inserts shall be installed flush with the surface of the pad.

25. Reinforcing bars shall be as per ASTM A615, Grade 40 minimum.

26. 24. All exposed edges shall have a 3/4-inch chamfer or radius.

27. Surface shall have a light broom or wood-float finish.

28. The surface of the pad shall be level and flat.

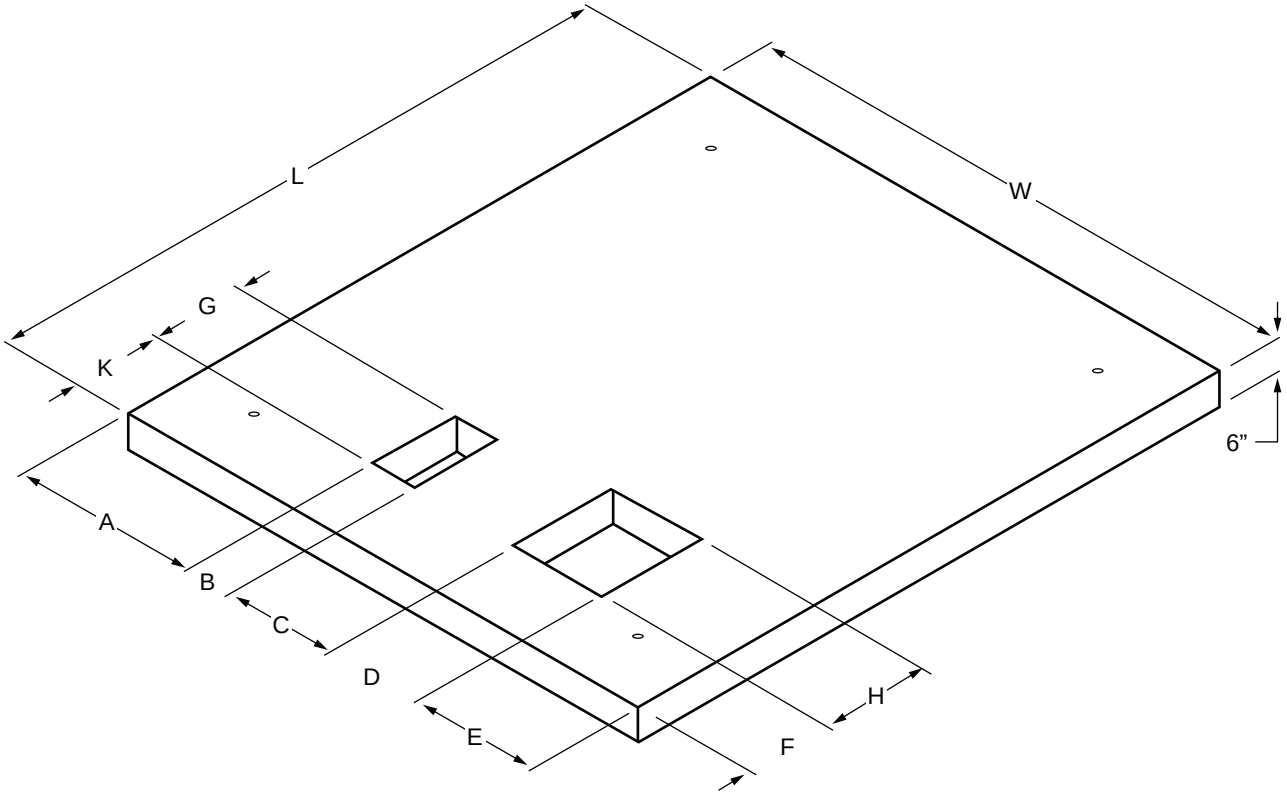
29. Precast pads shall be permanently identified with manufacturer's name and have the weight stenciled on top of the pad.

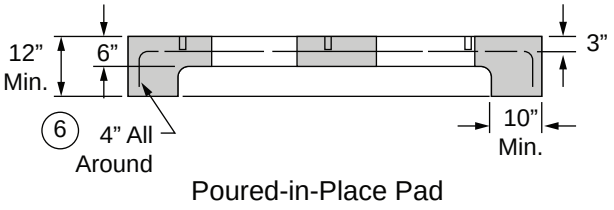
Concrete Pad Construction Details

MT-PML-RX-3P-XX-R1 Series

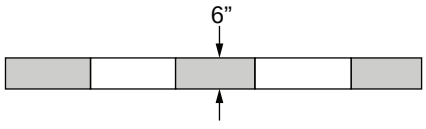
Three Phase Pad Mounted Transformers

Concrete Pad Details for Three Phase Transformers





Poured-in-Place Pad



Precast Pad

KVA SIZE	MAX WEIGHT (LBS)	A	B	C	D	E	F	G	H	K	L	W
75	2,375	17”	16”	15”	19”	13”	10”	8”	17”	14”	61”	80”
112.50												
150												
225												
300	4,830	22”	16”	15”	20”	17”	20”	8”	19”	26”	106”	90”
500												
750												
1,000												
1,500												
2,000												
2,500												

Certification

Manufacturer: Larson Electronics LLC
Address: 9419 US-HWY 175
Kemp, Texas 75143

Declare the following equipment conforms to the standard(s) as listed:

Model: MT-PML & MT-UPM Series
Description: Overhead & Pad Mounted Distribution Transformers

The MT-PML & MT-UPM series complies with the below standards set forth by the listed Association's requirements. Purchased and manufactured components are evaluated to Larson Electronics LLC Quality Control Management system per ISO 9001:2015. This certification applies to all specimens manufactured in accordance to the manufacture's drawings and options configured per the specification data sheet.

Evaluated Standards:

- **ANSI C12.1 (2014; E2016)**: Electric Meters - Code for Electricity Metering
- **ANSI C12.10 (2011):** Physical Aspects of Watthour Meters - Safety Standards
- **ANSI C12.7 (2014):** Requirements for Watthour Meter Sockets
- **ASTM A240/A240M (2020a):** Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- **ASTM D117 (2018)**: Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
- **ASTM D1535 (2014; R2018):** Standard Practice for Specifying Color by the Munsell System
- **ASTM D3487 (2016; E2017):** Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
- **ASTM D877/D877M (2019):** Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- **ASTM D92 (2012a):** Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- **ASTM D97 (2017b):** Standard Test Method for Pour Point of Petroleum Products
- **D4059-00 (2018):** Standard Specifications for Analysis of Polychlorinated Biphenyls in Mineral Insulating Oils By Gas Chromatography.
- **EPA 712-C-98-075 (1998):** Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"
- **EPA 821-R-02-012 (2002):** Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms
- **IEEE C57.106-1991 (R1998):** Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
- **IEEE 386 (2016):** Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
- **IEEE C2 (2017; E2017; INT 2017):** National Electrical Safety Code
- **IEEE C37.47 (2011):** Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches

LARSON ELECTRONICS LLC • 9419 E US HWY 175 • KEMP, TX 75143
p: 1-800-369-6671 • intl: 903-498-3363 • f: 903-498-3364 • sales@larsonelectronics.com

- **IEEE C57.12.00 (2015):** General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- **IEEE C57.12.25 (1990):** Requirements for Pad-Mounted Compartmental-Type Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors, High-Voltage, 34500 Grd. Y/19920 Volts and Below; Low Voltage, 240/120; 167 KVA and Smaller.
- **IEEE C57.12.28 (2014):** Standard for Pad-Mounted Equipment - Enclosure Integrity
- **IEEE C57.12.29 (2014):** Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
- **IEEE C57.12.34 (2015):** Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
- **IEEE C57.12.80 (2010):** Standard Terminology for Power and Distribution Transformers
- **IEEE C57.12.90 (2015; C2017):** Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
- **IEEE C57.13 (2016):** Requirements for Instrument Transformers
- **IEEE C57.98 (2011):** Guide for Transformer Impulse Tests
- **IEEE C62.11 (2020):** Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
- **NARA 10 CFR 431:** Energy Efficiency Program for Certain Commercial and Industrial Equipment
- NEMA 260 (1996; R2004): Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas
- **NEMA C12.10 (2011):** Physical Aspects of Watthour Meters - Safety Standards
- **NEMA Z535.4 (2011; R2017):** Product Safety Signs and Labels
- **TR-1 (2013):** Transformers, Regulators and Reactors
- **NETA ATS (2021):** Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

Signed for and on behalf of: Larson Electronics, LLC
Place of issue: Kemp, TX

Signature: James Thomas

Name: James Thomas
Position: Operations Manager

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Certification

Manufacturer: Larson Electronics LLC
Address: 9419 US-HWY 175
Kemp, Texas 75143

Declare the following equipment conforms to the standard(s) as listed:

Model: MT-PML, MT-UPM
Description: Liquid Filled Distribution Transformers

Evaluated Listings:

FCC: Radio Frequency Emission & Authorization Status

The MT-PML and MT-UPM Series of industrial liquid filled power distribution transformers complies with Federal Communications Commission requirements for Radio Frequency Emission & Authorization Status. This product is not capable of emitting rf energy and does not require FCC authorization. This certification applies to all specimens manufactured in accordance to the manufacture's drawings.

Signed for and on behalf of: Larson Electronics, LLC
Place of issue: Kemp, TX

Signature: James Thomas

Name: James Thomas
Position: Operations Manager

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Frequently Asked Questions (FAQ)

Q. What type of transformers does Larson Electronics offer?

A. Larson Electronics offered dry type transformers and liquid filled transformers. For liquid filled transformers, Larson Electronics' offers overhead distribution transformers (utility pole mount), pad mounted distribution transformers (mounts to a concrete pad), pad mounted power transformers, underground submersible distribution transformers, and substation transformers.

Q. What are the main benefits of a liquid filled transformer?

A. Liquid filled transformers have higher energy efficiency, durability, short circuit strength, low sound level, lower maintenance costs, and longer useful life expectancy compared to dry type transformers.

Q. What types of transformer liquids does Larson Electronics use?

A. Larson Electronics offered mineral oil fluid (ONAN) and biodegradable fluid (KNAN). On request we can provide brand name FR3 fluid or other brand name fluids for additional cost and lead time. All fluids offered by Larson Electronics are non-PCB containing fluids.

Q. What is the difference between mineral oil (ONAN) and biodegradable fluid (KNAN)?

A. Mineral oil has a flash point of 147-165°C. Biodegradable insulation fluids have a higher flash point up to 350°C. Using biodegradable fluids reduce the risk of potential fire due to the transformer overheating. Utilizing biodegradable fluids extends the lifespan on the transformer due to better insulation, higher flash point, better moisture resistance, and higher maximum voltage breakdown points over mineral oils.

Q. What is the difference between FR3 fluid and biodegradable fluid?

A. Envirotemp FR3 is a brand name of biodegradable ester oils made by Cargill. Cargill is not the only manufacturer of biodegradable ester fluids used for cooling liquid filled transformers. Larson Electronics stocks RAPO biodegradable fluid that exceeds testing for ASTM D6871. Cargill Envirotemp FR3 can be used in substitution of the standard biodegradable fluid. This substitution will increase cost and lead times.

Q. Do Larson Electronics transformers contain PCB?

A. All dry-type and liquid filled transformers manufactured by Larson Electronics are PCB (polychlorinated biphenyl) free at the time of shipment. Mixtures of polychlorinated biphenyls (PCB's) were banned commercially for use as transformers cooling fluids in 1977 due to being toxic, bio-accumulative, not at all biodegradable, and difficult to dispose of safely. None of Larson Electronics transformers contain PCB and only use PCB-free fluids.

Q. What are the transformer ratings?

A. IEEE Std C57.12.20 (Overhead Type), IEEE Std C57.12.34 (Three-Phase Pad-Mounted Compartmental), IEEE Std C57.12.38 (Single-Phase Pad-Mounted), IEEE Std C57.12.36 (Distribution Substation Transformers). For more detailed list of standards, please see the ASTM Certificate 1 link.

Q. Is this transformer UL Listed? Is this transformer CSA Listed?

A. By default, no. The majority of medium voltage transformer installations do not require certification by a Nationally Recognized Testing Laboratory (NRTL) unless being installed inside a building. Medium voltage equipment is built to and complies to ANSI, ASTM, DOE, IEEE, and NETA standards. UL is one of multiple NRTLs per OSHA certification for testing

facilities for USA standards. CSA is one of multiple NRTLs per Canada certification standards. For an additional fee, we can submit your order for NRTL testing after completion of build. This testing service is per order, requires payment of testing fees, and will increase lead time.

Q. What is the lifespan of a transformer?

A. The average lifespan of a liquid filled transformer is 25 years. Many transformers will survive past the 25 year mark and are still in service for up to 35 years.

Q. What is the difference between Loop Feed and Radial Feed?

A. Radial feed Transformers will have three high voltage bushings (H1, H2, and H3). There is one bushing for each phase to allow for the incoming high voltage cables. On Wye and Grounded Wye connected Transformers, there will also be an H0 bushing. Loop feed Transformers will have six high voltage bushings (H1A, H2A, H3A, H1B, H2B, and H3B). There are two bushings for each phase. This allows the customer to connect all of their Transformers in a loop configuration. It will also allow the customer to bring two feeds to the Transformer. A four position switch can be used to switch between the A feed and the B feed.

Q. What is the difference between Dead Front and Live Front?

A. Live-front: The voltage-carrying parts are exposed. Live-front terminations have high voltage connectors, arresters, or fuses are exposed to the operator after cabinet has been opened. Dead-front: Often referred to as dead-front bushings. Safety is enhanced as there are no current-carrying parts exposed to the operator. For overhead distribution transformers and underground submersible transformers, live front is common. For pad mount transformers, the primary is typically dead front and the secondary is live front. Protection barriers can be added to live front pad mounted transformers.

Q. What is the difference between copper and aluminum windings inside the transformer?

A. Transformers wound with aluminum or copper wire have similar losses and performance. The choice of using copper or aluminum windings depends upon the application and the individual preferences. The type of winding material does not affect the transformer's reliability. A transformer's life is defined by the life of its insulation system.

Q. How many BTU's of heat does a transformer generate?

A. The heat a transformer generates is dependent upon the transformer losses. To determine air conditioning requirements multiply the sum of the full load losses (obtained from factory or test report) of all transformers in the room by 3.41 to obtain the BTUs/hour. For example: A transformer with losses of 2000 watts will generate 6820 BTUs/hour.

Q. Do you have to ground this transformer?

A. In most cases the enclosure of the transformer is grounded for safety reasons. However, a transformer will function properly without being grounded. Be sure to research all grounding requirements for your specific application against the NETA and NEC as well as any local electrical codes.

Q. What types of transformer protection are available?

A. For over-current protection, Larson Electronics offers Fuses, breakers and interrupters. For over-voltage protection, Larson Electronics offers arresters. Larson Electronics can provide both Primary and Secondary protection equipment.

Q. What is required for mounting this transformer?

A. For mounting requirements, please see the ASTM Certificate 2 link.

Q. Does my primary and secondary voltage matter for a transformer?

A. Yes, this matters greatly. For primary voltage, most transformers will be equipped with a tap changer for small primary voltage changes due to voltage drop for losses experienced in the transmission line. Some transformers will be equipped with dual voltage primaries with a voltage selector switch to choose which voltage to operate the transformer on. In both cases, these are designed to provide a steady output voltage. It is very important to confirm what voltage your primary voltage being delivered from the utility provider and what the required electrical voltage for the building or house is. You cannot only provide the KVA size, or the abbreviated primary voltage as there is not standardized voltage across the country and each region can be different. Once manufacturing has started, these cannot be changed.

Q. Where is the detailed dimensional drawing for this unit?

A. We can provide a feature drawing that shows accessories and estimated form factor. Due to the variety of options and varying voltages, an exact dimensional drawing for the specific unit you have ordered is not available until after purchase and engineering has completed the drawing for your sales order. We do not offer completed detailed engineered drawings before purchase. The feature drawings are detailed enough for concrete pad designs and preliminary engineering site designs.

Q. What is the warranty of this transformer?

A. 12 months from point of connecting electrical service to the transformer or 18 months from point of ordering, whichever comes first.

Q. Can this transformer be customized?

A. Yes, Larson Electronics allows for customization of all transformers. Please send customization requests to sales@larsonelectronics.com. If you have an engineered specification or engineered drawings, please provide those at the time of request.