

# R-TEMP® FLUID

## DESCRIPTION

R-Temp fluid is a Fire Resistant Hydrocarbon Fluid (FRHF) dielectric coolant formulated for use in distribution transformers where its unique electrical, thermal and safety properties are advantageous.

R-Temp fluid is essentially non-toxic<sup>1</sup> and readily biodegradable<sup>2,3,4</sup>, making it eminently satisfactory to environmentalists. It is compatible with standard insulating materials, and processing equipment and procedures. R-Temp fluid also contains a proprietary chemical marker allowing confirmation via laboratory tests that it has not been diluted with other materials. R-Temp fluid is also referred to as a High Fire Point Fluid, a High Molecular Weight Hydrocarbon or a Less-Flammable Dielectric Liquid.

## TYPICAL R-TEMP FLUID PROPERTIES

Property	Value	Test Method
<b>Electrical</b>		
Dielectric Strength	56 kV @ 25°C (0.080 in. gap)	ASTM D1816
	43 kV @ 25°C	ASTM D877
Relative Permittivity [Dielectric Constant]	2.2 @ 25°C	ASTM D924
Dissipation Factor [Power Factor]	0.10% @ 100°C	ASTM D924
Volume Resistivity	1 X 10 <sup>14</sup> Ω-cm @ 25°C	ASTM D1169
<b>Physical and Chemical</b>		
Specific Gravity	0.87 @ 25°C	ASTM D1298
Interfacial Tension	40 mN/m @ 25°C	ASTM D971
Acid Number	5 x 10 <sup>-3</sup> mg KOH/g	ASTM D974
Kinematic Viscosity	113 cSt @ 40°C	ASTM D445
	12 cSt @ 100°C	
Color	L 1.5	ASTM D1500
<b>Thermal</b>		
Flash Point	276°C	ASTM D92
Fire Point	312°C	ASTM D92
Pour Point	-24°C	ASTM D97
Thermal Conductivity	3.1 X 10 <sup>-4</sup> cal/(cm •sec •°C) @ 25°C	CPS Method
Specific Heat	0.46 (cal/gm/°C) @ 25°C	ASTM D2766
Coefficient of Expansion	7.3 x 10 <sup>-4</sup> cc/cc/°C @ 25°C	CPS Method

Typical properties subject to change without notice. Contact CPS Dielectric Fluids for recommended acceptance values. Ask for R-Temp fluid Specification Guideline Bulletin 92009.

Due to its excellent performance characteristics, applications for R-Temp fluid have expanded into a variety of other equipment, including sectionalizing switches, electromagnets, voltage regulators, rectifiers and high voltage substations. The fluid is also used for askarel and oil retrofill applications and as a make-up fluid for askarel-filled equipment.

## FIELD PERFORMANCE HISTORY

Since the energization of prototypes in 1975, over 100,000 R-Temp transformers have been installed, accumulating hundreds of thousands of unit-years of reliable field service. **The fire safety record has been flawless.**<sup>5,6</sup>

The monitoring of operating R-Temp transformers, including the earliest prototypes, has demonstrated R-Temp fluid to be exceptionally stable, without the sludge formation common to conventional mineral oil.<sup>7</sup>

## APPLICATIONS

### ■ NEW TRANSFORMERS

Transformers filled with R-Temp fluid for indoor, submersible and outdoor applications are available from an extensive list of manufacturers in the United States and abroad.

For indoor applications, R-Temp transformers not only provide the proven performance of liquid-filled design, but at a lower total owning cost than other alternatives with equal ratings.

R-Temp transformers are also an excellent choice for outdoor, network or subsurface vault installations where an extra margin of safety against explosion and fire is desired as compared to conventional oil. Outdoor applications where enhanced safety is recommended include close proximity to buildings or valuable equipment, rooftop installations and close proximity to pedestrian areas. Types of transformers presently operating with R-Temp fluid include pole-mounted, pad-mounted, small and medium power substations (>700 kV BIL), network and rectifier units.

R-Temp transformers have been widely accepted by industry and government. The fluid's favorable health and environmental properties make R-Temp transformers a frequent choice in food processing plants. Contact Cooper Power Systems or your equipment supplier for a copy of the User's List, Bulletin 90048.

**Bulletin 92006**  
**Product Information**  
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## (Applications continued)

### ■ RETROFILLING CONVENTIONAL OIL-FILLED TRANSFORMERS

R-Temp fluid is well suited as a replacement fluid for upgrading the safety margin of conventional mineral oil-filled transformers.<sup>8</sup> R-Temp fluid advantages for mineral oil retrofilling are high dielectric strength, excellent lubricity, material compatibility and a coefficient of expansion similar to conventional mineral oil.

Contact Cooper Power Systems for application guidelines.

### ■ ASKAREL (PCB) RETROFILL

All major retrofilling companies list R-Temp fluid as a permanent fluid option. R-Temp fluid advantages for askarel retrofilling are high dielectric strength, excellent lubricity, material compatibility and a coefficient of expansion similar to askarel.

### ■ MAKE-UP FLUID

R-Temp fluid is fully miscible with askarel and oil. It may be used as a make-up fluid for topping off either type of transformer. Using R-Temp fluids as a make-up fluid eliminates the risk and expense of storing and handling askarel or other hazardous fluids such as chlorinated benzenes. For additional information, contact Cooper Power Systems or your equipment supplier.

### ■ LOADBREAK SWITCHING DEVICES

Excellent dielectric strength, lubricity and arc suppression make R-Temp fluid an excellent loadbreak switching medium.<sup>9</sup> Proven applications include new and retrofilled sectionalizing switches, voltage regulators and transformers with loadbreak accessories such as bayonet fusing, on-off switches, sectionalizing switches and load tap changers. Due to viscosity differences compared to conventional mineral oil, suitability of each application should be reviewed by the equipment manufacturer.

### ■ OTHER APPLICATIONS

The inherent safety and performance features of R-Temp fluid have led to its application in electrical equipment other than transformers, including industrial electromagnets, precipitator transformer/rectifier sets, power supplies for electrostatic painting equipment and electron beam furnaces. R-Temp fluid has excellent lubricity, an important characteristic for application in equipment with movable parts.

*R-Temp fluid has been successfully used in each of the listed applications. However, suitability of each application of R-Temp fluid is the responsibility of the user.*

## FIRE SAFETY

The National Fire Protection Association has not had any report of fires caused by transformers filled with R-Temp fluid.<sup>6</sup> This attests to the fire resistance of R-Temp fluid and other listed less-flammable fluids.

In many large and small scale tests, fire resistant hydrocarbon fluids have demonstrated greater fire resistance than other askarel substitutes. Based on large scale testing, a study conducted by the National Electrical Manufacturers Association for the National Institute of Standards and Technology concluded "silicone oil appeared slightly more flammable than high molecular weight hydrocarbons (e.g. R-Temp fluid) even though their flash and fire points are essentially the same."<sup>10</sup>

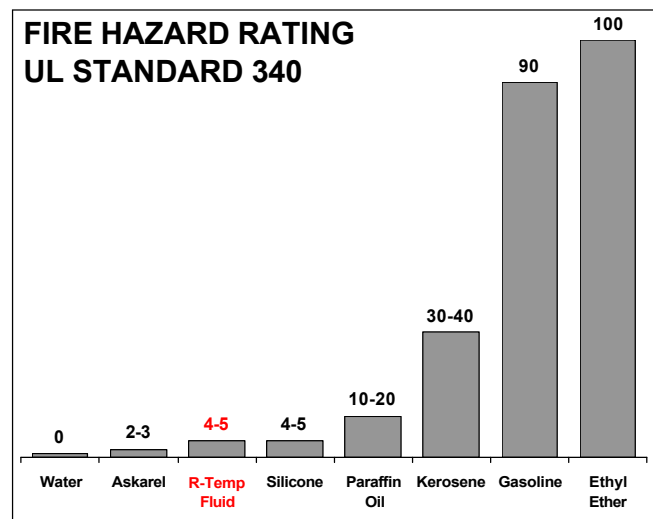
A fire hazard rating standard was developed by Underwriters Laboratories in 1972, UL Standard 340. The graph shown demonstrates the favorable rating assigned to R-Temp fluid. UL reports R-Temp fluid to be **non-flammable** at ordinary temperatures.<sup>11</sup>

Contact Cooper Power Systems for additional information on any of these tests.

## MEETING THE CODES

R-Temp fluid is recognized as a fire safeguard by Section 15 of the National Electrical Safety Code (Accredited Standards Committee C2-2002).<sup>12</sup> R-Temp fluid meets the 2002 National Electrical Code® Section 450-23 requirements as a **listed** less-flammable liquid.<sup>13</sup> It is covered by Occupational Safety and Health Association (OSHA) Article §1910.305, Section 5(v). For additional information, request the NEC®/NEC Requirements Guideline, Bulletin 92046.

R-Temp fluid is Factory Mutual Approved and has been UL Classified "Less-flammable" per NEC Article 450-23 since 1984.<sup>14,11</sup> R-Temp fluid is also recognized for use by Industrial Risk Insurers per their application guide (I.R.I.-IM.5.4.5).



## ENVIRONMENTAL & HEALTH

R-Temp fluid is carefully formulated to minimize health and environmental risk.

R-Temp fluid is not listed as hazardous by Environmental Protection Agency (EPA), OSHA or Department of Transportation (DOT). Oral toxicity animal tests reported no signs of toxicological reactions, nor have any human contact reactions been reported. R-Temp fluid is not classified as bioaccumulating or mutagenic.<sup>1</sup> Unlike silicone, R-Temp fluid is biodegradable.<sup>2,3,4</sup>

The University of Dayton, under an Electrical Power Research Institute (EPRI) contract, tested for thermal decomposition by-products from typical utility materials. R-Temp fluid was placed in the least hazardous category.<sup>15</sup>

Thermal decomposition by-products from R-Temp fluid were also analyzed by the EPA as reported in the Federal Register. R-Temp fluid "did not produce PCDF's (Furans) or PCDD's (Dioxins) under the experimental conditions."<sup>16</sup>

Testing for acute toxicity of thermal degradation products also produced a favorable rating - superior to most materials tested, even more favorable than other natural materials such as wood and cotton.<sup>17</sup>

Additional product safety information is provided in the R-Temp fluid Material Safety Data Sheet (MSDS) available upon request.

## GENERAL INFORMATION

### ■ SPECIFICATION GUIDELINE

The dielectric coolant shall be a listed less-flammable fluid meeting the requirements of National Electrical Code Section 450-23, including a minimum fire



Prior to shipment, R-Temp fluid undergoes extensive quality assurance testing. The facility where R-Temp fluid is produced is ISO 9001 Certified.

point of 300°C and the requirements of the National Electrical Safety Code (IEEE C2-2002), Section 15. The fluid shall be non-toxic, non-bioaccumulating and biodegradable. It shall be Factory Mutual Approved and UL Classified, R-Temp fluid or equal.

For recommended acceptance values, contact Cooper Power Systems or your equipment supplier for Bulletin 92009.

### ■ STORAGE AND HANDLING

The same basic procedures for storing and handling conventional mineral oil should be followed with R-Temp fluid. For additional storage and handling information, contact Cooper Power Systems or your equipment supplier.

### ■ FLUID MAINTENANCE

Periodic maintenance tests for R-Temp fluid-filled equipment should follow the same schedule used for conventional mineral oil-filled equipment. Recommended maintenance tests include:

1. Dielectric strength per ASTM D 877. The acceptable limit for continued use of service-aged R-Temp fluid is 24 kV minimum (69 kV equipment and below).
2. Flash Point and Fire Point. Relatively small amounts of conventional oil or other contaminants may reduce the flash point and fire point of R-Temp fluids. If it is suspected that the fluid may be contaminated, flash point and fire point should be measured in accordance with ASTM D 92.
3. Dissolved Gas Analysis. Recommended particularly for high value equipment or equipment servicing critical loads. ANSI/IEEE guide C57.104-1991 for detection and analysis of generated gases should be applied.<sup>18</sup>
4. Testing one or more of the following properties provides a good indication of possible fluid contamination or unusual degradation. Acceptable limits for continued use of service-aged R-Temp fluids: <sup>19,20</sup>

Dissipation Factor	D924	1.0% at 25°C max.
Acid Number	D974	0.25% mg KOH/g max.
Interfacial Tension	D971	22 mN/m at 25°C min.

For fluid not to be reconditioned, recommended disposal options include pick-up by a used oil reprocessor for recycling/refining or blending with fuel oil for industrial grade boilers and industrial furnaces. <sup>21,22</sup>

## ORDERING INFORMATION

To order R-Temp fluid, specify:

	Catalog Number
Bulk	0425200A01
55 gallon drum	0425589A01
5 gallon container	0425589A02
330 gallon Ecobulk container	0425589A03

*For warranty, sales terms and conditions information contact Cooper Power Systems or your equipment supplier for Cooper Power Systems Terms and Conditions Sheet.*

## UL CLASSIFICATION MARKING



CLASSIFIED BY UNDERWRITERS LABORATORIES INC.® AS TO FIRE HAZARD ONLY.

R-Temp® Fluid Classed 4 to 5 less hazardous than paraffin oil in respect to Fire Hazard.

CLASSIFIED BY UNDERWRITERS LABORATORIES INC.® AS TO SECTION 450-23 OF THE 2002 NATIONAL ELECTRICAL CODE.

Classified as a "Less-flammable liquid" as specified in the National Electrical Code when used in 3-phase transformers, 45 through 10,000 kVA with the following "use restrictions":

- A. For use only in 3-phase transformers having tanks capable of withstanding an internal pressure of 12 psig without rupture,
- B. Required use of pressure relief devices on transformer tank in accordance with the following tabulation to limit internal pressure buildup and prevent tank rupture due to gas generation under low current arcing faults, and
- C1 Required use of current limiting fusing in the transformer primary having I<sup>2</sup>t characteristics not exceeding the values in the following tabulation. Under-fluid expulsion fuses may be used in series with the current-limiting fuses, in accordance with the manufacturer's protection scheme, or
- C2 Required use of overcurrent protection in the transformer primary having I<sup>2</sup>t characteristics not exceeding the values in the following tabulation. If the fuse is designed to vent during operation (such as an expulsion fuse), it shall be located external to the transformer tank.

TRANSFORMER 3-Phase Transformer Rating, kVA	REQUIRED PROTECTION		REQUIRED PRC Minimum Required Pressure Relief Capacity, (++) SCFM at 15 psi
	Required Current Limiting Fusing (+) Maximum I <sup>2</sup> t (A <sup>2</sup> s)	Or Required Overcurrent Protection (+) Maximum I <sup>2</sup> t (A <sup>2</sup> s)	
45	500,000	700,000	35
75	500,000	800,000	35
112.5	550,000	900,000	35
150	600,000	1,000,000	50
225	650,000	1,200,000	100
300	750,000	1,400,000	100
500	900,000	1,900,000	350
750	1,100,000	2,200,000	350
1,000	1,250,000	3,400,000	350
1,500	1,500,000	4,500,000	700
2,000	1,750,000	6,000,000	700
2,500	2,000,000	7,500,000	5,000
3,000	2,250,000	9,000,000	5,000
3,750	2,500,000	11,000,000	5,000
5,000	3,000,000	14,000,000	5,000
7,500	3,000,000	14,000,000	5,000
10,000	3,000,000	14,000,000	5,000

(+) - This is an additional requirement to the overcurrent protection required in accordance with Section 450-3 of the 2002 National Electrical Code.

(++) - Opening pressure, 10 psig maximum.

35H9

## REFERENCES

- 1 Laboratory Test Record 11/82, Bioassay Systems Corp. Project No. 10477
- 2 Laboratory Test Record 12/77, Associated Analysts
- 3 "The Biodegradability of Three Dielectric Fluids"; Ortech International Laboratories; Mississauga, Ontario, Canada; 1990.
- 4 The Biodegradation of R-Temp Fluid, 1990, Cooper Power Systems.
- 5 C. P. McShane, The Health, Environmental, Safety, Performance and Economic Analysis of R-Temp Fluid: The First Decade, EPRI Substitute Workshop, 12/17/86
- 6 M. W. Earley, Minimizing the Hazards of Transformer Fires, *Fire Journal*, Jan/Feb 1988
- 7 C. P. McShane, Analysis of Service Aged R-Temp Fluid, 10/8/87
- 8 K. White, J. L. Corkran and P. G. Stenborg: Thermal Characteristics of Network Transformers, Mineral Oil Versus R-Temp Fluid, 1996 Power Distribution Conference, University of Texas - Austin, 10/23/96
- 9 E. Howells and G. P. McCormick, Arcing Resistance of High Fire Point Dielectric Liquids, IEEE Power Engineering Society Conference, October 1996
- 10 Development of Flammability Criteria for Transformer Dielectric Fluids, NB SIR 80-1992
- 11 Gas and Oil Equipment Directory, 2002, Underwriters Laboratories, Inc.
- 12 National Electrical Safety Code, ANSI C2, 2002 Edition, IEEE, Inc.
- 13 NFPA 70, National Electrical Code® 2002 Edition, National Fire Protection Association.
- 14 Loss Prevention Data Sheet 5-4/14-8, Revised 1/01, Factory Mutual Research Corporation.
- 15 P. H. Taylor, et. al.; Evaluation and Potential Health Hazards from Fires Involving Liquid and Solid Utility Materials, University of Dayton Research Institute, EPRI PCB Seminar, 10/6-9/87
- 16 Federal Register, Volume 50, No. 137, July 1985
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- 18 C. P. McShane, Methodology and Experience With Analysis of Dissolved Gases in a Fire Resistant Hydrocarbon Fluid, 1992, International Conference on Doble Clients.
- 19 IEEE Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers, IEEE C57.121 - 1988
- 20 ASTM D5222, Standard Guide for High Fire Point Electrical Insulation Oils of Petroleum Origin
- 21 40 CFR 261, February 1997
- 22 40 CFR 279, June 1996

To the best of our knowledge, the information and data in this brochure are accurate at the time of printing.

### FACTORY MUTUAL APPROVAL:

Fire point greater than 300°C (ASTM D-92-72)

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