		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 1 of 11

Table 1: Evaluations of Envirotemp FR3 fluid environmental properties and associated test methods.

Property	Test	Method	Report
ENVIRONMENTAL HAZARD			
Toxicity	Acute Aquatic Toxicity	OECD 203 [1]	[21]
	Acute Lethality Using Rainbow Trout	Environment Canada [2]	[21]
	Acute Oral Toxicity	OECD 420 [46]	[31-33]
Biodegradation	Aquatic Biodegradation	CEC L-33-A-93 ^a [5]	[17,18,24]
	Aerobic Aquatic Biodegradation	OPPTS 835.3100 [3]	[14 -16]
	Ready Biodegradation	OPPTS 835.3110 [4]	[26]
	Biochemical Oxygen Demand (BOD ₅)	SM 5210B [7]	[13]
	Chemical Oxygen Demand (COD)	SM 5220D [7]	[13]
	Oxidation Depletion	University of Cincinnati [30]	[30]
SITE ASSESSMENT			
Total Petroleum Hydrocarbons	Fuel Hydrocarbons	SW-846 Modified 8015B [6]	[22]
	Spectrophotometric	600/4-79/020 418.1 [8]	[22,28]
Extractable Petroleum Hydrocarbons		MADEP-EPH-04-1.1 [29]	[13]
Total Recoverable Oil and Grease	Gravimetric	600/4-79/020 413.1 [8]	[28]
	Spectrophotometric	600/4-79/020 413.2 [8]	[22,28]
Target Compound List	Semi-Volatile Organics	SW-846 Method 8270C [6]	[22,25]
	Volatile Organics	SW-846 Method 8260B [6]	[22,25]
Toxicity Characteristic Leaching Procedure	Metals	SW-846 Method 1311, 7000 series [6]	[20]
	Semi-Volatiles	SW-846 Method 1311, 3510, 8270 [6]	[23]
	Volatiles	SW-846 Method 1311, 5030, 8260 [6]	[23]
Total Threshold Limit Concentration	Metals	SW-846 Methods 6010, 7000 series [6]	[22]
	ASSESSMENT-RELATED PROPERTIES		
Heat of Combustion		ASTM D240 [9]	[22]
Ignitability	Pensky-Martens Flash Point	SW-846 Method 1010 [6]	[13]
	Setaflash Flash Point	SW-846 Method 1020A [6]	[19,22]
	Autoignition Point	ASTM E659 [48]	[47]
Total Organic Halides (TOX)	Extractable Organic Halides	SW-846 Method 9020B [6]	[22]
	Leachable Fluoride	600/4-79/020 340.2 [8]	[22]
Cyanides	Reactive Cyanide	SW-846 7.3.3 [6]	[22]
	Cyanides in Waste	ASTM D5049 ^b [10]	[13]
Sulfides	Reactive Sulfide	SW-846 7.3.4 [6]	[22]
	Sulfides in Waste	ASTM D4978 [10]	[13]
Soil and Waste pH		SW-846 Method 9045C [6]	[13]
Specific Gravity		SM 2710F [7]	[13]
Odor, Color, Appearance		ASTM D4979 [10]	[13]

^a This test method is no longer supported by CEC.

^b This test method was discontinued by ASTM in 1999.


		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 2 of 11

Table 2: Envirotemp FR3 fluid waste assessment-related parameters. Other dielectric fluid types, if included in the referenced test report, are listed for comparison.

Property	Envirotemp FR3 fluid	Shell Diala	R-Temp fluid	Envirotemp 200 fluid	Test Report
Fluid Type	natural ester	mineral oil	HMWH ^a	synthetic ester	[13]
Odor	slight	slight	slight	none	[13]
Color	yellow	yellow	yellow	yellow	[13]
Appearance	liquid	liquid	liquid	liquid	[13]
Free Liquid (%)	100	100	100	100	[13]
Specific Gravity	0.91	0.87	0.87	0.95	[13]
Flash Point (°F)					
Pensky-Martens	> 210	> 210	> 210	> 210	[13]
Setaflash	> 210	> 210	> 210	-	[19]
Setaflash	> 200	-	-	-	[22]
Heat of Combustion (BTU/lb)	16,200	-	-	-	[22]
Autoignition Temperature (°C)	402	226	358	374	[47]
Soil and Waste pH	5.80	5.64	5.76	5.72	[13]
Leachable Fluoride (µg/g)	2 U ^b	-	-	-	[22]
Extractable Organic Halides (µg/g)	5.8	-	-	-	[22]
Cyanides					
Reactive Cyanide (mg/kg)	10 U	-	-	-	[22]
Cyanides in Waste (ppm)	< 10 ^c	< 10 ^c	< 10 ^c	< 10 ^c	[13]
Sulfides					
Reactive Sulfide (mg/kg)	10 U	-	-	-	[22]
Sulfides in Waste (ppm)	< 2 ^c	< 2 ^c	< 2 ^c	< 2 ^c	[13]
BOD ₅ (mg/l)	250	< 6 ^c	< 6 ^c	230	[13]
COD (ppm)	560	82	34	680	[13]
BOD ₅ /COD	0.45	< 0.07 ^c	< 0.17 ^c	0.34	[13]

^a HMWH = high molecular weight hydrocarbon

^b U = not detectable

^c Below Quantifiable Limit (not detectable)


		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 3 of 11

Table 3: Total Petroleum Hydrocarbons (Fuel Hydrocarbons) of Envirotemp FR3 fluid. Environmental assessment of a simulated soil spill using Envirotemp FR3 fluid in sodium sulfate (Na₂SO₄). A 10% wt/wt ratio of FR3 fluid in sodium sulfate represents oil-saturated soil. [22]

Analyte	Total Petroleum Hydrocarbons (mg/kg)		Analyte	Total Petroleum Hydrocarbons (mg/kg)	
	10% in Na ₂ SO ₄	Neat		10% in Na ₂ SO ₄	Neat
naphtha	49 U ^a	2,800 U	fuel oil #6	49 U	2,800 U
aviation fuel	49 U	2,800 U	diesel fuel	49 U	2,800 U
mineral spirits	49 U	2,800 U	diesel range organics	20 U	1,100 U
gasoline	49 U	2,800 U	SAE 10	49 U	2,800 U
JP-4	49 U	2,800 U	SAE 20	49 U	2,800 U
JP-5	49 U	2,800 U	SAE 30	49 U	2,800 U
JP-8	49 U	2,800 U	SAE 40	49 U	2,800 U
kerosene	49 U	2,800 U	WD-40	49 U	2,800 U
fuel oil #2	49 U	2,800 U	other ^b	490	5,600
fuel oil #4	49 U	2,800 U			

^a U = not detected

^b The sample elutes within the range of diesel fuels, and is reported as "other". The peaks are not typical diesel fuel patterns.

Table 4: Total Recoverable Petroleum Hydrocarbons and Total Recoverable Oil and Grease of simulated Envirotemp FR3 fluid soil spills. Soil spills are simulated using Envirotemp FR3 fluid in soil and in sodium sulfate (Na₂SO₄). A 10% wt/wt ratio of FR3 fluid in sodium sulfate represents oil-saturated soil.

Matrix	Initial FR3 Concentration		Total Recoverable Oil and Grease (413.2)		Total Recoverable Petroleum Hydrocarbons		Test Report
	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	
neat	1,000,000	100	980,000	98	1,420,000	142	[22]
in Na ₂ SO ₄	100,000	10	89,800	89.8	81,300	81.3	[22]
in soil	20,000	2	13,600	68	307	1.50	[28]
in soil	10,000	1	8,200	82	234	2.34	[28]
in soil	5,000	0.5	2,440	48	213	4.26	[28]
in soil	40,000	4	31,500	78	445	1.11	[28]

Table 5: Envirotemp FR3 fluid site assessment and assessment-related parameters. An environmental assessment of a simulated soil spill using Envirotemp FR3 fluid in sodium sulfate. A 10% wt/wt ratio of FR3 fluid in sodium sulfate represents oil-saturated soil. [22]

Property	10% in Na ₂ SO ₄	Neat
Flash Point - Setaflash (°F)	> 200	> 200
Leachable Fluoride (µg/g)	2 U ^a	2 U
Extractable Organic Halides (µg/g)	5.1	5.8
Reactive Cyanide (mg/kg)	10 U	10 U
Reactive Sulfide (mg/kg)	10 U	10 U
Heat of Combustion (BTU/lb)	2,590	16,200

^a U = not detected

ENGINEERING DEVELOPMENT REPORT

Envirotemp FR3 Fluid Environmental Properties

TP05-DR-002

Revision: 00

May 7, 2007

Page 4 of 11

Table 6: Target Compound List – 65 Semi-Volatile Organics content of Envirotemp FR3 fluid. An environmental assessment of a simulated soil spill using Envirotemp FR3 fluid in sodium sulfate (Na_2SO_4). A 10% wt/wt ratio of FR3 fluid in sodium sulfate represents oil-saturated soil. [22]

Analyte	Semi-Volatile Organics ($\mu\text{g}/\text{kg}$)		Analyte	Semi-Volatile Organics ($\mu\text{g}/\text{kg}$)	
	10% in Na_2SO_4	Neat		10% in Na_2SO_4	Neat
acenaphthene	1700 U ^a	19000 U	4,6-dinitro-2-methylphenol	3300 U	37000 U
acenaphthylene	1700 U	19000 U	2,4-dinitrophenol	3300 U	37000 U
anthracene	1700 U	19000 U	2,4-dinitrotoluene	1700 U	19000 U
benzo(a)anthracene	1700 U	19000 U	2,6-dinitrotoluene	1700 U	19000 U
benzo(b)fluoranthene	1700 U	19000 U	di-n-octyl phthalate	1700 U	19000 U
benzo(k)fluoranthene	1700 U	19000 U	fluoranthene	1700 U	19000 U
benzo(ghi)perylene	1700 U	19000 U	fluorene	1700 U	19000 U
benzo(a)pyrene	1700 U	19000 U	hexachlorobenzene	1700 U	19000 U
benzoic acid	3300 U	37000 U	hexachlorobutadiene	830 U	9400 U
benzyl alcohol	3300 U	37000 U	hexachlorocyclopentadiene	1700 U	19000 U
bis(2-chloroethoxy) methane	3300 U	37000 U	hexachloroethane	1700 U	19000 U
bis(2-chloroethyl) ether	1700 U	19000 U	indeno(1,2,3-cd)pyrene	1700 U	19000 U
2,2'-oxybis(1-chloropropane)	1700 U	19000 U	isophorone	1700 U	19000 U
bis(2-ethylhexyl) phthalate	1700 U	19000 U	2-methylnaphthalene	1700 U	19000 U
4-bromophenyl phenyl ether	3200 U	36000 U	2-methylphenol	3300 U	37000 U
butyl benzyl phthalate	1700 U	19000 U	4-methylphenol	3300 U	37000 U
4-chloroaniline	1700 U	19000 U	naphthalene	1700 U	19000 U
4-chloro-3-methylphenol	3300 U	37000 U	2-nitroaniline	1700 U	19000 U
2-chloronaphthalene	1700 U	19000 U	3-nitroaniline	1700 U	19000 U
2-chlorophenol	3300 U	37000 U	4-nitroaniline	1700 U	19000 U
4-chlorophenyl phenyl ether	3300 U	37000 U	nitrobenzene	1700 U	19000 U
chrysene	1700 U	19000 U	2-nitrophenol	3300 U	37000 U
dibenzo(a,h)anthracene	1700 U	19000 U	4-nitrophenol	3300 U	37000 U
dibenzofuran	1700 U	19000 U	n-nitrosodiphenylamine	1700 U	19000 U
di-n-butyl phthalate	1700 U	19000 U	n-nitroso-di-n-propylamine	1700 U	19000 U
1,2-dichlorobenzene	1700 U	19000 U	pentachlorophenol	1700 U	19000 U
1,3-dichlorobenzene	1700 U	19000 U	phenanthrene	1700 U	19000 U
1,4-dichlorobenzene	1700 U	19000 U	phenol	1700 U	19000 U
3,3'-dichlorobenzidine	1700 U	19000 U	pyrene	1700 U	19000 U
2,4-dichlorophenol	3300 U	37000 U	1,2,4-trichlorobenzene	1700 U	19000 U
diethyl phthalate	1700 U	19000 U	2,4,5-trichlorophenol	3300 U	37000 U
2,4-dimethylphenol	3300 U	37000 U	2,4,6-trichlorophenol	3300 U	37000 U
dimethyl phthalate	1700 U	19000 U			
TENTATIVELY IDENTIFIED COMPOUNDS					
dimethylbenzene isomer	15000	-	unknown	33000	-
unknown	-	220000	unknown	18000	-
cyclohexadiene derivative	22000	-	hexanedioic acid derivative	80000	560000
possible benzenediol derivative	170000	1900000			

^a U = not detected


		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 5 of 11

Table 7: Target Compound List – 34 Volatile Organics content of Envirotemp FR3 fluid. An environmental assessment of a simulated soil spill using Envirotemp FR3 fluid in sodium sulfate (Na₂SO₄). A 10% wt/wt ratio of FR3 fluid in sodium sulfate emulates oil-saturated soil. [22]

Analyte	Volatile Organics (µg/kg)		Analyte	Volatile Organics (µg/kg)	
	10% in Na ₂ SO ₄	Neat		10% in Na ₂ SO ₄	Neat
acetone	1250 U ^a	1250 U	1,2-dichloropropane	625 U	625 U
benzene	625 U	625 U	cis-1,3-dichloropropene	625 U	625 U
bromodichloromethane	625 U	625 U	trans-1,3-dichloropropene	625 U	625 U
bromoform	625 U	625 U	ethylbenzene	625 U	625 U
bromomethane	1250 U	1250 U	2-hexanone	1250 U	1250 U
2-butanone	1250 U	1250 U	methylene chloride	625 U	625 U
carbon disulfide	625 U	625 U	4-methyl-2-pentanone	1250 U	1250 U
carbon tetrachloride	625 U	625 U	styrene	625 U	625 U
chlorobenzene	625 U	625 U	1,1,2,2-tetrachloroethane	625 U	625 U
chloroethane	1250 U	1250 U	tetrachloroethene	625 U	625 U
chloroform	625 U	625 U	toluene	625 U	625 U
chloromethane	1250 U	1250 U	1,1,1-trichloroethane	625 U	625 U
dibromochloromethane	625 U	625 U	1,1,2-trichloroethane	625 U	625 U
1,1-dichloroethane	625 U	625 U	trichloroethene	625 U	625 U
1,2-dichloroethane	625 U	625 U	vinyl acetate	1250 U	1250 U
1,1-dichloroethene	625 U	625 U	vinyl chloride	1250 U	1250 U
1,2-dichloroethene (total)	1250 U	1250 U	total xylenes	1875 U	1875 U

^a U = not detected

Table 8: Total Threshold Limit Concentration - Metals content of Envirotemp FR3 fluid. An environmental assessment of a simulated soil spill using Envirotemp FR3 fluid in sodium sulfate (Na₂SO₄). A 10% wt/wt ratio of FR3 fluid in sodium sulfate represents oil-saturated soil. SW-846 Method 6010 used unless otherwise indicated. [22]

Analyte	Content (mg/kg)		Analyte	Content (mg/kg)	
	10% in Na ₂ SO ₄	Neat		10% in Na ₂ SO ₄	Neat
antimony	0.42 U ^a	0.21 U	molybdenum	0.20 U	0.099 U
arsenic	0.32 U	0.59	nickel	0.16	0.60
barium	1.4	0.90	selenium	0.46 U	2.5
beryllium	0.059 U	0.030 U	silver	0.099 U	0.19
cadmium	0.049 U	0.025 U	thallium	0.49 U	0.46 U
chromium	0.34	15.7	vanadium	0.23	0.064 U
cobalt	0.089 U	0.044 U	zinc	5.9	8.6
lead	0.42	11.1	hexavalent chromium ^c	0.40 U	0.49 U
mercury ^b	0.033 U	0.0099 U			

^a U = not detected

^b SW-846 Method 7471

^c SW-846 Method 7196A

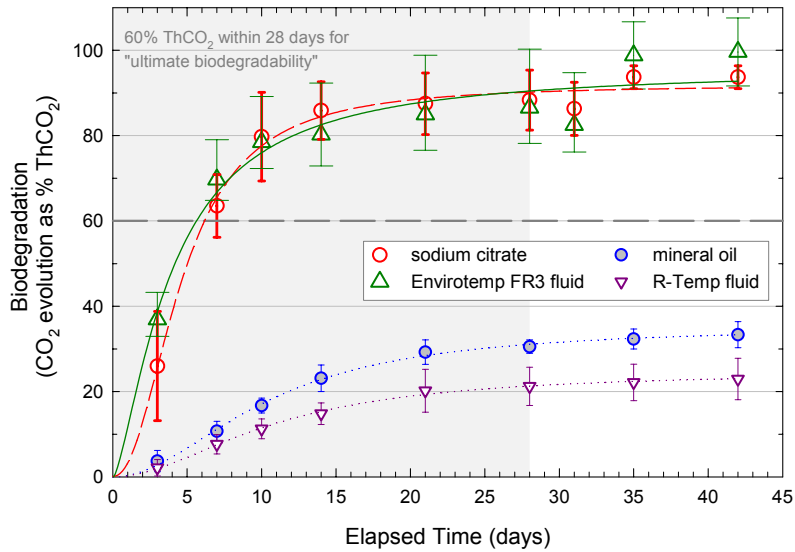


Figure 1: Aerobic Aquatic Biodegradation of Envirotemp FR3 fluid using Test Method EPA OPPTS 835.3100. To be “ultimately biodegradable”, a substance must reach 60% of the theoretical maximum conversion of total organic carbon to carbon dioxide (ThCO₂) within 28 days. [14-16]

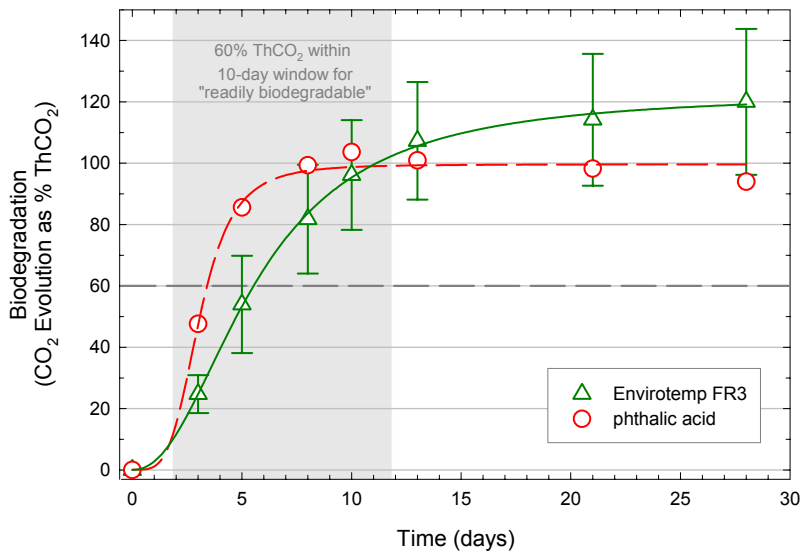


Figure 2. Ready Biodegradability of Envirotemp FR3 fluid using Test Method EPA OPPTS 835.3110(m). To be “readily biodegradable”, a substance must reach 60% of the theoretical maximum conversion of total organic carbon to carbon dioxide (ThCO₂) in a ten-day window starting at time to reach 10% ThCO₂. [26]


		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 7 of 11

Table 9: Ready Biodegradability of Envirotemp FR3 fluid. Biodegradation is measured by CO₂ evolution as a percentage of the theoretical maximum conversion of total organic carbon to CO₂. [26]

Time (days)	Lot 01C6		Lot 01D1		Lot 01P2		Phthalic Acid ^b
	Test 1 ^a	Test 2	Test 1	Test 2	Test 1	Test 2	
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	17.8	18.4	24.1	28.7	34.0	25.3	47.6
5	25.1	48.8	59.1	64.8	69.7	56.2	85.6
8	47.5	87.4	82.9	95.1	95.5	82.2	99.3
10	62.4	106.7	96.8	109.5	108.8	92.8	103.6
13	71.3	114.5	110.6	123.5	121.2	102.6	100.9
21	74.8	124.5	115.9	135.8	126.1	107.9	98.2
28	76.6	135.3	122.0	143.3	130.2	112.5	94.0

^a The endpoint for this sample is significantly lower than other FR3 fluid samples, suggesting that this sample was compromised (leaked CO₂) during the study.

^b EPA "ultimately biodegradable" reference material

Table 10: Aerobic Aquatic Biodegradation of Envirotemp FR3 fluid. Biodegradation is measured by CO₂ evolution as a percentage of the theoretical maximum conversion of total organic carbon to CO₂. [14-16]

Material	Sample	Time (days)								
		3	7	10	14	21	28	31	35	42
TRIAL 1										
sodium citrate ^a	1	36.49	72.47	85.39	87.47	88.04	88.08	90.68	-	-
	2	28.57	60.46	75.31	76.79	77.19	78.67	81.87	-	-
Envirotemp FR3 fluid	1	32.29	58.30	64.03	65.15	66.43	68.75	70.03	-	-
	2	42.14	75.35	81.07	85.07	88.04	88.80	90.20	-	-
	3	41.42	73.91	82.27	82.35	84.47	86.35	87.64	-	-
	4	42.86	73.67	78.55	79.59	82.19	82.47	84.83	-	-
	5	41.18	76.19	83.59	84.27	90.12	93.20	94.48	-	-
TRIAL 2										
sodium citrate	1	7.40	55.34	67.47	86.19	91.00	91.60	-	91.80	92.24
	2	31.49	65.79	90.76	93.04	93.64	94.96	-	95.59	96.12
Envirotemp FR3 fluid	1	29.45	64.59	78.03	84.38	93.63	95.07	-	96.59	97.39
	2	40.74	80.67	94.36	98.80	105.76	107.08	-	107.52	108.44
	3	34.85	72.63	83.91	88.12	90.88	91.96	-	92.28	92.96
R-Temp fluid	1	2.68	8.28	12.12	14.17	18.01	18.25	-	19.49	19.57
	2	3.76	9.60	13.09	17.65	25.93	26.41	-	27.09	28.49
	3	0.04	5.16	8.64	12.73	16.69	19.09	-	19.89	20.81
mineral oil	1	5.92	13.33	18.73	25.45	31.69	31.69	-	34.97	36.73
	2	4.24	9.84	15.49	24.37	30.01	31.21	-	31.53	32.53
	3	1.04	9.04	16.01	19.61	26.09	28.73	-	30.49	30.77

^a EPA "ultimately biodegradable" reference material


		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 8 of 11

Table 11: Total organic carbon content of Envirotemp FR3 fluid.

Sample ID	Total Organic Carbon Content (%)	Test Report
Lot 01C6	77.73	[26]
Lot 01D1	74.84	[26]
Lot 01P2	76.09	[26]
Z-0992	77.65	[27]
Average	76.58	


Table 12: Biodegradation of Envirotemp FR3 Fluid

Laboratory	Method	Biodegradation	Test Report
California EPA	OPPTS 835.3110	VFR3-011 ^a	132.7% of ThCO ₂
		VFR3-051 ^a	121.4% of ThCO ₂
		VFR3-101 ^a	105.9% of ThCO ₂
	Indicated biodegradation	100%	
Thomas A. Edison Technical Center	OPPTS 835.3100	ML 304-98.002	100%
		ML 304-98.003	100%
PowerTech Laboratory	CEC L-33-A-93	99%	

^a The higher than expected biodegradability percentages may be due to a loss of CO₂ from leaks in the stock solution test system.

Table 13: Acute oral toxicity of Envirotemp FR3 fluid [31-33].

Method	Test	Animals	Dose (mg/kg)	% Mortality Total	14 Day Average Body Weight (g)		
					Initial	7 Day	Final
OECD 420	Sighting	1 F	2,000	0	226.0	251.2	259.9
	Main	5 F	2,000	0	221.5	265.0	280.6
		5 M	2,000	0	285.3	352.0	378.8

		Transformer Products	
ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 9 of 11


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ENGINEERING DEVELOPMENT REPORT			
Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 10 of 11

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Envirotemp FR3 Fluid Environmental Properties			
TP05-DR-002	Revision: 00	May 7, 2007	Page 11 of 11

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