ENVIRONMENTALLY ACCEPTABLE INSULATING FLUIDS

MAY REPLACE ASKAREL

BY:

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PRESENTED AT:

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TRANSMISSION AND DISTRIBUTION COMMITTEE
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TOWOLDMON0057880

Environmentally Acceptable Insulating Fluids May Replace Askarel

The transformation of electrical energy poses a fire hazard in high-rise buildings, large industrial plants, and other locations. Utilities and contractors have four choices in supplying power to these locations, none of which have been economically practical but have met the fire codes and non-flammable conditions set forth by insurance underwriters and other regulatory bodies. These four choices include:

1. Remote transformers with long secondary runs at utilization voltage (occasionally at intermediate voltages which employ additional dry type transformers at key locations)

2. Dry type or gas cooled transformers

3. Fire-proof vaults

4. Askarel cooled transformers

The disadvantages of remote transformers are immediately apparent. High cost and system complexity are difficult to justify. Voltage regulation problems exist.

Gas cooled and dry type transformers have limitations in physical size and voltage. High cost, low overload capacity, and poor reliability make these a difficult choice.

Fire-proof vaults with mineral oil transformers also have high installation costs. Space limitations tend to make this choice unacceptable for many installations.

This leaves the latter choice of askarel cooled transformers. Askarel cooled transformers have the advantages of lower initial unit cost than the previously mentioned choices, higher kV and kVA ratings, and better reliability, physical size, and weight.

The disadvantages of askarel come from its fire-proof characteristics. Askarel, a polychlorinated biphenyl, is extremely stable in the environment. It does not bio-degrade and builds in the food chain affecting fish and certain types of birds. This has led to criticism by environmentalists. Costly precautions must be taken to either reclaim or dispose of askarels when their useful life is expended.

Askarel is a powerful solvent and requires special sealing and insulation systems which add to its cost.

Under arcing conditions, askarel produces hydrogen chloride, which is corrosive and toxic, and carbon, which prevents the use of submerged fuses and switching devices.

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Environmentally Acceptable Insulating Fluids May Replace Askarel

The purpose of this paper is to acquaint you with the problems associated with askarel, and to share with you our attempts to develop a substitute insulating fluid that is environmentally acceptable and will still do all the things necessary to provide successful transformer performance.

The concern over askarel began in the mid-1960's with the search for the presence of DDT in the oceans. Refinements led to improved test equipment and monitoring techniques. Biphenyls, closely related to DDT, were also found to be prevalent in the environment. This led to restrictions and limitations on the amounts of biphenyls that could be allowed to enter the waterways. Open and semi-open systems utilizing askarels were abandoned and their use outlawed.

In Japan, during the early 1970's, a food processing company was using askarel as a heat transfer fluid. A leak occurred, and many people were poisoned with excessive amounts of biphenyls. Because of this, and several other political issues of the time, Japan outlawed the use of askarels. They have since approved silicones for use in electrical devices on the National Rail System, where a replacement was necessary.

These events led Dow Corning into research toward developing a silicone fluid for use as an alternate transformer coolant. Dow Corning reviewed their alternative fluid with Commonwealth Edison who suggested a joint venture with RTE, who could produce additional tests and sample transformers.

During the 1960's, RTE was studying dielectric fluids for use in a new high temperature transformer. This design, the Power Seed, is a small kVA, porcelain enclosed, Class H, direct buried transformer. It was produced in the early 70's as a pilot project for development of a total underground system and is presently undergoing field testing at various utility sites.

When approached by Commonwealth Edison and Dow Corning, RTE chose to also include the fluid used in the Power Seed, RTEMP, and leave the door open for additional choices to provide an atmosphere for development.

Fault Tests

The main question was, "How do the fluids react when subjected to a high energy arc?" A fluid which continues to burn after a catastrophic fault has occurred could expand the explosion into a building fire. A fluid which does not continue to burn would limit the explosion to the immediate vicinity of the device. Would these new fluids, mainly because of their high flash points, put themselves out after an explosion, or would they continue to burn?

A series of high current fault tests were performed. These tests compared transformer oil, Silicone DC-200, RTEMP, and askarel under high current submerged arcing conditions.

Approximately four gallons of each fluid were placed in separate cylindrical containers and pre-heated to 150°C. Each container had fused internal electrodes

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Fault Tests (cont'd):

mounted on the end of SBT Bushings. The electrodes were shaped upward with an expanding gap; this produced an effect which forced the arc upward and into the gas space, where it was present in the gasses and vaporized fluids as they were blown out of the test container (Figure 1).

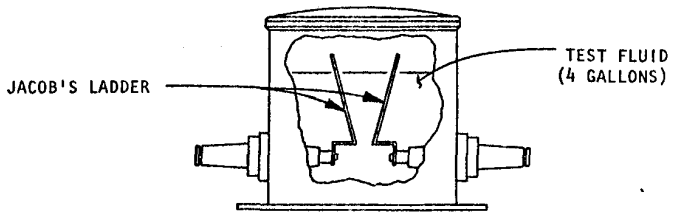


FIGURE 1
TEST CONTAINER

The container was sealed before the test to contain the hot gasses in the air space prior to the explosion. A cable was attached to the cover to prevent it from leaving the test site.

Barriers (Figure 2) were placed around the test container to simulate types of wall surfaces which might collect the flaming liquids and promote burning.

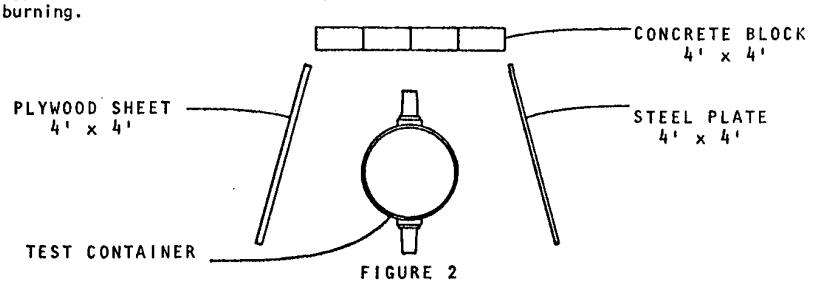


FIGURE 2
TEST SITE

To protect the surrounding environment from contamination, a nylon reinforced plastic sheet was laid down approximately 30 feet in the direction of the wind (less than 5 mph at test time). This was covered with a coating of sand to collect any unburnt fluids. After the tests were completed, the entire package was buried in a dry land fill area.

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Test Circuit

The test circuit utilized is shown in Figure 3.

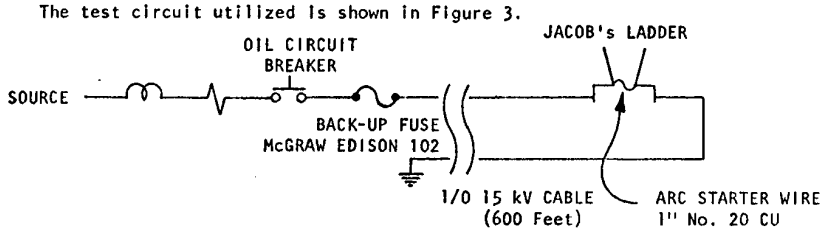


FIGURE 3
TEST CIRCUIT

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Comments on each test follow with the visual and electrical data summarized:

Test Number One - Transformer Oil

This test was expected to be violent in nature and was placed in the series as a control sample. Results met expectations.

The test current applied was 4820 amperes at 4800 volts. The back-up fuse cleared the fault after 10½ cycles.

The explosion was very violent with an initial fireball, orange and yellow in color, approximately 20 feet high by 15 feet in diameter. This mushroomed into a cloud of flame and smoke approximately 55 feet high by 40 feet in diameter. The resulting smoke cloud produced was voluminous and black to dark grey in color.

The test container and surrounding area were covered with burning liquid which was manually extinguished quickly to avoid damage to the test cable and connectors.

Test Number Two - Silicone Fluid DC-200 (50 CS)

The test current applied was 4760 amperes at 4800 volts. The back-up fuse did not blow. The fault self-cleared after 4-½ cycles; this will be discussed later.

Compared to Test One, the explosion and the noise produced were mild. A fireball, orange and yellow in color, approximately 30 feet high by 15 feet in diameter was noted. The flash appeared to be very bright in comparison to the other tests.

The smoke produced was white in color and of less volume than Test One. Black flakes were seen in the cloud. White particles, identified as silica, were noted floating in the air after the explosion. Films show a flame, low in magnitude and quiet in nature, to burn for a few seconds in the test container after the explosion then self-extinguish.

Test Number Three - RTE High Temperature Liquid (RTEMP)

The test current applied was 4700 amperes at 4800 volts. The fault self-cleared after 4 cycles. The explosion was mild in comparison to Test One and resulted in a fireball approximately 15 feet high by 10 feet in diameter. A quantity of non-burning fluid was noted preceding the fireball upward; this can be seen falling back to earth in the films. The smoke was grey-white in color and similar in volume to the smoke cloud of Test Number Two. Noise was mild compared to Test One.

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Test Number Three (cont'd)

A re-strike occurred approximately 115 cycles after the initial fault.

The loss of fluid in the test container was due to the placement of the arc and the physical dimensions of the container. The fluid self-cleared and the electrodes were energized as the remaining fluid began to settle. The current tracked across the contaminated surface and was cleared by the back-up fuse. This effect was noted in the rehearsal tests for both Silicone and RTEMP and should not be considered a negative point toward the fluids, but a criticism of the physical parameters selected for the containers and electrodes.

Comments were made that possibly the secondary flashover extinguished the flame; however, films show RTEMP burning in the test container after the re-strike and self-extinguish.

Included with this report is a series of sequential photographs for each test. The machine driven camera speed was 12 frames/11 seconds, or approximately 0.92 seconds (55 cycles) between frames. By this timing, the re-strike would occur between frame two and three of the sequence. From the remaining frames, it can be seen that the flame was present for a few seconds after the re-strike. High speed movies also verify this.

Test Number Four - Askarel

The askarel used in the test was Inerteen* 70-30. The test current was 4660 amperes at 4800 volts. The back-up fuse cleared the circuit after 11-½ cycles.

A fireball of bright orange flame, approximately 25 feet high by 15 feet in diameter, rose in a pitch black smoke cloud for 1-½ seconds after the explosion; black stringers were noted falling from the cloud. There was no fire in or around the test sample.

The smoke cloud was voluminous, approximately 25 feet high by 40 feet in diameter, and remained in the air about 20 feet above the ground for approximately five to ten minutes before dissipating. The test site and equipment were covered with black fluid and the area had a very noxious odor.

Dielectric tests show the fluid to retain little dielectric strength after the fault. Before the test, the fluid was good for 34 kV; after the test, it was reduced to only 7 kV.

It would be an understatement to say that the observers were shocked at the poor performance of this approved "safe" fluid. Although the fluid itself did not burn, flame was present in the smoke cloud (experts from Monsanto have identified this as possibly "free carbon" igniting). The dense smoke was considered a dangerous by-product.

*Trademark of Westinghouse Electric Corporation

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Test Conclusions

Both RTEMP and Silicone DC-200 (50 CS) passed the test requirements and deserve further investigation toward approval as an alternate for the environmentally hazardous askarels.

In Test One, transformer oil, all liquid thrown out of the container would have been consumed by fire if it had not been extinguished. This could have led to a disastrous building fire.

As the temperature of the liquids were below the fire point in the remaining tests, Silicone, RTEMP, and askarel,the fluids self-extinguished. This would limit the after effects of an explosion and, with reasonable precautions, would allow electrical equipment with these fluids to be mounted inside building structures.

The gasses produced by the askarel are considered extremely dangerous to the well-being of anyone in the area. Askarels are non-biodegradable in the environment and dangerous as they build in the food chain. They were established at a time when little or no concern was felt for these objections, and it's doubtful that any testing was done to research these areas. A simple non-flammability test would meet the requirements for indoor applications; historical usage has gained universal approval.

Silicone fluid, although also non-biodegradable, is not known to be dangerous in the environment. The only questionable by-product of an explosion is silica particles, of which only minimal exposure is possible.

The RTE High Temperature Fluid, like transformer oil, is biodegradable. The gasses produced during an explosion are essentially hydrocarbons.

Both Silicone and RTEMP limited the duration of the fault and self-cleared; this is a property which adds to the value of these liquids and is a desirable feature for designs requiring submerged high voltage fuses, breakers, and switching devices.

Table I shows the fluid properties before and after the arcing tests. This data reflects the remaining dielectric integrity of the fluids after high current arcing and shows RTEMP to surpass all tested fluids.

The electrodes in all cases showed signs of arcing along the entire length and burning at the top. This indicates that the arcs followed theory and were present in the gasses and vaporized fluids as they were thrown upward.

Approximately one gallon of fluid was left in each of the test containers after each test.

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Test Conclusions (cont'd.)

The level of fault currents applied during the tests, 4,000 to 5,000 amperes, and the voltage, 4.8 kV, could be considered low under today's conditions of higher available fault energy and increasing voltage levels. These values were selected to extend the possible fault time to 8-12 cycles with available back-up fusing. Higher values of energy, I^2t, could be released into the test containers if the current were increased. Higher voltages might promote arc expansion to the walls of the container and other ground points. The physical placement of the arc and the mass of the fluid in the container would also effect the results. It has been discussed that this should suggest further testing to study the explosive potential of the various liquids under these varied conditions; however, the purpose of these tests was to determine the flammability of the liquids after an explosion. Both Silicone and RTEMP self-extinguished and passed the test.

Higher values of I^2t might create a greater explosion in any of the fluids but would not effect the self-extinguishing feature unless the mass of the fluid was so small as to have its surface temperature raised to values in excess of the fire point of the liquid. Although the temperature at the point of arcing is several thousand degrees, this can last only for a few cycles and cannot significantly effect the temperature of a container the size of even a small distribution transformer. Greater values of I^2t would create a more spectacular test, but the flammability results would remain the same.

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		DIELECTRIC STRENGTH (kV) ASTM D87	IFT (dyne/cm) ASTM D971	VISCOSITY (SSU) ASTM D88
TRANSFORMER OIL	BEFORE TEST	32.0	49.0	58 @ 25°C
	AFTER TEST	20.4	45.5	77.4 @ 25°C
SILICONE FLUID DC-200	BEFORE TEST	42.0	20.8	50 @ 25°C
	AFTER TEST	15.5	22.2	66 @ 25°C
RTE HIGH TEMPERATURE FLUID (RTEMP)	BEFORE TEST	34.0	25.5	4000 @ 25°C
	AFTER TEST	24.5	50.0	1900 @ 25°C
ASKAREL	BEFORE TEST	35.0	50.0	54 @ 25°C
	AFTER TEST	7.0	54.5	66 @ 25°C

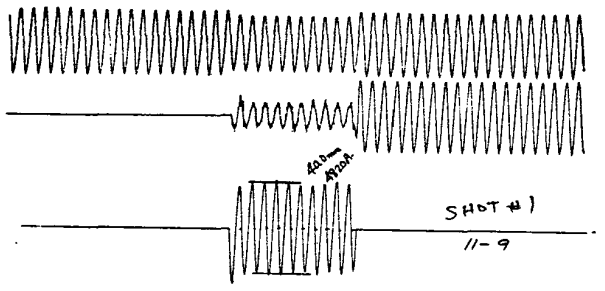
TABLE I

FLUID PROPERTIES

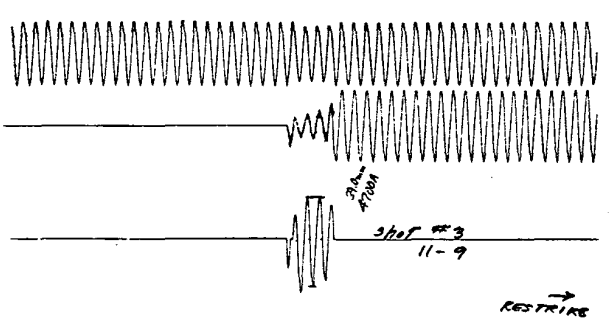
BEFORE AND AFTER FAULT TESTS

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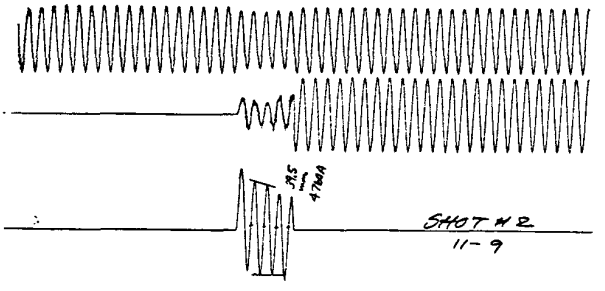
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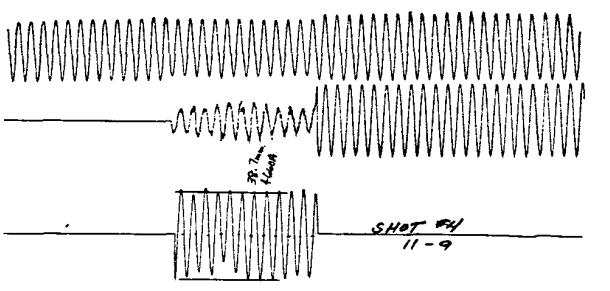
TEST No. 1 TRANSFORMER OIL



TEST No. 3 RTE HIGH TEMP (RTE MP)



TEST No. 2 SILICONE FLUID DC— 200



TEST No. 4 PCB

OSCILLOGRAPHS

RTE CORPORATION Waukesha, Wisconsin

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TEST No. 1 TRANSFORMER OIL



TEST No. 2 SILICONE FLUID DC – 200



TEST No. 3 RTE HIGH TEMP (RTEMP)



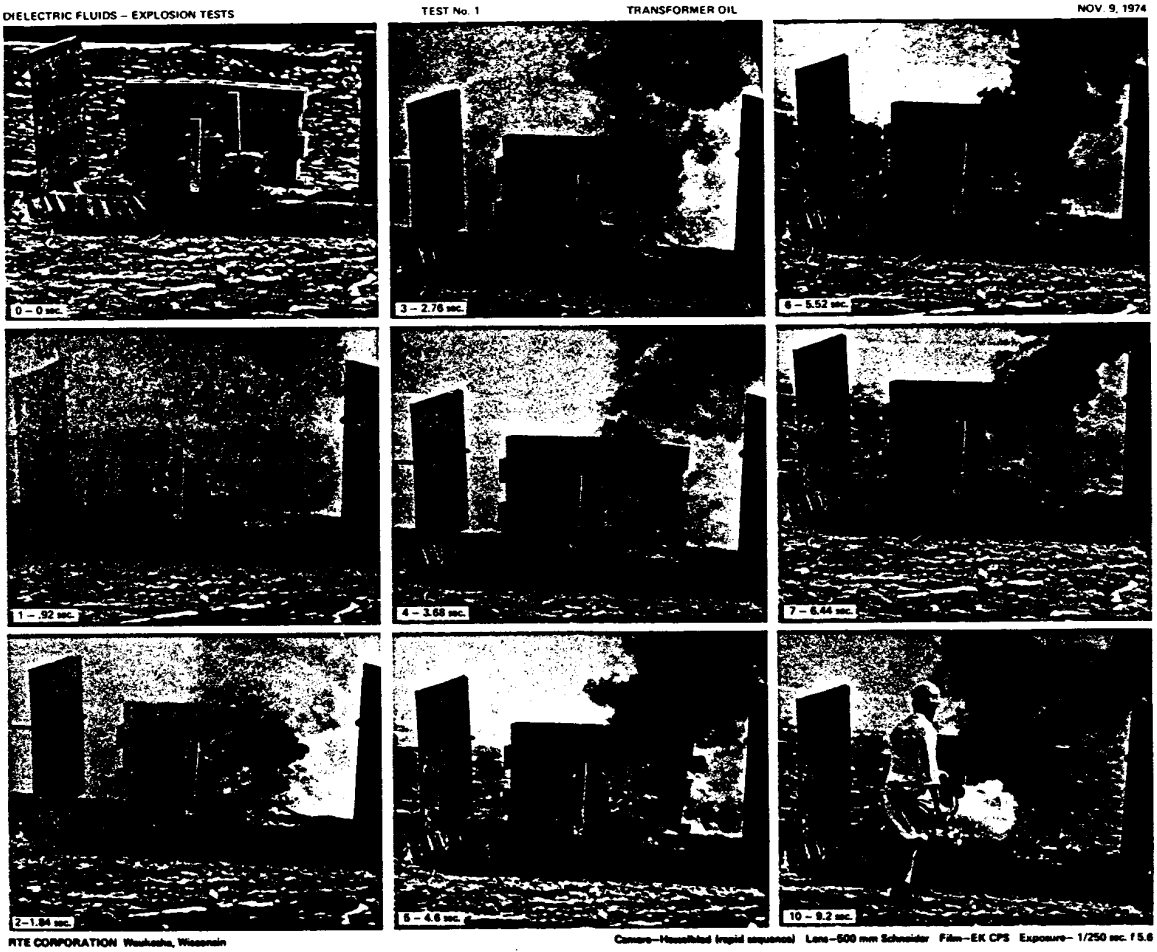
TEST No. 4 PCB (ASKAREL)

RTE CORPORATION Waukesha, Wisconsin

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DIELECTRIC FLUIDS – EXPLOSION TESTS | TEST No. 1 | TRANSFORMER OIL | NOV. 9, 1974



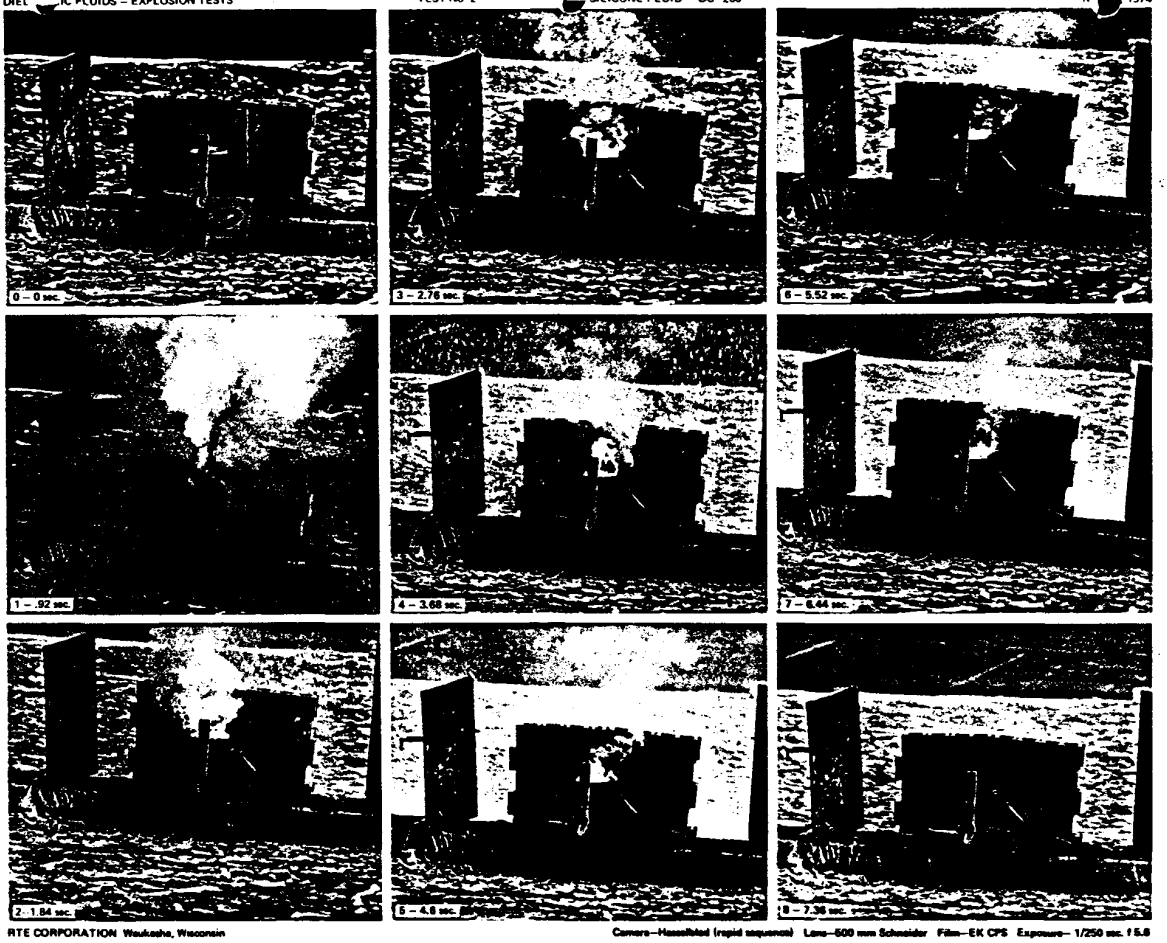
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RTE CORPORATION Waukesha, Wisconsin

Camera—Hasselblad (rapid sequence) Lens—500 mm Schneider Film—EK CPS Exposure—1/250 sec. f 5.6

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DIEL CTR IC FLUIDS – EXPLOSION TESTS TEST No 2 SILICONE FLUID DC-200 A 1974

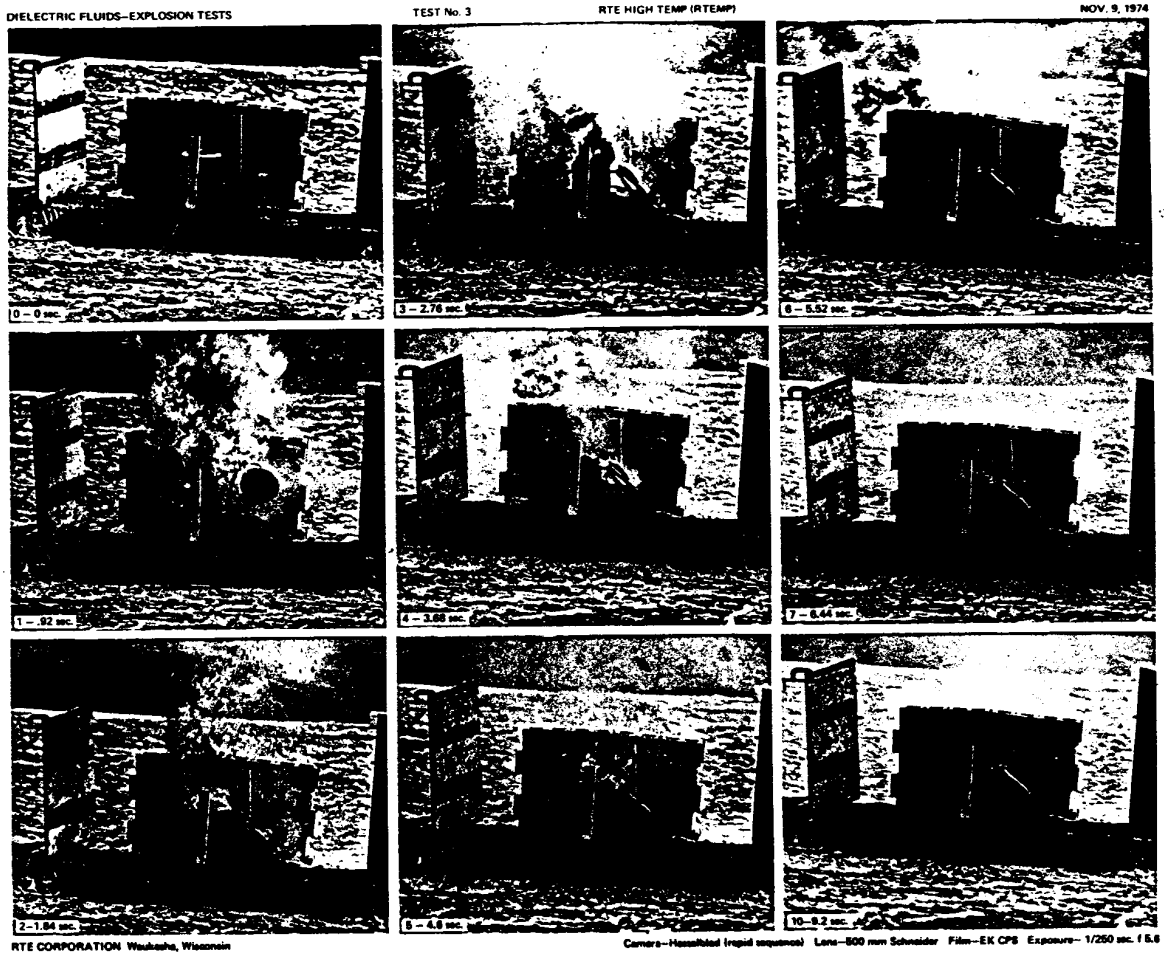


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RTE CORPORATION Waukesha, Wisconsin Camera—Hasselblad (rapid sequence) Lens—500 mm Schneider Film—EK CPS Exposure— 1/250 sec. f 5.6

TOWOLDMON0057893

DIELECTRIC FLUIDS–EXPLOSION TESTS TEST No. 3 RTE HIGH TEMP (RTEMP) NOV. 9, 1974

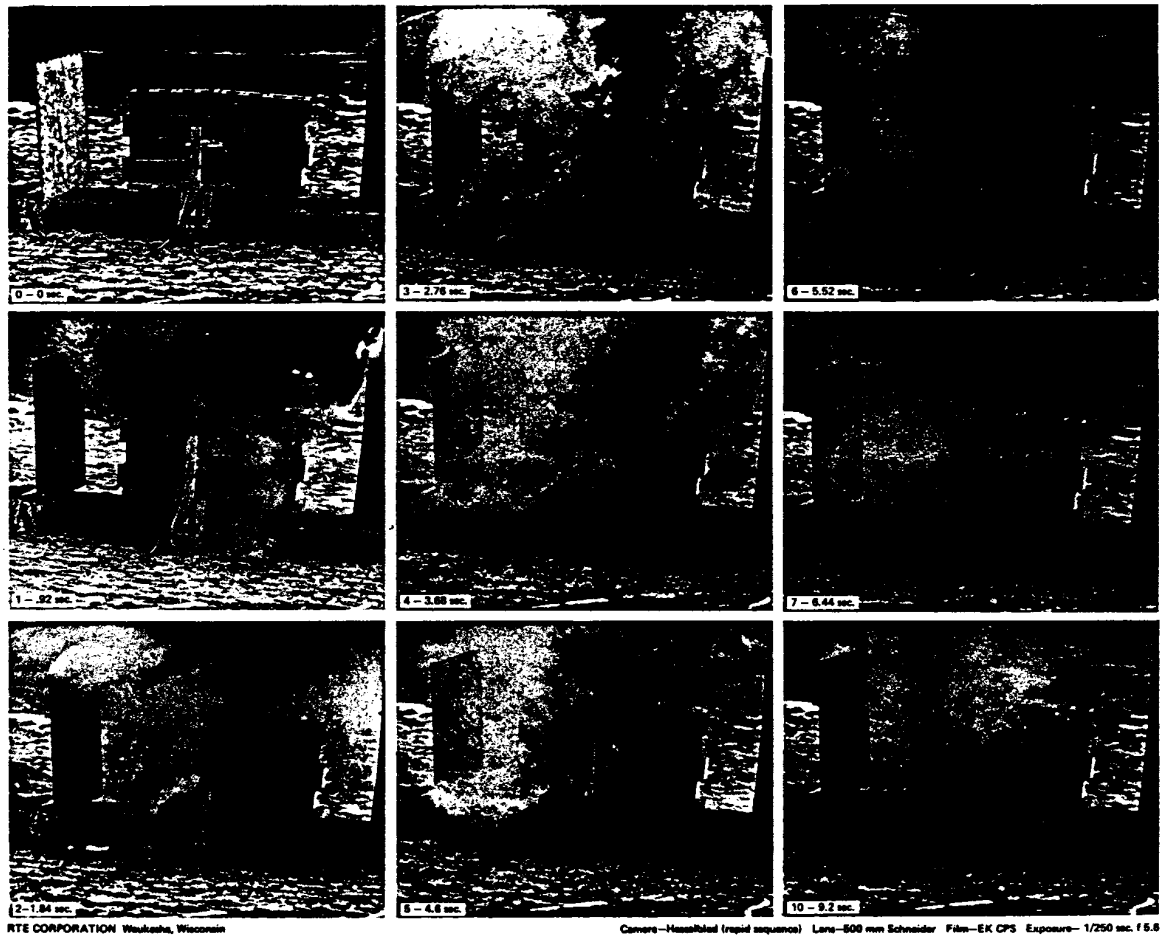


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RTE CORPORATION Waukesha, Wisconsin Camera–Hasselblad (rapid sequence) Lens–500 mm Schneider Film–EK CPS Exposure– 1/250 sec. f 5.6

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DIELECTRIC FLUIDS—EXPLOSION TESTS TEST No. 4 PCB (ASKAREL) NOV. 9, 1974



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RTE CORPORATION Waukesha, Wisconsin Camera—Hasselblad (rapid sequence) Lens—500 mm Schneider Film—EK CPS Exposure— 1/250 sec. f 5.6

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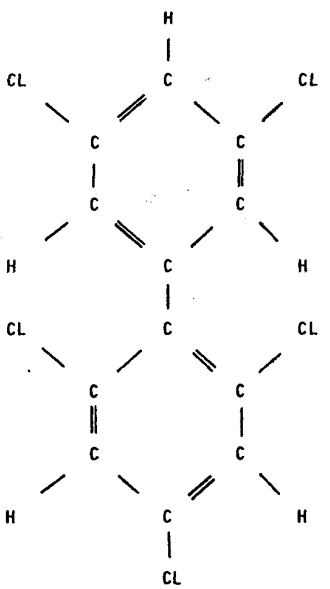
CHEMICAL BONDS AND GASES PRODUCED DURING ARCING

Askarels

Askarels are mixtures of polychlorinated biphenyls. Depending on the manufacturer, they may be such a mixture as Pyranol*1470 which is 4½:4:1½ chlorinated diphenyl, trichlorobenzine and tetrachlorobenzine, with 0.125% by weight, amount of tin-tetraphenyl added as a "getter" to react with the hydrochloric acid produced during aging.

The material used in the tests was 70% pentachlorobiphenol and 30% trichlorobenzine. These have the following chemical bonds:

PENTACHLOROBIPHENOL

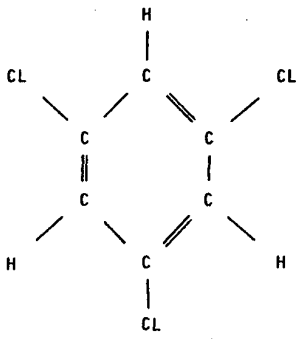


*Trademark of General Electric Company

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TRICHLOROBENZINE



During breakdown, the products of decomposition are:

ABSENCE OF OXYGEN	PRESENCE OF OXYGEN
Hydrochloric Acid (HCL)	Hydrochloric Acid (HCL)
Free Carbon (C)	Carbon (C) Water (H_2O) Carbon Monoxide (CO) Carbon Dioxide (CO_2)

Further, with arcing in the presence of paper, phosgene gas ($C\ CL_2\ O$) is also possible.

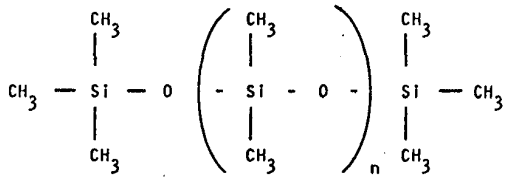
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Silicone DC-200

The silicone fluid used in the test was DC-200, 50 CS. This is a dimethyl silicone fluid which has the chemical bonds shown below:

DIMETHYL SILICONE FLUIDS



Some of the gasses produced during arcing are:

ABSENCE OF OXYGEN	PRESENCE OF OXYGEN
Silicon Dioxide ($Si\ O_2$)	Silicon Dioxide ($Si\ O_2$)
Hydrogen (H_2)	Hydrogen (H_2)
Hydrocarbons (CH_n)	Water (H_2O)
	Carbon Monoxide (CO)
	Carbon Dioxide (CO_2)
	Hydrocarbons (CH_n)

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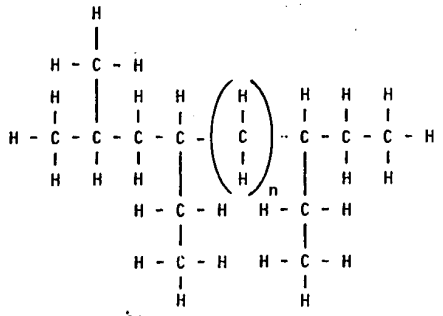
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RTEMP

RTEMP is essentially a mineral oil. It is refined from a paraffinic type base oil. A special two-stage hydro-treating process is used in its manufacture which results in a highly refined stable oil of food grade. It has been used in food products and associated equipment, and would be considered safe in the environment.

The chemical bonds of this type of oil would be similar to the paraffinic group shown below:

TYPICAL PARAFFINIC TYPE OILS



As can be seen, the paraffins are characterized by long straight chain segments with relatively few off-shoots or attachments. Under arcing conditions these chains would be broken and the products of decomposition would be those released during the breakdown of any hydro-carbon of similar structure. Shown below are some of the typical products of decomposition which would be found during this process:

ABSENCE OF OXYGEN	PRESENCE OF OXYGEN
Hydrogen (H_2)	Water (H_2O)
Carbon (C)	Carbon Monoxide (CO)
Hydrocarbons (CH_n)	Carbon Dioxide (CO_2)
	Hydrocarbons (CH_n)

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FLUID PROPERTIES:	TRANSFORMER OIL	RTEMP	SILICONE DC-200	ASKAREL
DIELECTRIC				
Dielectric Strength (ASTM D-877) kV (25°C-fluids as received from vendor)	31	37	34	40
Dielectric Constant	2-2.5	2.2	2.74	4.5
Power Factor 50°C	<.01	0.6	0.6	--
100°C	1.0	2.2	0.9	--
150°C	2.5	10.5	1.5	--
Dissipation Factor (ASTM D-150)	.0004	<.05	.0002	.03
Volume Resistivity (ASTM D-1169) Ohm-cm	1.0×10^{12}	1.1×10^{13}	5.6×10^{14}	5.0×10^{12}
THERMAL				
Flash Point °C	150	296	304	--
Fire Point °C	162	321	360	--
Pour Point °C	<-57	-21	-55	-37
Thermal Conductivity 25°C cal/(sec-cm^2-°C)/cm	.000318	.000297	.000360	.000262
Specific Heat (cal/gm/°C) 25°C	.393	.450	.340	.264
Coefficient of Expansion(cc/cc-°C)	.00063	.0008	.00104	.00067
PHYSICAL				
Specific Gravity (ASTM D-1810) 25°C	.883	.883	.961	1.545
Interfacial Tension (dyne/cm)	49.4	25.5	20.8	50.0
Neutralization Number (mgKOH/gram)	<.02	.011	<.01	<.01
Viscosity (centistokes)				
25°C	16	800	50	18
50°C	8	150	30	10
100°C	3	24	16	4
150°C	--	8	12	<3

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MATERIAL COMPATIBILITY STUDY

Transformer oil, RTEMP, Silicone DC-200, and Askarel have been compared in sealed bomb accelerated aging tests. This is a standard material compatibility test at 150°C for 6 weeks. The sealed bombs contain paper, epoxies & varnishes, various coated wire samples, and the insulating fluid. Physical and electrical characteristics are compared at the end of the test period.

RESULTS:

	TRANSFORMER OIL		RTEMP		SILICONE DC-200		ASKAREL	
	INITIAL	6 WKS AGING @150°C	INITIAL	6 WKS AGING @150°C	INITIAL	6 WKS AGING @150°C	INITIAL	6 WKS AGING @150°C
FLUID PROPERTIES								
Dielectric Strength (kV)	37.1	21.5	39.8	24.7	35.0	(29)*	38.5	29.0
IFT (dyne/cm)	48.0	40.4	55.7	47.7	30.8	24.2	35.9	432.2
NEUT NUMBER (mgKOH/gr)	.0015	.078	.011	.099	.0025	.103	.005	.095
PAPER								
Tensile Strength (kpsi)	14.9	11.6	14.9	12.0	14.9	12.2	14.9	11.7
Dielectric Strength (v/mil)	1480	1540	1480	1610	1480	1530	1480	1460
WIRE								
Dielectric Strength (v/mil)	3000	3400	3000	3500	3000	3330	3000	3600

*Average of best three readings (discussed further in test conclusions)

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HEAT RUNS ON SAMPLE 167 kVA 7200 - 120/240 TRANSFORMERS

Transformers of identical design have been constructed and filled with transformer oil, RTEMP, and Silicone DC-200 (50CS). Heat Runs have been made to determine the thermal effects of the higher viscosity fluids at operating loads:

		100% LOAD	125% LOAD	150% LOAD
TRANSFORMER OIL	TOP OIL RISE °C	58	84	111
	AVERAGE WINDING RISE °C	64	90	120
RTEMP	TOP OIL RISE °C	73	95	125
	AVERAGE WINDING RISE °C	83	110	141
SILICONE DC-200 (50CS)	TOP OIL RISE °C	69	96	126
	AVERAGE WINDING RISE °C	80	113	147

TABLE II

STEADY STATE TEMPERATURE RISE

This data agrees with the measured viscosity-temperature characteristics of the fluids and questions the ability to make direct fluid substitutions without design modifications to maintain a 65°C rise limitation in transformers designed for mineral oil.

Mineral oil, however, has been shown to be about 30% better as a heat transfer media than askarel. This would suggest that direct replacement of either Silicone DC-200 or RTEMP for askarel in units designed for askarel is probably possible.

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Insulating Fluids
(After Aging)

Transformer Oil

The transformer oil was clear and without sediment. The color was a golden amber.

RTEMP

The RTEMP fluid was free of sediment and yellow to amber in color.

DC-200

The color of the DC-200 in one bomb was a water white and clear. The other bombs' fluid was milky white.

Askarel

The askarel yellowed slightly during aging. The duplicate bomb of this set was full of sediment and the wire film insulation had blackened considerably.

Paper and Magnet Wire
(After Aging)

Examination of the paper and magnet wire revealed that one bomb containing askarel exhibited severe blackening of the film insulation on the magnet wire. The other bomb containing askarel exhibited a jelly-like material on the paper insulation. The remaining bombs containing transformer oil, RTEMP, and Silicone DC-200 did not show any visible signs of degradation.

Test Conclusions

The RTEMP fluid compares favorably with askarel and slightly better than transformer oil. The dielectric strength of both the magnet wire and paper for transformer oil, RTEMP, and Silicone DC-200 showed some improvement during the aging tests. This is because of the increased quality of impregnation of the materials. This would be reduced on longer test runs where breakdown of the insulation would begin to occur. The paper in the askarel shows both physical and dielectric deterioration.

The dielectric strength of the Silicone DC-200 is difficult to measure on ASTM D-877. The material forms resistive bridges (approximately 13k ohms) across the gaps on each test shot which must be cleaned off before continuing the test. This phenomena is very questionable and should be investigated further. However, it should be pointed out that initial dielectric strength is more important than rehealing ability after an arc. The insulating fluid should prevent the arc and the silicone appears to be an excellent fluid from this standpoint. The resistive bridges would be of interest in designs utilizing load tap changers and similar load switching devices.

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Environmentally Acceptable Insulating Fluids May Replace Askarel

Conclusions:

The availability of RTEMP, Silicone Fluid, and askarel depend upon demand. Presently, facilities are in existance for manufacturing large quantities of the askarels. Monsanto is working to develop new fluids which are more environmentally acceptable and will utilize their facilities. Dow Corning is studying the equipment necessary to enter this market. The supplier of RTEMP is ready to go with limited quantities presently but can, over a period of time, increase his facilities and lower the cost of RTEMP considerably.

The possibility of new fluids other than those already studied is great. Dow Corning is working to modify their silicones and, as already mentioned, Monsanto is developing new fluids for use in their facilities. After having several discussions with various oil companies, it appears as though possible new candidates may be setting on laboratory shelves waiting for someone to find a use for them. These are being explored.

For RTEMP to find total acceptability, a modification must be made in the material to obtain a lower pour point. Tests will have to be conducted to make sure these modifications do not affect the fluid's desirable properties. Presently, usage of this material should be limited to sub-surface (below the frost line) and indoor applications. Precautions for installation during extreme cold periods would be necessary.

For any dielectric fluids to find acceptability, national approval and recognition must be obtained. We are currently working with insurance underwriters to set up a testing program and provide a proposal for modification of the national fire code. If approved, the earliest possible date any new fluid could be listed in the NEC would be in the 1978 printing.

In the meantime, several utilities are conducting testing programs and requesting sample transformers for evaluation. Economic studies covering the total installed, operating, insurance, and disposal costs are being planned.

Manufacturers must explore the impact of storage, processing, and handling facilities.

Additional testing may be required. Thermal and dielectric properties might be further explored. Tests such as submerged switching of loads and perhaps additional explosion tests with higher kV, kA arcs may be necessary. Additional measurement of explosion violence and gasses produced may be desired.

If you, as a user of these products, now feel a positive step is required, we ask for your participation. Please write RTE and express your interests. Feel free to ask questions and make suggestions. We need all comments, positive and negative, to formulate future planning.

1. What further testing should be done to probe the flammability questions?
2. Who needs to be convinced to get acceptability of these new products?
3. How do we go about it?
4. What testing program must be submitted to the NEC to gain national approval?

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