3708 Woodcliff Drive
Lafayette, IN 47905
August 27, 1975

Mr. R.C. Osthoff
General Electric Co.
Transformer Laboratories Operation
100 Woodlawn Ave.
Pittsfield, Mass. 01201

Dear Mr. Osthoff:

Enclosed are two copies of a written report based on our recent visit with you. This is an informal document which will not appear in our final report and is only for internal use as an intermediate step in reaching our final conclusions. Its accuracy is important, however, in order that our final results be guided by the best possible data, and I am therefore sending these copies to you for your inspection. If you feel that I have inaccurately or incompletely stated your contribution, I would very much appreciate your sending me appropriate corrections. It would be useful to receive your corrected version back (to the Lafayette address, please) by September 19 since the NBS Project team will be meeting on that day to make detailed plans for completing the final report.

We appreciate your very useful contributions to this effort.

Yours very truly,

David B. Miller

David B. Miller
Electrical Engineer

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PLAINTIFF'S EXHIBIT 51

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TRIP REPORT

August 3-4, 1975

Travelers: O. Petersons
F. R. Kotter
D. B. Miller

To: General Electric Company
Transformer Laboratory Operation (TLO)
100 Woodlawn Avenue
Pittsfield, Mass.

Representing GE: Robert C. Osthoff, Mgr., Transformer Laboratory Operation

Edward L. Raab, Consultant, TLO

J. McQuade, TLO

William A. Fessler, TLO, Sr. Insulation Chemist

Arne Torkelson, Mgr., F&S Development
Silicone Prod., Waterford, N.Y.

Jim C. Frewin, Silicone Products
J. S. Hurley, Jr., Silicone Products

Edward L. Simons, Manager, Environmental Protection Operation
Schenectady, N.Y.

George E. Moore, Manager, Combustion Applications Projects
Schenectady, N.Y.

1. Askarels

   a. Present market (estimated): 2/3 to capacitors, 1/3 to transformers (probably equally divider between utility and contractor sales, but many transformers originally sold to contractors ends up under utility control). Precipitator and railroad transformers represent probably less than 10% of the transformer market but their importance is growing.

   b. Continued use: EPA will probably allow continued use, under perhaps increasingly restricted conditions, but the effluent standards which are imposed on manufacturing sites may be so stringent as to in fact prevent manufacture. Assumption of liability for transport and use will also be an important future issue limiting use.

   c. The definition of "askarel" has been evolving with time in the standards, such as IEEE, ASTM, NEC, in order to reflect the true condition in transformers.

   d. It is important to differentiate among the PCB's.

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e. In arc explosion tests of askarels, the fluid is probably electrically heated to decomposition temperature and since this decomposition is exothermic it gives a burning appearance.

2. Alternatives for PCB's in transformers

a. Tri-tetra chlorobenzene; non-flammable, poor low temperature behavior, more toxic but probably less environmentally persistent than askarels, not yet identified toxicity, very strong solvent, incompatible with presently used enamel insulation, so would require a significant change in transformer design, lower cost than PCB's, not yet available in the quantities required for a major share of the transformer market.

b. Fluorocarbons: high cost, toxic decomposition products, unknown environmental impact.

c. Silicones

1) Electrical characteristics are acceptable.

2) Some incompatibility with existing transformer materials so some minor design changes would be needed before marketing. This could be done in a relatively short time.

3) Later, more major transformer design changes might occur in order to optimize silicone transformer design.

4) The cost effect of going to silicones is difficult to estimate.

5) Combustion: flammability is somewhere between mineral oil and askarels. Firepoint is not defined. An ASTM standard on the oxygen index for fluids is desired. The flashpoint measures volatile products, so oxygen index is a better measure of silicone flammability. An oxygen index of 25 is desired, but this is inconsistent with the desired low viscosity (about 10 centistokes), so some compromise is required with probable derating or increased size of the transformer if the low flammability is maintained.

6) Toxicity: Long term testing and use in cosmetics and foods verifies low toxicity. These are based on well defined FDA screening and acceptance tests. Whether the feeding tests for LD50, chronic and carcinogenic toxicity are adequate for EPA requirements depends upon EPA establishing acceptance protocols; this might be done by proposed toxic substances legislation.

7) Degradation; dimethyl siloxanes, used for transformer fluids, are known to degrade. GE will supply references.

8) Under arcing decomposition, silica is produced in very small glassy (amorphous) particles and so does not represent the air hazard typical of quartz (crystalline) silica.

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3. Combustion

   a. Existing tests (e.g., flashpoint, oxygen index) are okay for ranking but not for qualification of commercial equipment. An ASTM standard for oxygen index is desirable.

   b. The final criterion is the opinion of the insurance company, such as Factory Mutual, who will probably want to carry out a total transformer system test on a new fluid, as UL did in 1934 for pyranol. Definition of such tests in terms of their effects on insurance rates would be desirable.

   c. The under-fluid arc explosion test is difficult to control and interpret, and may not be representative since most transformer faults are between turns or layers. The arc is therefore more in contact with the solid insulation than the fluid; arc products are more typical of the cellulose than the fluid material, and arc currents are not at the "bolted" fault level.

   d. For the tank rupture situation, whether from arcing or pressure build up from an external fire, the atomized spray or "oil burner" type of test may be more meaningful. An insurance company such as Factory Mutual would probably want to work with both the transformer manufacturer and the user in developing this type of test.

   e. In understanding flammability, the action of the fluid vapor and of decomposition products must be differentiated.

4. Tests and standards; qualifications and acceptance

   a. A transformer with a new fluid would first be tested by the manufacturer, then field tested on a customers system and finally marketed as a fully qualified item. Standards would generally follow field testing. GE feels that field test sites on interested customers' systems could be found which would not fall under National Electric Code or OSHA restrictions.

   b. Underwriters Laboratories is consumer oriented and so has not played a major role in the askarel transformer business.

   c. National Electrical Code is concerned with the total apparatus and so would need total transformer qualification. This code is important particularly in the contractor market, and also because it is often adopted as the local building code.

   d. ASTM

      1) D877 has special precautions for askarels, and so might also not be directly applicable to new fluids (D1816 is just for mineral oils).

      2) There are no ASTM standards for thermal conductivity, specific heat and coefficient of expansion, all important transformer fluid parameters.

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3) ASTM is working on a material compatibility test standard for screening before applications engineering.

4) Vested interest companies (manufacturers and users) are not participating in D27 (Committee on Electrical Insulating Liquids and Gases), and so no personnel or funds are available to prepare the required standards in this area.

e. General philosophy: It is not useful to try to prepare standard test procedures applicable to any fluid since each fluid requires its own special considerations.

f. Life testing; this is an important stage of testing which must progress simultaneously with material flammability and total transformer combustion tests. The compatibility with other transformer materials, under transformer thermal and electrical stress conditions is important.

xc: Bower
Macek

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