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TRANSFORMER

Askarel

Inspection & Maintenance Guide

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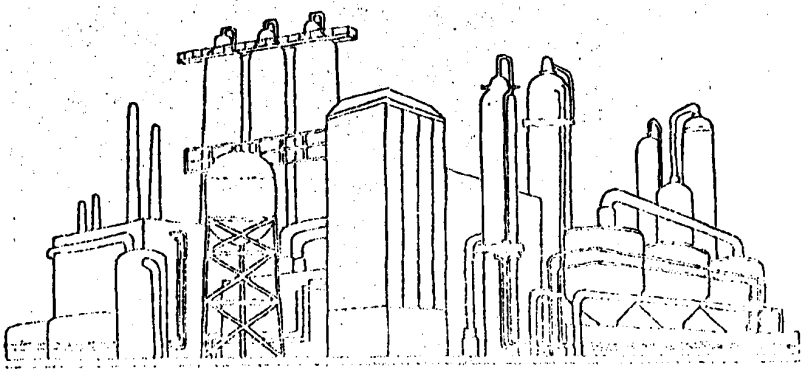
Monsanto



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Section A
Transformer Askarel

I. Introduction

The term "askarel" as defined by IEEE, ASTM and the National Electrical Code generally describes a broad class of fire-resistant* synthetic chlorinated hydrocarbon insulating liquids widely used in transformers, reactors and accessory equipment operated at power frequencies. Askarels of various compositional types are in use. (For the general properties and types see ASTM D-2283.) Under arcing conditions the gases produced, while consisting of predominantly non-combustible hydrogen chloride, can contain varying amounts of combustible gases depending upon the askarel type.

This manual describes the operating characteristics of transformer askarel liquid insulation as manufactured by Monsanto and how it differs from mineral oil. Appropriate handling and disposal procedures for both scrap askarel liquid and impregnated solid materials are given in accordance with the guidelines recommended by the American National Standards Institute.

The information is based on facts gathered by Monsanto over 40 years as a producer of askarel, plus knowledge gained from the experience of transformer manufacturers and users. This guide outlines the maintenance required for askarel fluid in "modern" transformers and offers suggestions for sealing and maintaining askarel in old units. By following this guide, we believe users will obtain maximum service from askarel insulation with a reasonable minimum of maintenance. If questions arise relating to the designing and building of transformers, those should be referred to regular transformer suppliers.

Monsanto gratefully acknowledges the assistance, guidence and the contributions of certain data by the following:

Edward L. Raab – General Electric
Dr. T. K. Sloat – Westinghouse Electric

II. History of Trade Name Types

"Askarel" is the generic name for the fire-resistant liquid insulation and coolant first used by General Electric Company in 1932 for their Pyranol[1] brand name fire-resistant transformers, Westinghouse Electric Corporation uses their brand name, Inerteen.[2]

Whatever the trademarked brand, the askarel contains chlorinated biphenyl – one of the best liquid insulations developed by science. This inert material is chemically stable, fire-resistant, heat stable, non-corrosive, and has high dielectric strength under the operating conditions encountered in transformers.

In addition to manufacturing Aroclor® (chlorinated biphenyl), Monsanto also mixes this dielectric fluid with chlorobenzenes to produce the presently used Inerteen and Pyranol blends described in Table I.

*"NOTE: Materials designated 'fire resistant' generally are more difficult to ignite, or once ignited, burn at a slower rate than corresponding conventional materials. This term does not mean that fire resistant materials will not burn. However, when properly used, Monsanto's fire resistant ASKAREL FLUIDS are useful in helping customers meet their fire safety requirements."

[1]Trademark of General Electric Company
[2]Trademark of Westinghouse Electric Corporation

®Registered trademark of Monsanto Company

operating askarel transformers – take every precaution to guard the askarel insulation from exposure to high humidity and moisture contamination. Keep 5 or 55 gallon drums of askarel dry; lay stored drums on their sides with the bung at the highest point from floor to keep water off the drum head (which can be sucked into the askarel by the drum "breathing"). This precaution is not necessary when drums are stored indoors, which is the preferred place for storage.

To avoid leakage the drums used for askarel are of heavy construction. Sixteen gauge metal is used, with special rim seal and bung construction. The drums should be drained as completely as possible and then flushed twice with kerosene type solvent to remove all of the askarel. Accumulated liquids and washings should be collected and should be incinerated at high temperatures, e.g., about 2000°F, to destroy the polychlorinated biphenyls (PCBs). See Section A, VIII.

Tank cars used to transport askarels are in exclusive service and not used interchangeably for other products. All cars must be unloaded through the top (dome fitting) either by pumping or with controlled pressure using dry air or dry nitrogen. If nitrogen has been used for unloading it is necessary to advise the shipper so *that when the car returns the nitrogen can be replaced with dry air* before any one may enter the car. If the car is to be unloaded by pumping it will be necessary to use a dryer on the air intake line to remove moisture.

All tank cars are fitted with steam coils, which are available for unloading under extreme low temperature conditions.

Convenient handling and pumping temperatures are given in Table III.

B. Use Ordinary Personal Precautions:
Transformer askarel has been made, handled, and used for over 40 years. It can be handled safely with recommended precautions. If accidentally spilled on hands, no serious skin irritation will occur. However, liquid askarel has a solvent action (similar to paint

Table III
Handling and Pumping Temperatures

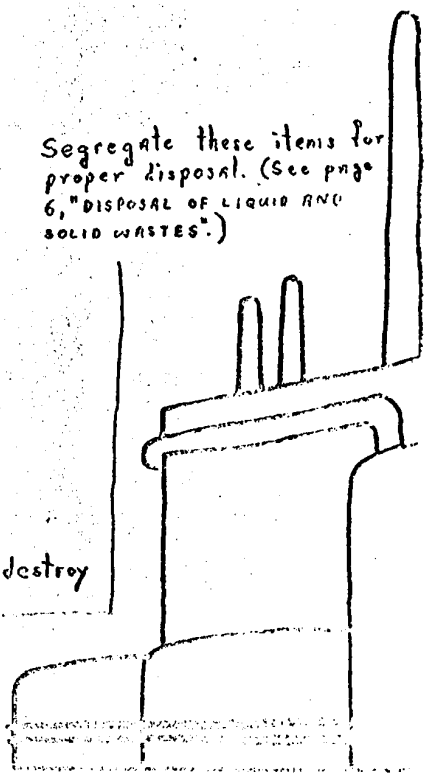
Product	Unloading, Handling and Pumping Temperature °C
Pyranol A1383B-3	20 - 55
Inerteen 70-30	20 - 55
Inerteen 100-42	35 - 75

thinner) on the fats and oils of the skin and prolonged contact may lead to drying and chapping of the skin.

In case of contact, wash the skin with soap and water; remove and discard saturated clothing. Clean up spills with rags, sawdust and absorbent clay. Eye contact may result in painful irritation but no permanent damage to tissues. If askarel gets in the eyes, flush with large amounts of water. As with all eye first aid, refer to a physician. To relieve irritation, physicians have used an opthalmic anesthetic solution as well as opthalmic cortisone acetate solution.

Infrequent exposure to askarel vapors will not cause ill effects. However, prolonged exposure to high vapor concentrations should be avoided. If hot askarel must be handled in a closed or confined area, provide the area with mechanical exhaust ventilation or

Segregate these items for proper disposal. (See pag 6, "DISPOSAL OF LIQUID AND SOLID WASTES".)



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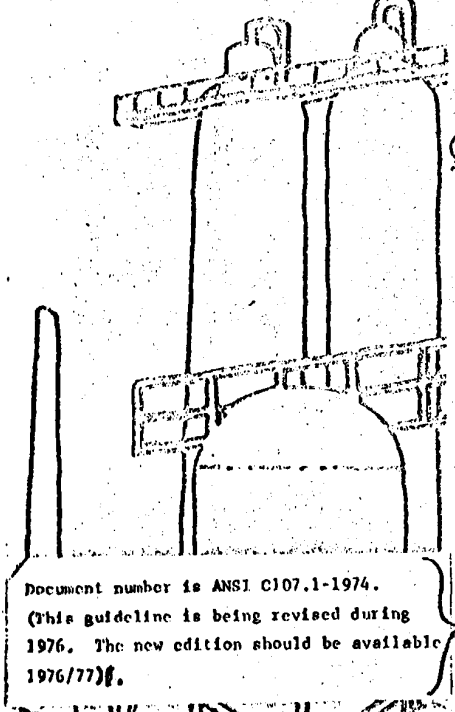

wear an Organic cartridge respirator approved by the U.S. Bureau of Mines.

C. Precautions On Opening an Askarel Transformer:
Askarels of various compositional types are used. Under accidental conditions the gases produced, while consisting of predominantly non-combustible hydrogen chloride, can yield varying amounts of combustible gases depending upon the askarel type.

Insulation systems incorporating these askarels and cellulosic or other organic materials may, when arced, produce gaseous mixtures which are moderately flammable. As a precaution, such gases should be removed from the askarel by bubbling dry nitrogen through the askarel and flushing the gas space with dry nitrogen before any work is performed on the apparatus.

IEEE Std 76-1974

The American Institute of Electrical and Electronic Engineers Guide No. 76, March, 1974 gives more detailed instructions and guidance *"For Acceptance and Maintenance of Transformer Askarel in Equipment"*. This guide is published by the Institute of Electrical & Electronics Engineers, Inc., 345 East 47th Street, New York, New York 10017. We recommend that users of askarel transformers refer to this IEEE document.

VIII. Avoid Environmental Pollution

Transformer askarels contain polychlorinated biphenyls (PCBs) which have been used in the United States and elsewhere over the past 40 years for many industrial and consumer applications. During the past several years evidence has accumulated to indicate that PCBs are widely dispersed throughout the environment and that they can have adverse ecological and toxicological effects.

The United States Government's Interdepartmental Task Force on PCBs, Com 72-10419, in their March 20, 1972 report titled, *"Polychlorinated Biphenyls and the Environment"*, recommended restricting PCBs to use in capacitors and transformers.

This report is distributed by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151.

A document titled, *"Guidelines for Handling and Disposal of Capacitor and Transformer Grade Askarels, Containing Polychlorinated Biphenyls"*, has been prepared and is available from the American National Standards Institute, Committee C107, 1430 Broadway, New York, New York 10018.

Document number is ANSI C107.1-1974.
(This guideline is being revised during 1976. The new edition should be available 1976/77).

The scope, objectives and the composition of this committee are:

ANSI Committee C107

Scope:
Procedures and guides for safe use, maintenance and disposal of askarel and askarel-soaked materials used in electrical equipment.

Objectives:
1. Source of technical information and advice for Federal, State, local authorities and all others concerned.
2. Encourage development of suitable disposal facilities and keep all concerned informed.
3. Serve as the advisory group for United States participation in international organizations: CEE, IEC, CIGRE.

Composition:
Organizations active in or represented by the ANSI committee include: National Electrical Manufacturers Association, Electronic Industries Association, Institute of Electrical and Electronic Engineers, American Society for Testing and Materials, Electric Light and Power Association, Certified Ballast Manufacturers Association, Environmental Protection Agency, Office of Environmental Affairs General Services Administration, General

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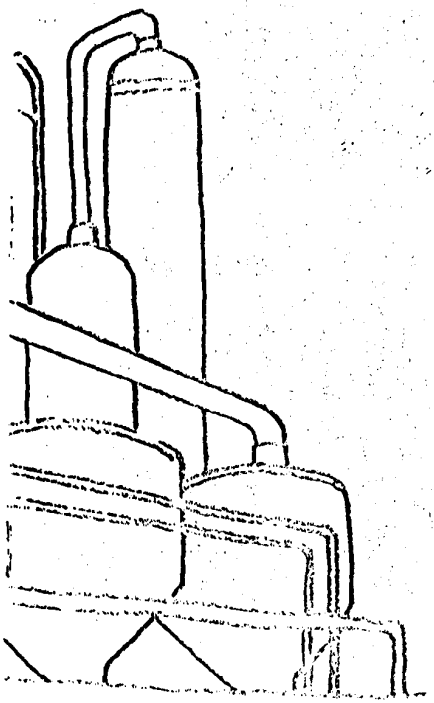

A. Visual Inspection:
Askarel is a clear, faint yellow liquid. After long term use this color may gradually intensify to light brown. The fluid should remain clear and free from turbidity or cloudiness.

Any color change – such as to a green, red or blue cast – indicates extraction of impurities (color materials) from the solid insulation. If a distinct foreign color pick-up is noted, check the complete range of electrical characteristics and notify the transformer maker. Blackening of the askarel may indicate an arcing condition. Other color changes alone are not danger signals since the dielectric breakdown voltage is not likely to be impaired.

B. Dielectric Breakdown Voltage
If the dielectric breakdown voltage has decreased significantly from the last inspection, or if it has gradually decreased below 26 KV range (at 25°C) – RUN A CHECK FOR MOISTURE. Use ASTM D1533 (Karl Fischer Method).

The dielectric breakdown voltage of askarel is the major indicator to the operating efficiency of your liquid insulation. Besides the visual inspection tests, dielectric breakdown voltage is the only test necessary to run on a routine basis. Well-sealed askarel transformers have service records of 25 to 30 years on the original askarel.

XVII. Inspection Checklist

1. If askarel is clear – even though darkened to light brown, has no sediment or turbidity, has dielectric breakdown voltage over 26 KV – give it the inspection "OK".

2. If askarel is clear, but has foreign color of blue, green, red . . . it is "extracting color" from internal materials. This is not, of itself, an operating hazard when the dielectric breakdown voltage stays over 26 KV and moisture remains low. However, this rare occurrence calls for checking into the condition of the interior construction and consulting the transformer maker. However, when sampling the fluid care should be taken to avoid getting color into the askarel from paint that may be inside or outside of the sample valve.

3. If the moisture content is found to be above 70 ppm at operating temperature, then sampling should be done at more frequent intervals to establish a possible trend, particularly on outdoor installations.

4. If askarel is clear, but dielectric breakdown voltage drops to 22 or lower KV, and moisture rises over 80 ppm when sampled at operating temperature . . . the askarel is ready for simple "refining". If the moisture is near the saturation level (about 125 ppm at room temperature) a thorough inspection should be made for water droplets in the transformer tank, and even for "globules" of water floating on the askarel surface. If found, the transformer manufacturer should be consulted for reconditioning both the transformer and the fluid.

5. If askarel is dark brown to black, if black particles of carbon are seen, and dielectric strength is low . . . the askarel has been broken down by arcing. It cannot be refined and should be removed and incinerated under proper conditions. (See ANSI Committee C107A report on *Use and Disposal of Askarel and Askarel-Filled Materials*, 1430 Broadway, New York, New York 10018.)

If any of these five simple inspection tests appear out of the ordinary or the relationship between appearance and test values is abnormal, contact your transformer supplier for a complete analysis.

Whenever a sample is to be shipped to Monsanto, please follow the directions shown under, "SAMPLING ASKAREL".

{NOTE: New $ charges for Analyses to come from R.E.N.)

Section D Analytical Services on Transformer Askarel Available From Monsanto

Transformer users not wishing to make their own fluid analyses can obtain the service from Monsanto. Simply contact Monsanto and specify what analyses are wanted. You will be sent the proper-sized, clean sample container, fitted with a proper label. When you receive this, carefully take your sample (following the procedure for sampling in this guide). Send the container to Monsanto's laboratory. Charges listed include sample container and laboratory costs. The charges are those in effect ~~March 1,~~ August 6, 1976, and are subject to change.

Types of Analyses Available

Analysis 1)
ROUTINE MAINTENANCE CHECK Total Charge: ~~$93.00~~ $35.00 Per Sample

To determine the general condition of the fluid and find whether further analysis is necessary. (one-quart sample required)

Properties Tested	Dielectric Breakdown Voltage
Color and Condition	Moisture

You will be notified of the results of this test. If further testing is indicated, and you want a complete analysis, you will be sent a five-pint sample container. This sample will be used for the following series of tests:

Analysis 2)
COMPLETE ANALYSIS Total Charge: ~~$[illegible]~~ $166.00 Per Sample

(1) To determine the extent of fluid contamination, (2) earth refinement to determine what degree of restoration of electrical and insulating properties is possible, (3) check test to see how the fluid responded to earth treatment.

a) Complete Analysis: to determine the extent of contamination

Properties Tested	Free Chlorides
Color and Condition	Acidity
Specific Gravity	Dielectric Breakdown Voltage
Refractive Index	Power Factor, Dielectric Constant, and Resistivity
Water	

b) Earth Refinement Response:
Consists of treatment for 2.5 hours at 50-60°C. with 0.1 to 0.2 percent by weight of properly conditioned Attapulgus clay and then filtration through dry filter paper.

c) Analysis After Laboratory Earth Refinement:

Properties Tested	Acidity
Refractive Index	Dielectric Breakdown Voltage
Water	Power Factor, Dielectric Constant, and Resistivity
Free Chlorides	

You will be notified of the results of this test series on your sample. Then after refining your entire transformer fluid fill you can check on the results by requesting the following analysis:

Analysis 3)
ANALYSIS AFTER EARTH REFINEMENT Total Charge: ~~$[illegible]~~ $70.00 Per Sample
(This charge will not apply when analyses 1 and 2 have already been made.)

To determine whether the entire lot of the askarel fill responded to the same extent as the laboratory sample. (five-pint sample required)

Properties Tested	Free Chlorides
Color and Condition	Acidity
Refractive Index	Dielectric Breakdown Voltage
Water	Power Factor, Dielectric Constant, and Resistivity

To arrange for the tests described above write to the following address:
David Wood
Monsanto Industrial Chemicals Company
800 North Lindbergh Blvd.
St. Louis, Missouri 63166

Samples to be tested should be clearly marked for identification and sent directly to:
Monsanto Company
W. G. Krummrich Laboratory
Sauget, Illinois 62201
Attention: ~~R. N.~~ J. A. Gloeckner

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APPENDIX J

Seals, Properties and Procurement

Dow Corning Corporation, Midland, Michigan with Districts at Atlanta, Boston, Chicago, Cleveland, Dallas, Los Angeles, New York City, Washington, D.C. and Toronto has available Bulletin 07-019, August 1962 entitled "Silastic Design Data". This lists the gasket fabricators throughout the country from whom the "Silastic 50" gasketing can be purchased in sheet, extrusions or molded shapes.

Generally, Silastic 50 sheet goods are stocked by local die cutters, hence, could be generally purchased locally. Usually small quantities of gaskets are die cut. If larger quantities are needed, tools are made of the same type used to cut other elastomers.

Where the gasket is extruded for fitting into a machined groove or between gasket stops, Dow Corning advises use of a scarved joint. This joint is then cemented using Dow Corning's Silastic 140 (clear) or their RTV 731 (white) materials, which air cure.

Dow Corning points out that the local "rubber" fabricators purchase the Silastic 50 in billet form. This is worked on a roll mill in preparation for sheeting or extrusion. Then to obtain the desired physical properties the fabricator must oven cure the Silastic 50 for 24 hours at 480°F.

SPECIFICATIONS*

	Color	White
	Specific Gravity at 77°F	1.20 ± 0.02
ASTM D676	Hardness, Shore A. Scale	45 to 60
ASTM D412	Tensile Strength, psi, min	800
ASTM D412	Elongation, percent, min	250
ASTM D395	Compression Set after 22 hrs at 300°F, percent, max	30

*All physical properties measured on 0.075 inch thick samples molded 5 minutes at 240°F, and oven cured 24 hours at 480°F.

APPENDIX K

Caution Label

The following or equivalent caution statements should be fixed on all containers of transformer askarels and the transformers themselves:

This product contains Polychlorinated Biphenyls (PCBs). Care should be taken to prevent entry into the environment through spills, leakage, use, vaporization, or disposal of liquid or containers. Avoid prolonged breathing of vapors or mists. Avoid contact with eyes or prolonged contact with skin. If skin contact occurs, remove by washing with soap and water. Following eye contact, flush with water. In case of spillage onto clothing, the clothing should be removed as soon as practical, skin washed, and clothing laundered.

Monsanto

FUNCTIONAL

MONSANTO INDUSTRIAL CHEMICALS COMPANY
SPECIALTY PRODUCTS GROUP
800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI 63166

The information herein regarding obtaining optimum results from askarel fluids in your transformer has been accumulated by Monsanto for over 40 years from the experience of makers and users of askarel transformers and it is believed will be helpful.

Nothing herein shall be construed as applying to other than askarel insulation. Data and maintenance suggestions herein do not apply to the other components of the transformer. All operating and maintenance suggestions recommended by the manufacturer of the transformer should also be carefully followed.

Because these maintenance directions apply only to the askarel insulation, Monsanto disclaims any liability for damage to property or injury to persons arising from transformer operation.

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