

GUIDELINES FOR HANDLING AND DISPOSAL OF TRANSFORMER-GRADE ASKARELS

FIRST DRAFT - FOR ANSI C-107 - APRIL 3, 1972

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PART I - GENERAL GUIDELINES

I. INTRODUCTION

Askarels consisting of or containing polychlorinated biphenyls (PCB's) have been used in many applications for over forty years, but only recently was evidence discovered that PCB's are widely dispersed in the environment. Systematic investigations of the biological effects of PCB's have been undertaken within the past few years to establish the effects of specific formulations upon specific species. Some studies have shown that PCB's may be an environmental contaminant. Simultaneously, significant steps have been taken by U. S. industry to further limit PCB releases to the environment.

PCB's have been used in three broad types of applications for the past 40 years, as follows: (a) "open ended" applications....for example, in paints, speciality inks, paper coatings, plastics, etc., (b) "nominally closed" applications....for example, as the working fluid in hydraulic or heat transfer systems; and (c) "closed system" applications....specifically, as the insulating fluid in certain types of transformers and capacitors. The Monsanto Company is the sole U. S. producer of PCB's. It has discontinued supplying the material for all applications of type (a) and (b).

Some public statements have been made recommending the discontinuance of type (c) applications as well, but appear to have been made without consideration of the alternatives and risk/benefits involved.

Benefits

1. Askarel-filled transformers do not burn or explode under conditions of electrical arcing that can cause fires or incendiary explosions as in mineral oil-filled transformers. Therefore, they are used in or near public, commercial or industrial buildings where oil-insulated transformers would present a potential danger to life and property.
2. Askarel-filled power and industrial capacitors are significantly smaller, more reliable, more durable, and safer than oil-filled capacitors. As a result, askarels have supplanted mineral oils in more than 90% of the power and industrial capacitors made today. Over the past few decades most of the equipment that incorporates such capacitors has been configured to take particular advantage of the size, safety and reliability benefits of askarel capacitors (e.g., many types are today less than 14% of the size of equivalent oil capacitors and have a life expectancy of 10 to more than 20 years).

The vital role that askarel-insulated transformers and capacitors have played in the safe, reliable, and efficient delivery of electric power is reflected in various standards, codes, and regulations that now effectively require or encourage continued use.

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Risks

In the United States, medical records show that over a nearly 40-year period the only adverse health effects experienced by U. S. workers exposed to askarels, either during the manufacture of these liquids or of electrical equipment containing these liquids, have been limited to occasional cases of non-chronic chloracne or other temporary skin lesions or irritations.

Askarel-filled transformers and capacitors are delivered to customers as sealed units from which there is no escape of askarel under normal operation. While certain types of equipment failures can permit loss of some askarel to the environment, such failures are limited to approximately 0.02% of the units in service per year. In addition, limited amounts of PCB's can get into the environment during the manufacture, delivery, improper use, maintenance, repair and disposal of transformers and capacitors.

Specific control measures have been instituted by individual manufacturers and are supplemented and strengthened by national standards and procedures such as this American National Standard Institute Guide. This guide is designed to prevent the inadvertent loss of PCB's to the environment at all stages from initial askarel manufacture through ultimate disposal.

Alternatives

1. For technical and code reasons it would be impossible to replace most askarel-filled transformers now in service with oil-filled units of equivalent rating and reliability without major construction changes that would be required to compensate for the fire and explosion resistance of the askarel-filled units. For certain applications and locations, dry-type transformers may replace askarel-filled transformers.

For new installations, while many of the limitations noted above would still apply; building and installation design provisions could be made to accommodate the use of oil-filled, open dry-type, or sealed, dry-type transformers providing necessary technical, code, physical size, and cost considerations are properly evaluated.

2. The principal alternative to askarels for capacitors is mineral oil, but such replacement would return capacitor technology to its pre-1932 level and would necessitate redesign and replacement of such widely used equipment as fluorescent light fixtures and racks for power and induction heating capacitors, which could not now accommodate the increased size of oil capacitors while maintaining their present ratings.
3. The cost of askarel liquids is about five to ten times more expensive than mineral oil. Thus, long before there were any environmental concerns about PCB's, there was a strong economic incentive to find other less expensive insulating liquids with the desirable characteristics of askarels. Since the 1930's, at least 10 major chemical or electrical companies have invested large amounts of time and money in this search, all with no success. While potential substitutes that are more costly than askarels have also received

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Alternatives (Cont'd)

3. (Cont'd)

some consideration (e.g., fluorinated liquids) little is known about either their electrical performance or possible ill effects upon the environment. There are today no fluids that can be used as a direct replacement for askarels.

II. DEFINITIONS

The term askarel generally describes a broad class of nonflammable synthetic halogenated hydrocarbon insulating liquids widely used in transformers, reactors, and accessory equipment operated at power frequencies. Askarels of various compositional types are in use (see ASTM D-2283). Under arcing conditions, the gases produced, while consisting of predominantly non-combustible hydrogen chloride, can yield varying amounts of combustible gases depending upon the askarel type.

The following trademarks are used by electrical manufacturers to designate the askarels used in their products:

Abestol
Chlorextol
Elemex
Inerteen
No-Flamol
Pyranol
Saf-T-Kuhl

III. SAFETY PRECAUTIONS

Askarels have been considered as relatively harmless materials to humans based on about forty years of safe industrial usage. There has been no known instance of human injury when used under the normally prescribed conditions of precaution and handling.

Although it has been generally thought that exposure to transformer askarels is not hazardous, provided simple precautions are taken, exposure should still be avoided and minimized.

(a) - Vapors

The odor of askarel is noticeable -- well below the maximum safe air concentrations. From 0.5 to 1.0 mg per cubic meter of air has been determined to be the maximum safe level of exposure during an eight-hour work day. (See American Industrial Hygiene Association Hygienic Guide Series - January/February, 1965.)

Breathing vapor or fumes from heated askarels should be avoided. High concentration of vapors can cause irritation of the eyes, nose, throat and upper respiratory tract. Provisions for adequate ventilation and

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(a) - Vapors - (Cont'd)

regulation of manufacturing operations to avoid open exposure of hot askarels (55C or higher) shall be made. The gases produced when askarel is decomposed by very high temperatures (such as that of an electric arc) in the presence of air or organic insulating materials contains a high percentage of hydrogen chloride, and small percentages of other gases. Minute concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. If exposure to high concentrations of askarel or its arced products is necessary under emergency conditions, an acceptable gas mask of the organic canister-type or self-contained breathing apparatus must be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of accident. If the odor of askarel or its arced products is detected by the person wearing protective equipment, he should immediately go into fresh air.

(b) - Fluid

Unlike mineral insulating oil, there is no fire hazard in handling askarels. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should avoid contact with any askarels. The use of porous gloves which can absorb and retain askarels is to be avoided. Resistant gloves and aprons of the Neoprene, polyethylene, Viton type should be used if contact is unavoidable. In case of spillage on the clothing, the clothing should be removed as soon as practical and the skin washed.

Medicinal washes or mild detergents followed by application of cold cream will reduce irritation resulting from askarel contact with an open cut or abrasion.

Safety glasses with side shields or a face shield should be worn when handling askarels. Eye exposure to liquid askarel should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician if the irritation persists. (A drop of castor oil has been found to reduce irritation caused by eye contact.)

Persons developing a skin irritation or respiratory tract irritation while working with askarels should be placed under supervision of a physician.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or use of toilet facilities.

IV. TRANSPORT CONTAINER MARKING

Any transformer askarels, new or used, as shipped in tank cars, tank trucks, drums, cans, etc., should be labeled with the following warning:

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THIS PRODUCT CONTAINS POLYCHLORINATED BIPHENYLS WHICH SOME STUDIES HAVE SHOWN MAY BE AN ENVIRONMENTAL CONTAMINANT. EXTREME CARE SHOULD BE TAKEN TO PREVENT ANY ENTRY INTO THE ENVIRONMENT THROUGH SPILLS, LEAKAGE, USE, VAPORIZATION, LIQUID OR CONTAINER DISPOSAL OR OTHERWISE.

The label should also list the following caution:

"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."

V. RECEIVING, HANDLING, AND STORAGE OF ASKARELS

Askarels are shipped in tank cars, tank trucks, steel drums, metal cans and test sample containers. When received all containers should be inspected for leaks.

(a) - Storage Tanks

It is desirable that all storage tanks should be erected on a cement base so that inspection can be made for leaks and a cement wall should be erected around the tank to provide a holding basin to contain all the askarel in the storage tank in the event of a tank failure. The base and wall should be constructed with askarel-resistant expansion joints to prevent cracking of the cement. A sump drain with pump should be provided to remove any accumulation of surface water but must not be tied into a sanitary or storm sewer. The pump will be manually activated when required. The sump pump must also be of sufficient capacity to pump the askarel from the storage tank basin into containers for salvaging the material or for scrapping in case of a spill. All tank piping must be exposed to permit inspection for leaks.

(b) - Tank Car and Tank Trucks

All bulk shipment equipment should be inspected for leaks immediately upon receipt. Drain pans must be provided to prevent spillage from unloading hoses and connections. Askarel fluid collected in drain pans should be placed in "scrap askarel" drums for disposition.

(c) - Steel Drums, Cans, and Test Sample Containers

On delivery all such shipments will be carefully inspected for leaks. The containers should be stored indoors in an area especially selected for this purpose. A cement curb should enclose the area to provide a basin for containing the askarel from one or more containers, should the container be damaged. The area must not have a drain which is connected to a sanitary or storm sewer.

If an indoor storage area is not possible, the containers should be stored under a lean-to on a cement slab with a cement curb. When stored outdoors the drums should be stored with the bungs down to prevent collection of moisture.

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VI. WATER AND VAPOR EFFLUENTS - SAMPLING, CONCENTRATION LIMITS, ANALYTICAL PROCEDURES

(A) - Control of Water Effluents

The industry goal is to minimize the concentration of askarel in plant water effluent streams. However, it is recognized that existing drain systems from manufacturing plants, repair shops and installation sites may be contaminated as a result of past practices. Other sections of this Guide provide that no askarel wastes of any kind be disposed of in any water effluent streams, and that accidental spills be prevented from getting into such streams.

1. Concentration Limits

The maximum allowable concentration of PCB's in water should be 200 parts per billion. On a 24 hours basis, the PCB content of all plant water effluent streams from manufacturing plants and repair shops should not exceed 5 pounds.

2. Monitoring Streams

On a regular basis, not to exceed 3 month intervals, and on a more frequent basis if required by the local plant situation, all effluent streams should be analyzed to determine compliance with the limits in Part 1. This can be done by taking a "worst" sample during the day, and a 24-hour composite. The procedures for performing the necessary analyses are contained in the section, "Analysis of Water and Sediment for Polychlorinated Biphenyls" (or its equivalent shall be used).

3. Methods for Minimizing Effluent Stream Contamination

The ideal approach is to totally isolate all effluent streams that could be contaminated with askarels during manufacturing processes and prevent them from being discharged from the plant. Procedures that could be implemented to this end are as follows:

- a. Collect askarel bearing streams and either by gravimetric or centrifugal separation recycle the water phase for reuse and dispose of the askarel rich phase under the liquid disposal guidelines described elsewhere.
- b. In all manufacturing areas where askarel spills can occur, connect drains to an isolated sump where the spills can be accumulated and pumped out for disposal.
- c. Carbon adsorption, limestone beds, and solvent extraction are techniques which can be applied to reduce the askarel content from effluent streams. This may be required to meet the limits defined in Part A above. This may be most appropriate in cleaning up water used in plant processing and recycled, but which ultimately may have to be disposed of. Such disposal could be done through incineration, but may be more practical by adsorptive cleanup.

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VI. (A) 4. Procedure for Water Sampling

Initially all effluent streams from the plant should be sampled to identify askarel-bearing streams. Hourly samples of each askarel-bearing stream should be taken during a typical operating period to determine the maximum PCB concentration for any period which must not exceed 200 parts per billion. The flow rate of each stream should be measured. Either by compositing the hourly samples in ratio to the flow rate or by taking a single sample collected over the operating period, determine the 24-hour PCB output of each stream. In a similar fashion, determine the total output of the plant which must not exceed 5 pounds per 24-hour day. Analysis shall be performed in accordance with "Analysis of Water and Sediment for Polychlorinated Biphenyls" (or its equivalent shall be used).

(B) Control of Vapor Effluents

Normal plant ventilation may carry askarel vapors (chlorinated benzenes and PCB's) to the environment. The PCB portion in the vapor is expected to be the lower chlorinated fractions which have the higher vapor pressures (but also have the higher degree of biodegradability).

1. Concentration Limits

The total plant stack emissions of PCB's shall not exceed 5 pounds per day.

2. Monitoring

The monitoring of appropriate stack effluents should be done over a typical 24-hour operating period at least four times per year or more frequently if required. Analysis shall be performed in accordance with "Procedure for the Determination of Airborne Polychlorinated Biphenyls" (or its equivalent shall be used).

3. Procedure for Air Sampling

The sample is collected by aspirating a known volume of the exhaust gases through hexane. The askarel, being soluble in hexane, will be collected and a quantitative determination of its PCB content made through the use of gas chromatograph/electron capture techniques as described in the section on analyses.

From the quantitative determination and with a knowledge of the volumetric flow rate of a given stack, the actual weight of PCB discharge can be computed.

(C) Analytical Procedures

1. Analysis of Water and Sediment for Polychlorinated Biphenyls

(SEE ATTACHED.)

2. A Tentative Procedure for the Determination of Airborne - Polychlorinated Biphenyls

(SEE ATTACHED.)