

GUIDELINES FOR HANDLING & DISPOSAL
OF CAPACITOR & TRANSFORMER GRADE ASKARELS
CONTAINING POLYCHLORINATED BIPHENYLS

SECTION 2 - CAPACITOR GUIDELINES

I. INTRODUCTION

The environmental effects of askarels are under in-depth study by governmental and other agencies. Askarels have been considered as materials relatively harmless 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 accepted precautions and conditions of handling, in both manufacturing and user applications.

Traces of askarels are being found in the environment and in fish and birdlife. The long term genetic and ecological effects are not yet completely understood. For these reasons care should be taken to contain askarels and minimize their entry into the environment.

There are two general classes of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their high degree of non-flammability, they are used in transformers where personnel safety is of paramount importance.

Capacitor grade askarel has a lower degree of chlorination (composed primarily of the 3-chlorine isomers of biphenyl), a higher degree of biodegradability, and generally has not been found in animal life. It is used in capacitors where the extreme degree of non-flammability required in transformers is of less importance.

Although capacitor and transformer grade askarels both contain members of the PCB family they do differ in composition, degree of biodegradability, persistence in nature, electrical stability, chemical stability, and degree of non-flammability (both are recognized as non-flammable). It is for these reasons that this portion of the Guideline is intended to apply only to capacitor grade askarel.

II. CAPACITOR GRADE ASKAREL

In September of 1971, a new grade of capacitor impregnant, Aroclor 1016, was made available to the industry. This new grade contains a typical concentration of 0.4% by weight of the pentachloro and higher chlorinated components. Aroclor 1016 replaces Aroclor 1242 which previously was the major capacitor impregnant and contained around 7% of the pentachloro and higher fractions (the more persistent in nature). This 0.4% level of the higher chlorinated components should be the maximum concentration acceptable in any capacitor impregnant. Aroclor 1242 and 1254, previously used as impregnants, do not meet this requirement and should no longer be used in capacitors.

Aroclor 1016 has the same non-flammability rating by UL as Aroclor 1242. Its typical properties are given in Table I.



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TABLE I - TYPICAL PROPERTIES OF AROCLOR 1016

Color (APHA)	40, max.
Condition	Clear
Sp. Gravity @ 25/15.5°C	1.362-1.372
Acidity (mg. KOH/g.)	0.010 max.
Moisture	35 ppm, max.
Refractive Index @ 25°C	1.6215-1.6235
Inorganic (Free) Chlorides	0.05 ppm, max.
Pour Point	-14°C or lower
Dielectric Constant (1000 Hz @ 100°C)	4.70-4.90
Resistivity (500 VDC @ 100°C. 0.1" Gap.)	500, min.
Hydrolysis Stability Test (As Chlorides)	0.5 ppm, max.
Monsanto Stability Test (As Chlorides)	0.4 ppm, max..
Distillation Range (ASTM D-20 corrected)	
10% Distilled by Wt.	323°C, min.
90% Distilled by Wt.	356°C, max.
Penta and Hexachloro Biphenyls	0.4%
Sulfates	None
Dielectric Strength @ 25°C KV	35 min.
Flash Point °F	338 min.
Fire Point	None to B.P.
Corrosion Test (6 hrs. @ 210°C with bright Al foil)	
Change in wt. of Al %	0.0
A.C. Color (APHA)	60, max.
A.C. Condition	Clear
A.C. Acidity (mg. KOH/G)	0.010, max.
A.C. Inorganic (Free) Chlorides	0.05 ppm, max.
Viscosity @ 100°F (SUS)	71-81
Specific Heat @ 25°C	0.30
Coefficient of Expansion (25-65°C) CC/CC°C	0.00068
Fixed Chlorine	41.3 ± .5%
Power Factor @ 100°C	
Typical Values 60 Hz	5
1000 Hz	-

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III. PLANT HOUSEKEEPING AND EMPLOYEE SAFETY

The following procedures and limits are intended to be minimum requirements to be met by manufacturers and users of capacitors containing askarel. Handling, control and disposal procedures are given, together with exposure limits and indicated antidotes and cleanup procedures.

- A. Material. Askarel for use in capacitors should consist of homologues and isomers of chlorinated biphenyl with the concentration of the pentachloro and higher chlorinated fractions at about 0.4%. Aroclor 1016 is considered the standard impregnant meeting these requirements.

Solvents include benzene, kerosene, acetone, amyl alcohol, ether, and chloroform. Typical vapor pressure data for Aroclor 1016 are:

0°C	=	0.001	mm
25°C	=	0.006	mm
150°C	=	4.3	mm
200°C	=	29.0	mm

At 25°C and 760 mm Hg pressure, saturated air contains approximately 0.09 mg/liter

(1 mg/liter = 90.0 ppm (v/v))
(1 ppm (v/v) = 0.011 mg/liter)

- B. Bulk Fluid Shipment, Receiving, and Transfer. Shipment of askarel from point of manufacture to point of receiving should be done in closed containers: rail tank cars; truck tanks; marine or barge tanks; or sealed drums. Containers should be labeled as to contents, and carry a label cautioning against loss of fluid to the open environment. Containers used for transport of askarel should not be used for storage or transport of other material without being completely cleaned of all traces of askarel. (Cleaning procedures must take cognizance of precautions against excessive exposure and of the need for proper disposal of contaminated cleansing solvents and materials as set forth in Section V.) Transfer from shipping containers to processing systems should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluid lost by leakage or spills from the transfer system and from the storage containers.

Drums to be retired from use should be cleaned before crushing, delivery to scrap dealers, or other disposal. Contaminated cleaning fluids and materials should be disposed of as indicated in Section V.

- C. General Safety Precautions. Although it is generally accepted that exposure to capacitor grade askarel is not hazardous provided simple precautions are taken, exposure should still be avoided.

- (1) Vapors. The odor of askarel is noticeable well below the maximum air concentrations considered safe. Up to 1.0 milligram per cubic meter of air has been determined to be the maximum safe level of exposure during an 8-hour work day (Reference 8 - Part G below). The procedures for performing the necessary analyses are contained in SECTION 5, "A Tentative Procedure for the Determination of Airborne-Polychlorinated Biphenyls."

(1) Vapors (continued)

Breathing vapor or fumes from heated askarel should be avoided. Provisions should be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure to askarel (especially at 55°C or higher). 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, contain a high percentage of hydrogen chloride, and small percentages of carbon dioxide, carbon monoxide, and oxygen. 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 is necessary under emergency conditions, an approved gas mask or self-contained breathing apparatus should be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of an accident. If the odor of askarel is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval, and be maintained on a regular schedule in accordance with the manufacturers' recommendation.

- (2) Liquid. Unlike insulating oil, there is virtually no fire hazard in handling askarel. 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 the eye tissue.

Operating procedures should be such as to minimize or eliminate contact with askarels. Use of eye protection is recommended. The use of porous gloves which can absorb and retain askarels is to be avoided. Barrier creams* or resistant gloves** should be used if contact is unavoidable. Use of enclosed transfer and handling equipment, processing equipment, and mechanical washers reduces direct contact.

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. If eye contact to liquid askarel occurs, the eyes should be irrigated immediately with large quantities of running water for fifteen minutes and then examined by a physician. (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 the supervision of a physician.

* e.g. PLY No. 9 Gel by Milburn Co., Detroit, Michigan, or Kerodex #71 distributed by Ayers Laboratories, P.O. Box 8236, Church Street Station, New York, N. Y. 10049

* Edmont, Solvit 5-352, sold by Mersick of Bridgeport, 22 Cross St., Bridgeport, Conn. 06601

(2) Liquid (continued)

Askarels are regarded as being moderately toxic if taken internally, and could cause irritation of the digestive tract and internal reactions. Hands should be washed clean of askarels with warm water and soap before eating, drinking, smoking or use of toilet facilities after handling.

D. Manufacturing Housekeeping. Manufacturing equipment and operating procedures should safeguard against loss of askarels to the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 55°C. Enclosure should preferably extend to all other portions of the system insofar as practicable.

Containment provisions should be established around all askarel processing areas to assure against inadvertent loss to sewer systems by spillage, leakage, or other uncontrolled conditions or events.

Spills of askarel should be removed promptly by use of absorptive material such as sawdust, or trapped and removed by pumping or other suitable means.

Waste fluids containing askarel not suitable for reconditioning or reuse should be collected (by means of traps, drip pans, trays, etc.) from the various parts of the manufacturing and processing area (including washers or other cleaning devices). Disposal should be in accordance with Section V.

Wiper rags, clothing and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled laundering or disposal (see Disposal of Liquid and Solid Scrap - Section V).

E. Disposal of Askarel Wastes. Methods for disposal of liquids and saturated solids generated by the manufacturing operation should be in accordance with those outlined in Section V of this Guide, and should include (but not be limited to) the following:

1. Liquid askarel contaminated by aliphatic materials and other substances such as to make it unsuitable for reclaiming as a dielectric fluid.
2. Liquid askarel from solvent operations or water/detergent type washers.
3. Saturated earth or other absorbent media from filtering operations.
4. Saturated sawdust or other absorptive materials from spills.

E. Disposal of Askarel Wastes (continued)

5. Saturated filters from vapor control devices and other filters.
6. Saturated wastes (paper, rags, etc.).
7. Saturated, spent gasket materials.
8. Askarel contaminated vacuum pump oils.
9. Askarel contaminated steam jet vacuum system condensates.

F. Miscellaneous Procedures

1. Spills by leakage from finished capacitors should be cleaned up promptly by use of absorbent media which should then be moved to containers for that purpose within the containment area, and later disposed of properly.
2. Askarel wastes should never be disposed of down effluent drains or sewers. The utmost care must be exercised to prevent accidental loss by these avenues to the environment.
3. Capacitors failing test or otherwise designated for disposal must be controlled and handled in accordance with the intent of the procedures above, finally being disposed of by one of the means outlined in Section V.

G. References

1. Monsanto Company, Organic Chemical Division: Tech. Bulletin #PL-306, Aroclor Plasticizers (December 1960).
2. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. AMA Arch. Environ. Health 9:545 (1964).
3. Treon, J.F., F.P. Cleveland, J. Cappel, and R.W. Atchley: The Toxicity of the Vapors of Aroclor 1242 and Aroclor 1254. Amer. Ind. Hyg. Assoc. Quart. 17:204 (1956).
4. Elkins, H.B.: The Chemistry of Industrial Toxicology. John Wiley and Sons, Inc., New York (1959).
5. Drinker, C.K., M.F. Warren, and G.A. Bennet: The Problem of Possible Systemic Effects from Certain Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 19:283 (1937).
6. Drinker, C.K.: Further Observations on the Possible Systemic Toxicity of Certain of the Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 21:155 (1939).
7. Greenburg, L., M.R. Mayers, and A.R. Smith: The Systemic Effects Resulting from Exposure to Certain Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 21:29 (1939).
8. Hygienic Guide Series "Chlorodiphenyls" (January-February 1965) by the American Industrial Hygiene Assoc., 210 Haddon Avenue, Westmont, N. J. 08108.

IV. CONTROL OF WATER EFFLUENTS

The industry goal is to eliminate askarel in plant water effluent streams. However, it is recognized that existing drain systems in capacitor manufacturing plants are probably contaminated as a result of past practices, and askarel traces may continue to show up in effluent streams for some time. However, the level should continue to decrease with the proper containment of askarel wastes and no further discharges into drain systems. 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.

- A. Concentration Limits. The 1972 EPA proposals are to keep PCB levels in rivers and lakes below 0.01 parts per billion. Plant effluent streams should be managed and controlled in a manner consistent with this goal.
- B. Monitoring Streams. On a regular basis consistent with plant situations, all effluent streams should be analyzed to determine compliance with the goals in (A) above. The procedures for performing the necessary analyses are contained in APPENDIX A, ANALYSIS OF WATER AND SEDIMENT FOR POLYCHLORINATED BIPHENYLS. This procedure or its equivalent should be used.
- C. 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. Carbon adsorption limestone beds, and solvent extraction are techniques which can be applied to reduce the askarel content of effluent streams. These techniques may be most useful in cleaning up water used in plant processing and to permit recycling.

V. SCRAP DISPOSAL PROCEDURES

The manufacture and use of capacitors involve processes producing askarel saturated solids, and liquids containing or composed entirely of askarel, which should be disposed of as wastes. Disposal should be done in a manner consistent with proper concern for the environment, and which minimizes any release of askarels to the environment. Specific sources of these materials appear throughout this document but may be placed into three categories:

1. Capacitor units impregnated with askarel; Production and Field Rejects.
2. Manufacturing process liquid wastes containing askarel.
3. Solid waste purposely or accidentally saturated with askarel.

A. Disposal of Capacitor Units

Scrap capacitor units can be generated during manufacturing processes, or during field service.

A. Disposal of Capacitor Units (continued)

Production rejects are those capacitors which are rejected after the impregnation process, in the course of production by the capacitor manufacturer. They may be rejected for mechanical or electrical reasons, or because of obsolescence.

Field rejects are those which are rejected, or which for other reasons are to be scrapped, after shipment from the plant where they were manufactured.

Disposal Procedures

1. Production Rejects

Rejected capacitors are generated in sizeable quantities in capacitor manufacturing plants, and because they represent a concentration of askarel, it is important that their disposition be made in a manner consistent with proper concern for the environment. Therefore, capacitors should be disposed of only in dry landfill sites which meet all applicable State requirements.

Care should be exercised to insure that no loss of liquid will occur during transportation to the disposal site.

Incineration of scrap capacitors in facilities designed to accept such solids is a disposal alternative as such services become available in the future.

2. Field Rejects

Small capacitors (define as containing less than 2 pounds of askarel) are practically always used as components in other electrical or electromechanical equipment. Typical examples of large quantity usage of such capacitors are in fluorescent lamp ballasts and residential air conditioning equipment. Failure of such capacitors may result in scrapping of the device of which it is a part (as in a fluorescent ballast), or replacement and scrapping of the individual capacitor (as in a room air conditioner). However, the majority of such capacitors do not fail in service, but are scrapped as a result of wearout or obsolescence of the devices in which the capacitors are used as components. Thus, the matter of disposal is characterized by low concentration of small quantities of askarel throughout the country and indeed throughout the world. Fortunately, the nature of the devices and equipment in which such capacitors are used is such that they are normally disposed of in dry landfills as a matter of convenience. Since it is impractical at present to exercise any meaningful control over disposition of the bulk of such devices and equipment, it is imperative that askarel used for impregnating small capacitors be limited to the recently introduced type which contains a typical concentration of 0.4% of the higher chlorinated components (5 or more chlorine atoms per molecule).

Large capacitors (those incorporating more than 2 pounds of askarel) should be disposed of according to the procedure for Production Rejects (see paragraph 1 of this Section).

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B. Disposal of Liquid Wastes

All waste askarel or liquid wastes containing askarel should be disposed of according to one of the following procedures:

1. Incineration

Facilities capable of incineration at temperatures of at least 2000°F, with minimum residence time of 2.0 seconds, and having exhaust gas scrubbing equipment as part thereof are suitable for this purpose.

These facilities should meet applicable requirements of the State in which located, and should control effluents within the limits set forth in this document.

2. Toxic and Hazardous Waste Disposal Sites

Certain landfill sites have been classified by State and Federal Governments as suitable for the disposal of toxic and hazardous liquids. Where such approved sites exist they may be used for the disposal of liquid wastes described in this document. (See Section VII).

The following guidelines should be observed in the packaging and shipment of liquid wastes for disposal.

1. Transportation to the disposal facility should be in containers which will prevent leakage and accidental loss of askarel to the environment.
2. Containers should be labeled as to contents and precautions relative to loss to the environment.
3. Containers used for this purpose should not be used for any other materials or retired from service until they are completely cleaned. Any solvents used in cleaning these containers will be contaminated with askarel and should be disposed of according to the same procedures herein described.

C. Disposal of Solid Wastes (see "A" for Scrap Capacitors)

All solid wastes which have been saturated with askarel should be disposed of by the following procedure:

The saturated wastes should be placed into leak-proof containers and transported to a dry landfill site meeting State requirements as described in Part B of this Section. Alternatively, they can be disposed of by incineration in State approved facilities.

Solid absorbents used for spills can be disposed of uncontained in the dry landfill site -- transport to the site should be in closed containers. Alternatively, solid incineration can be used in accordance with Part B (see Section VII for facilities).

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VI. LABELING

Capacitor units vary greatly in size and in end use or application. Small capacitor units are frequently applied as a component of another piece of equipment such as a fluorescent lighting ballast, a roadway or area lighting luminaire, a motor, etc. In such applications a label on the capacitor unit referencing approved disposal procedure would not normally be visible when the piece of equipment is disposed of.

For the above reasons the method of relating disposal instructions for small capacitors and large capacitors shall be treated separately and in the following manner.

Small Units (Incorporating less than 2 pounds of askarel)

Small capacitors are defined as those which contain askarel in quantities up to about two (2) pounds each and in which the free liquid does not exceed about 0.4 pound. They are hermetically sealed in metallic cases. Such capacitors are applied as a component of a larger piece of equipment. Attaching a label to such equipment referencing this Guideline or describing disposal procedures would be of limited practical value. The amount of askarel involved in disposal of a single such equipment, the frequency of such disposal, the localized concentration of askarel resulting from such failed equipments, and the likelihood that the small capacitor is still a sealed unit are factors suggesting minimum environmental effects. Therefore the labeling of small capacitor units or equipments in which they are used is not considered necessary.

Large Capacitor Units (Incorporating more than 2 pounds of askarel)

The capacitor manufacturer should affix a label in a conspicuous place, referencing this document or describing disposal procedures consistent with it. This label should contain as a minimum the following information:

CAUTION

This capacitor contains a Polychlorinated Biphenyl (PCB). To avoid possible environmental contamination, it should be disposed of only in supervised dry landfill areas meeting State requirements or in incineration facilities designed for disposal of PCB's.

SEE AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINE
for further information (available from manufacturer or
ANSI, 1450 Broadway, New York, N. Y. 10017).