GENERAL ELECTRIC COMPANY

JOHN STREET, HUDSON FALLS, NEW YORK 12839 . . . AREA CODE 518, TELEPHONE 747-3341

INDUSTRIAL AND POWER

CAPACITOR DEPARTMENT

cc: E. L. Raab

March 1, 1972

ANSI C 107 WORKING GROUP ON CAPACITORS

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Attached is the revised Guideline for capacitors as a result of our February 8 meeting.

Parts VIII and IX are not included. You have received Part IX in an earlier communication and the only change I anticipate is the deletion of some of the reference chromatograms of pesticides. I will coordinate this with Ed Raab of the Transformer Group since the analytical procedures would probably be common.

I have had our legal people review the " should" versus "shall" question and the writeup is as recommended by our Company attorney.

You will note that the suggested warning label on the last page contains more information than originally thought might be needed. After further discussions within General Electric I am advised that it is desirable to state the fact that PCB's are involved and to identify the potential hazard (i.e. environmental contamination).

Please let me know by March 15 of either your approval or if you have any changes. My next step will be to get together with Ed Raab to review our Guideline writeups.

A. Pozefsky
Manager-Engineering

Pg
att.



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D R A F T INFORMATION PURPOSES ONLY -- NOT FOR EXTERNAL USE

SECOND DRAFT - For ANSI C 107 Review on ~~February 8, 1972~~

Guidelines for Handling and Disposal of Capacitor Grade Askarels

I. INTRODUCTION

The environmental effects of askarels are under in-depth studies by governmental and other agencies. 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 accepted conditions of precaution and handling, in both manufacturing and customer applications.

Traces of askarels are being found in the environment and in fish and birdlife. Although they have not been considered as toxic to humans, 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 grades of askarels used by the electrical industry. The higher chlorinated grades are the more persistent in nature. Because of their non-flammability, they are used in transformers where personnel safety and reliability are of paramount importance.

Capacitor grade askarel has a lower degree of chlorination, 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 (the largest capacitors use in the order of 2 to 7 gallons of askarel compared to hundreds of gallons in larger transformers). Capacitor grade askarel is

composed primarily of the 3-chlorine isomers of biphenyl. This degree of chlorination is found to be more stable chemically and electrically in capacitors than the higher chlorinated fractions, and is most important in getting good capacitor life and reliability.

Although capacitor and transformer grade askarels are both 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).

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 maximum concentration of 0.4% by weight of the pentachloro and higher chlorinated components. Aroclor 1016 replaces Aroclor 1242 which previously as 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 uased 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.

III. PLANT HOUSEKEEPING & EMPLOYEE SAFETY

The following procedures and limits are intended to be minimum requirements to be met by manufacturers and users of capacitors containing polychlorinated biphenyl.

TABLE I - TYPICAL PROPERTIES OF AROCLOR 1016

Color (APHA)	40, max.
Condition	Clear
Sp. Gr. @ 25/15.5°C	1.362-1.372
Acidity (mg. KOH/g.)	0.010 max.
Mositure	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.
Hydrolosis Stability Test (As Chlorides)	0.3 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% max.
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.
Misc. @ 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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Handling, control and disposal procedures are given, together with exposure limits and indicated antidotes and cleanup procedures.

1. Material. Chlorinated biphenyl for use in capacitors should consist of chlorinated homologues and isomers of biphenyl with the pentachloro and higher fractions not exceeding 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 properties of 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. ppm (v/v))
(1 ppm (v/v) = 0.011 mg/liter)

2. Bulk Fluid Shipment, Receiving, and Transfer. Shipment of polychlorinated biphenyl 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 labelled as to contents, and carry a precautionary lable 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 VI.) Transfer from shipping container to processing system should be through closed piping or tubing with appropriate valves, pumps, etc. Provision should be made for trapping and disposing of fluids lost by leakage or spills from the transfer system and from the storage containers.

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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 VI.

3. 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 and minimized.

(a) Vapors. The odor of askarel is noticeable well below the maximum air concentrations considered safe. Maximum atmospheric concentration limit (8 hours exposure) shall not exceed one milligram of capacitor grade askarel per cubic meter of air.

Breathing vapor or fumes from heated askarel shall be avoided. Provisions must 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 contains 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 must 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.

(b) Fluid. 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 eye tissue.

Operating procedures should avoid contact with any askarels. Use of eye protection is recommended. The use of porous gloves which can absorb and retain askarels is to be avoided. Barrier creams (e.g. PLY No. 9 Gel by Milburn Co., Detroit, Mich.) 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.

Ingestion or swallowing of askarels is not generally regarded as a problem of the industry. 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.

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*McClain & Clark to furnish [illegible]

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4. Manufacturing Housekeeping. Manufacturing equipment and operating procedures must safeguard against loss of askarels tc the environment through proper containment and disposal procedures.

Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers are to 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.

Ventilation of the area and exhaust of pump and systems gases should be controlled to restrain vapor losses to the atmosphere (see Section V).

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 and 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 by approved incineration or in clean landfill areas in sealed containers, if permitted (see Section VI).

Wiper rags, clothing and other extraneous materials saturated with askarels should be collected within the containment area for properly controlled in-plant laundering or dispo (see Disposal of Liquid and Solid Scrap - Section VI). Outside commercial laundering or dry cleaning services should be used only if their disposal procedures are consistent with the guildelines in Section VI.

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5. 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 VI of this Guide, and should include (but not be limited to) the following:

A. Liquid askarel contaminated by aliphatic materials and other substances such as to make it unsuitable for reclaiming as a dielectric fluid.

B. Liquid askarel from solvent operations or water/detergent type washers.

C. Saturated earth or other absorbent media from filtering operations.

D. Saturated sawdust or other absorptive materials from spills.

E. Saturated filters from vapor control devices and other filters.

F. Saturated wastes (paper, rags, etc.)

G. Saturated, spent gasket materials,

H. Askarel contaminated vacuum pump oils.

I. Askarel contaminated stream jet vacuum system condensates.

6. Miscellaneous Procedures.

A. Spills by leakage from sealed, finished capacitors should be cleaned up promptly by use of absorbent media which should then be removed to containers for that purpose within the containment area, and later disposed of properly.

B. 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.

C. 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 VI.

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7. References:

A) Monsanto Company, Organic Chemical Division: Tech. Bulletin #PL-306, Aroclor Plasticizers (December 1960).

B) American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. AMA Arch. Environ. Health 9:545 (1964).

C) 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).

D) Elkins, H.B.: The Chemistry of Industrial Toxicology. John Wiley and Sons, Inc., New York (1959).

E) 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).

F) Drinker, C.K.: Further Observations on the Possible Systemic Toxicity of Certain of the Chlorinated Hydrocarbons. J. Ind. Hyg. Toxicol. 21:155 (1939).

G) 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).

H) Hygienic Guide Series "Chlorodiphenyls" by the American Industrial Hygiene Association, 14125 Prevost, Detroit, Michigan.

IV. CONTROL OF WATER EFFLUENTS

The industry goal is "zero" concentration of 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.

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I do not believe this is acceptable to enforcement agencies. USBP

A. Concentration Limits. The maximum allowable concentration of askarel in water should be 200 parts per billion. On a 24 hour basis, the askarel content of all plant water effluent streams shall not exceed five pounds.

B. 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 A. This can be done by taking a "worst" sample during the day, or a 24 hour composite. The procedures for performing the necessary analyses are contained in Section IX, ANALYSIS OF WATER AND SEDIMENT FOR POLYCHLORINATED BIPHENYLS (or its equivalent).

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. Procedures that could be implemented to this end are as follows:

1. 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 herein.

2. 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.

3. 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 purification.

D. Procedure for Water Sampling. Initially all effluent streams from the plant should be sampled to determine values and to identify askarel bearing streams. Hourly samples of the streams should be taken during a typical operating period to insure the samples are representative of the effluent, or a single sample collected continuously over the operating period. The flow rates of the effluent streams should be measured when the samples are taken. The hourly samples from each stream are then composited in proportion to the flow rate of the stream. Analyses of the composite samples are done in accordance with the procedures outlined in Section IX.

The actual askarel discharge of any effluent can be computed from the quantitative analysis of its composite samples and the mean flow rate of the stream.

V. CONTROL OF VAPOR EFFLUENTS

Normal plant ventilation will carry askarel vapors to the environment. The composition of askarel in the vapor is expected to be ~~heavier~~ higher in the lower chlorinated fractions of MCS 1016 which have the higher vapor pressures (and also have the higher degree of biodegradability).

Too high WBP

A. Concentration Limits. The total plant stack emissions should not exceed 5 pounds per day.

B. Monitoring. The monitoring of appropriate stack effluents should be done on a periodic basis not to exceed 3-months, and more frequently if required by the local situation. Test Method 70-6 contained in Section IX, PROCEDURE FOR THE DETERMINATION OF AIRBORNE POLYCHLORINATED BIPHENYLS (or its equivalent) should be used.

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C. Other Considerations. Large exposed surface areas of askarel, especially if maintained at an elevated temperature, will be the major contributor to any concentration of askarels found in stack effluents. Open containars should be enclosed with vapor tight covers to avoid this.

D. Procedure for Air Sampling. Identify exhaust stacks which may contain airborne askarel. A composite sample of each stack should be gathered over a typical 24 hour operating period. 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 can be made through the use of gas chromatograph/electron capture techniques as described in Section IX.

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

VI. SCRAP DISPOSAL PROCEDURES

The manufacture and use of capacitors involve processes wherein askarel saturated solids and liquids containing, or composed entirely of askarel, must be disposed of in a manner consistent with proper concern for the environment. Specific sources of these materials appear throughout this document but may be placed into three categories:

A. Capacitor units impregnated with Askarel; Production and Field Failures (mechanic or electrical); obsolete items.

B. Manufacturing process liquid wastes containing askarel.

C. Solid waste purposely or accidentally saturated with askarel.

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PART A Disposal of Capacitor Units

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

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 ~~Federal and~~ State requirements.

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

Solid incineration of scrap capacitors is preferable a disposal alternative as such services become available in the future.

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2. Field Rejects

Small capacitors 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 grade which contains a minimum concentration (0.4% maximum) of the higher chlorinated (5 or more chlorine atoms per molecule) components.

PART B Disposal of Liquid Wastes

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

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Incineration: Facilities capable of incineration at temperatures ~~of~~ exceeding 800 °C and having exhaust gas scrubbing equipment as a part thereof shall be suitable for this prupose.

These facilities shall meet requirements ~~have approval~~ of the State in which located for such purpo and shall control liquid and vapor effluents within the limits set forth in this document.

A description of, and availability of these incineration facilities is contained in Section VIII of this document.

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.

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

1. Transportation to the incineration facility should be in sealed 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 prupose 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.

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PART C Disposal of Solid Wastes (see Part A for Scrap Capacitors)

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

The saturated wastes shall be placed into leak-proof containers and transported to a ~~State-approved~~ 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 shall be in closed containers. Alternatively, solid incineration can be used in accordance with Part B (see Section VIII for Services).

VII. 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 procedures 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) NEV 024413

Definition

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.

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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 appropriate 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 in a conspicuous place a label referencing this document or describing disposal procedures consistent with it. This label is available from NEMA and will read as follows:

[Use Uniform Industry Label]

TO BE DESIGNED

NOTICE

This capacitor contains PCB's. To avoid possible environmental contamination, it should be disposed of only in dry landfill areas meeting State requirements or in approved incineration services.

See AMERICAN NATIONAL STANDARDS INSTITUTE GUIDELINE*

for instructions.

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