ANSI/IEEE Std 799-1987

An American National Standard

IEEE Guide for Handling and Disposal of Transformer Grade Insulating Liquids Containing PCBs

Sponsor
Transformers Committee
of the
IEEE Power Engineering Society

Approved March 11, 1982
Reaffirmed May 1, 1992

IEEE Standards Board

Approved June 4, 1986
Reaffirmed October 26, 1992

American National Standards Institute

IEEE Standards documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE which have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least once every five years for revision or reaffirmation. When a document is more than five years old, and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally question may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE Standards Board
345 East Tn Street
New York, NY 10017
USA

Foreword

(This Foreword is not a part of ANSI/IEEE Std 799-1987, IEEE Guide for Handling and Disposal of Transformer Grade Insulating Liquids Containing PCBs.)

This guide was prepared by the Subcommittee on Insulating Fluids of the Transformers Committee of the IEEE Power Engineering Society. The purpose of the guide is to bring to the attention of anyone handling askarels or mineral oils containing PCBs the sensitivity of these materials and to advise them of procedures for handling and analyzing them.

At the time this guide was approved, the Insulating Fluids Subcommittee, which prepared this document, had the following membership:

H. A. Pearce, *Chair*

D. J. Allan	D. A. Gillies	E. L. Morrison
L. Baranowski	F. J. Gryszkiewicz	V. R. Muhall
J. G. Bryant	T. J.Haupert	R. J. Musil
G. Bryant	F. W. Heinrichs	W. M. Mutschler, Jr.
N. Burns	P. J. Hoefler	S. Northrup
R. A. Burns	T. Hunt	T. Orbeck
J. Corkran	B. G. Hunter	L. L. Preston
D. W. Crofts	O. Keller	C. P. Raymond
B. Cupples	J. J. Kelly	T. O. Rouse
D. H.Douglas	T. G. Lipscomb	L. J. Savio
J. A. Fidinger	R. I. Lowe	G. J. Schreuders
J. A. Forster	G. G. McCrae	J. A. Thompson
F. M. Frey	K. McManamon	R. M. Vincent
M. Frydman	R. E. Minkwitz, Sr.	L. Wagenaar
J. P. Germain	C. K. Miller	F. M. Young

The following persons were on the balloting committee that approved this document for submission to the IEEE Standards Boards:

L. C. Aicher	J. D. Douglass	R. H. Hollister
B. F. Allen	J. K. Easley	C. C. Honey
R. Allustiarti	J. A. Ebert	C. Hurty
S. J. Antalis	R. L. Ensign	G. W. Iliff
E. H. Arjeski	H. G. Fischer	R. G. Jacobsen
J. C. Arnold	J. A. Forster	A. J. Jonnatti
R. Bancroft	S. L. Foster	C. P. Kappeler
S. Bennon	M. Frydman	J. J. Kelly
J. J. Bergeron	H. E. Gabel	W. N. Kennedy
J. V. Bonucchi	D. A. Gillies	W. Lampe
J. D. Borst	A. W. Goldman	H. F. Light
G. H. Bowers	R. L. Grubb	T. G. Lipscomb
F. J. Brutt	F. J. Gryszkiewicz	R. Little
D. J. Cash	G. Gunnels	L. W. Long
E. Chitwood	G. H. Hall	R. I. Lowe
O. Compton	J. H. Harlow	M. L. Manning
F. W. Cook, Sr.	T. K. Hawkins	J. W. Matthews
J. Corkran	F. W. Heinrichs	L. S. McCormick
D. W. Crofts	W. Henning	G. G. McCrae
M. G. Daniels	K. R. Highton	C. J. McMillen
D. H. Douglas	P. J. Hoefler	W. J. McNutt

N. J. Melton
C. K. Miller
C. H. Millian
R. E. Minkwitz, Sr.
C. Mitchell
H. R. Moore
R. J. Musil
W. J. Mutschler
S. Northrup
E. T. Norton
B. K. Patel
H. A. Pearce
D. A Roach
L. J. Savio
B. E. Smith
W. W. Stein
L. R. Stenslund
R. B. Stetson
F. R. Stockam
D. Tackack
A. L.Tanton
F. W. Thomason
T. P. Traub
D. E. Truax
R. E. Uptegraff, Jr.
R. A.Veitch
L. B. Wagenaar
J. W. Walton
S. A. Wiencek
W. E. Wrenn
D.Yannucci
E. J. Yasuda

When the IEEE Standards Board approved this standard on March 13, 1986, it had the following membership:

John E. May, *Chair*
Irving Kolodny, *Vice Chair*
Sava I. Sherr, *Secretary*

James H. Beall
Fletcher J. Buckley
Paul G. Cummings
Donald C. Fleckentein
Jay Forster
Daniel L. Goldberg
Kenneth D.Hendrix
Irvin N. Howell
Jack Kinn
Joseph L. Koefringer *
Edward Lohse
Lawrence V. McCall
Donald T. Michael
Marco W. Migliaro
Stanley Owens
John P. Riganati
Frank L. Rose
Robert E. Rountree
Martha Sloan
Oley Wanasalja
J. Richard Weger
William B. Wilkens
Helen M. Wood
Charles J. Wylie
Donald W. Zipse

* Member emeritus

CLAUSE PAGE

An American National Standard

IEEE Guide for Handling and Disposal of Transformer Grade Insulating Liquids Containing PCBs

1. Introduction

This guide applies only to the United States and its territories. Beginning in 1979, the US Environmental Protection Agency issued the "Final Rule" (CFR, Title 40, Part 761 [7][1]). This rule implements the provisions of the Toxic Substance Control Act (TSCA) ban on polychlorinated biphenyls (PCBs).

Electrical equipment manufacturers, owners, operators, and maintenance personnel who utilize PCBs or conduct maintenance or manufacturing operations through which PCBs can be encountered are subject to the new regulations. There are requirements for identification, labeling, and servicing equipment, and handling and disposal of equipment and materials. There are also requirements for handling spills and leaks and for keeping comprehensive records.

The specific purpose of this guide is to cover in detail the procedures for handling askarels and mineral insulating oil that contain PCBs, and to describe the analytical procedures for measuring them.

It is not the intent of this guide to contravene in any way any elements of CFR, Title 40, Part 761 [7] or any state or local regulations.

2. Scope

The scope of this guide is to describe the requirements for handling and disposal of the transformer grade insulating liquids containing PCBs; the definition of PCB levels in electrical insulating liquids; the analytical method of detection and measurement of the PCBs in electrical insulating liquids; and regulations covering the identification and the disposal of electrical insulating liquids containing PCBs.

[1]The numbers in brackets correspond to those reference listed in Section 4.

3. Definitions

	Term	Definition	Examples
(1)	PCB, PCBs 761.3(s)*	Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances that contains such substance ≥ 50 ppm dry weight basis. (761.1 B)	PCB liquids and nonliquids
(2)	PCB transformer 761.3(y)	Any transformer that contains 500 ppm PCB or greater.	PCB askarel-insulated units; some oil-filled units; some retrofilled units
(3)	PCB contaminated electrical equipment 761.3(z)	Any electrical equipment, including but not limited to transformers (including those used in railway locomotives and self-propelled cars), capacitors, circuit breakers, reclosers, voltage regulators, switches (including sectionalizers and motor starters), bushings, electromagnets, and cable, that contain 50 ppm or greater PCBs but less than 500 ppm PCB. Oil-filled electrical-equipment other than circuit breakers, reclosers, and cable whose PCB concentration is unknown must be assumed to be PCB-contaminated electrical equipment. (See 761.30 (a) and (h) for provisions permitting reclassification of electrical equipment containing 500 ppm or greater PCBs to PCB-contaminated electrical equipment.)	Some oil-filled units; some retrofilled units
(4)	non-PCB transformer 761 Preamble II C.3	Transformers that contain less than 50 ppm PCB. No transformer may ever be considered to be a non-PCB transformer unless its dielectric fluid has been tested or otherwise verified to contain less than 50 ppm PCB.	Transformers so identified
(5)	PCB article 761.3(t)	Any manufactured article, other than a PCB container that contains PCBs and whose surface(s) has been in direct contact with PCBs.	PCB large high- and low-voltage capacitors; PCB transformer; PCB cooler motor
(6)	PCB container 761.3(v)	Any package, can, bottle, bag, barrel, drum, tank, or other device that contains PCBs or PCB articles and whose surface(s) has been in direct contact with PCBs.	Bottle, barrel, drum, or box
(7)	PCB article container 761.3(u)	Any package, can, bottle, bag, barrel, drum, tank, or other device used to contain PCB articles or PCB equipment, and whose surface(s) has not been in direct contact with PCBs.	Shipping or storage cartons for capacitors
(8)	PCB equipment 761.3(w)	Any manufactured item, other than a PCB container, that contains a PCB article or other PCB equipment.	Microwave oven, power-factor-corrected lighting ballast
(9)	PCB item 761.3(x)	Any PCB article, PCB article container, PCB container, or PCB equipment that deliberately or unintentionally contains or has apart of it any PCB or PCBs at a concentration of 50 ppm or greater.	PCB askarel contaminated transformer (mineral) oil, or coolants retrofilled to transformer formerly cooled with askarel
(10)	mark 761.3(o)	The descriptive name, instructions, cautions, or other information applied to PCBs and PCB items or other objects subject to these regulations.	Figures 1 and 2

	Term	Definition	Examples
(11)	marked 761.3(p)	The marking of PCB items and PCB storage areas and transport vehicles by means of applying a legible mark by painting, fixation of an adhesive label, or by any other method that meets the requirement of these regulations.	Figures 1 and 2
(12)	transport vehicle 761.3(gg)	A motor vehicle or rail car used for the transportation of cargo by any mode, each cargo carrier (for trailer, railroad freight car) is a separate vehicle.	
(13)	spill 761.3(h)	(See (15) disposal.) Spills, leaks, and other uncontrolled discharges of PCBs constitute the, disposal of PCBs (761.60(d)(1))	
(14)	PCB storage for disposal 761.65(b)(1)(i–v)	The facilities shall meet the following criteria: (a) Adequate roof and walls to prevent rain water from reaching the stored PCBs and PCB items. (b) An adequate floor that has continuous curbing with a minimum 6 in high curb. The floor and curbing must provide a containment volume equal to at least two times the internal volume of the largest PCB article or PCB container stored therein or 25% of the total internal volume of all PCB articles or PCB containers stored therein, whichever is greater. (c) No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area. (d) Floors and curbing constructed of continuous smooth and impervious materials, such as Portland cement, concrete, or steel, to prevent or minimize penetration of PCBs. (e) Not located at a site that is below the 100-year flood water elevation.	
(15)	disposal 761.3(h)	Intentionally or accidentally to discard, throw away, or otherwise complete or terminate the useful life of PCBs and PCB items. Disposal includes spills, leaks, and other uncontrolled discharges of PCBs as well as actions related to containing, transporting, destroying, degrading, decontaminating, or confining PCBs and PCB items.	Spill, chemical dechlorination, landfill, incineration
(16)	leak 761.3(m)	Any instance in which a PCB unit (PCB article, PCB container, PCB equipment) has any PCBs on any portion of its external surface.	

	Term	Definition	Examples
(17)	decontamination 761.79(a)(b)	(a) Any PCB container to be decontaminated shall be decontaminated by flushing the internal surfaces three time with a solvent containing less than 50 ppm PCBs. The solubility of PCBs in the solvent should be 5% or more by weight. Each rinse shall use a volume of the normal diluent equal to approximately 10° of the PCB container capacity. The solvent may be reused for decontamination until it contains 50 ppm PCBs. The solvent shall then be disposed of as a PCB in accordance with 761.60(a). Nonliquid PCBs resulting from the decontamination procedures shall be disposed of in accordance with the provisions of 761.60(a)(4). (b) Movable equipment used in storage areas shall be decontaminated by swabbing surfaces that have contacted PCBs with a solvent meeting the criteria of (17)(a).	
(18)	askarel (ASTM D2864-84 [3])	A generic term for a group of synthetic, fire-resistant, chlorinated aromatic hydrocarbons used as electrical insulating liquid. They have a property under arcing conditions such that any gases produced will consist predominantly of noncombustible hydrogen chloride with lesser amounts of combustible gases. Askarel does not necessarily contain PCBs.	
(19)	retrofill	The process of replacing the dielectric liquid in a transformer.	
(20)	hazardous substance (CFR, Title 49, Parts 171, 172, and 173 [8])	A quantity of material offered for transportation in one package or transport vehicle, when the material is not packaged that equals or exceeds the reportable quantity (RQ) specified for the material in CFR, Title 40, Parts 116 and 117 [6].	

*This and similar numbers found in Section 3 refer to the specific section and paragraph within CFR, Title 40, Part 761[7] that is the source of that particular definition.

4. References

The following publications shall be used in conjunction with this standard:

[1] ANSI / ASTM D93-80, Method of Test for Flash Point by Pensky-Martens Closed Tester.[2]

[2] ASTM D2283-86, Specification for Chlorinated Aromatic Hydrocarbons (Askorels) for Transformers.[3]

[3] ASTM D2864-84, Definitions of Terms Relating to Electrical Insulating Liquids and Gases.

[4] ASTM D3278-82, Test Method for Flash Point of Liquids by Setaflash Closed Cup Apparatus.

[5] ASTM D4059-86, Method for Analysis of Polychlorinated Biphenyls in Mineral Insulating Oils by Gas Chromatography.

[6] CFR (Code of Federal Regulations), Title 40, Part 116: Designation of Hazardous Substances; Part 117: Determination of the Reportable Quantities for Hazardous Substances, US Environmental Protection Agency, Washington, DC.[4]

[7] CFR, Title 40, Part 761: Polychlorinated Biphenyls (PCBs) — Manufacturing, Processing, Distribution, and Use Prohibition, US Environmental Protection Agency, Washington, DC.

[8] CFR, Title 49, Parts 171, 172, 173: Hazardous Materials—General Information, Regulations, and Definitions; Tables, Communications, Regulations; General Requirements for Shipments and Packaging; US Department of Transportation, Washington, DC.

[9] CFR, Title 49: Parts 178.80, 178.82, 178.102, 178.115, 178.118 (Shipping Container Specifications), US Department of Transportation, Washington, DC.

[10] Federal Water Pollution Control Act (Clean Water Act) of Feb 1972, Public Law 92-500, amended through Aug 22, 1984, Public Law 98-396, Washington, DC: US Government Printing Office.

[11] Clean Water Act, *Federal Register*, vol 44, no 169, Aug 29, 1979, p 50777.

[12] Marine Protection, Research, and Sanctuaries Act of 1972, Public Law 92-532, Oct 23, 1972, Washington, DC: US Government Printing Office (contained within US Code, Title 33).

[2]ANSI publications are available from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.
[3]ASTM publications are available from Sales Service, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.
[4]US Government publications are available from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

5. Detection and Measurement of PCBs in Mineral Oils

5.1 Sampling.

It is common practice to sample insulating liquids from transformers for periodic maintenance. Sampling from batch accumulators or other containers is also permissible. Samples that may contain PCBs should be taken in such a manner as to avoid any direct personal contact with the fluid, and to avoid any contamination of the environment. Drained liquids should be collected in approved, sealed, and labeled containers[5] and disposed of in a manner approved of by CFR Title 40, Part 761 [6]. The sampling containers used to send samples to the laboratory should be packed according to appropriate regulations (presently, these regulations call for packing the sample containers in absorbing material contained in a sealed plastic bag, which in turn is contained in a cardboard box) and clearly labeled as containing PCBs.

It is the testing laboratory's responsibility to make sure that any tested liquid containing PCBs is disposed of in an approved manner.

5.2 Measurement.

The quantitative determination of PCBs in insulating oil is difficult and requires carefully controlled procedures. Gas chromatography is the analytical method of choice for detection of PCBs in insulating liquids. Although this procedure is the most practical, discriminating between the chlorine compounds in PCBs and similar compounds normally found in mineral oils is difficult.

There are over 200 chlorinated biphenyl compounds. A complete quantitative determination would require the use of a gas chromatograph / mass spectrometer system. However, many electrical grade askarels manufactured in the United States contain blends of PCBs consisting of fairly uniform mass ratios of individual compounds. Commercial PCB askarel products canbe separated by a gas chromatograph into a pattern of peaks. Generally each peak is the result of a number of isomers that were eluted simultaneously. The identity of the commercial compound can be determined by comparing the pattern of its chromatogram to that of known compounds obtained under similar conditions. A quantitative determination of PCBs in an unknown sample can be made by comparing individual peaks in its chromatogram to the corresponding peaks in a chromatogram of a known standard obtained under similar conditions. The amount of PCB in each peak of the standard must be known independently.

ASTM D4059-86 [5] has been found useful and is recommended for the determination of PCBs in insulating oil.[6] This method is based on the use of a gas chromatograph with an electron capture detector and known standard solutions of PCBs[7] in oil. The sensitivity of some electron capture detectors is affected by hydrocarbons, so it is imperative that the ratio of solvent to oil in the unknown samples and in the standards be the same.

This method, with appropriate modifications, has also been used to determine PCBs in water, soils, and other solid materials. In general, the PCBs are extracted with a suitable solvent and compared to known standards in the same solvent.

The precision and lower limit of detectability of the method presented by ASTM D4059-86 [5] for determining PCBs in insulating oil are under study by ASTM Committee D-27.

[5]Under present regulations (as of October 7, 1980) approved containers are specified in CFR, Title 49: 178.80, 178.82, 178.115 [9] and in CFR, Title 40: 761.12(e) [7].

[6]The suitability of the method presented in ASTM D4059-86 [5] has not been established for certain other insulating liquids—for example, silicone fluid.

[7]Aroclor 1242, 1254, and 1260, or their equivalent. (Aroclor is the Monsanto trade name for the polychlorinated biphenyls.) The numbers 42, 54, and 60 indicate the approximate percent by weight of chlorine.

6. Spills and Leaks

In case of spills or leaks of insulating fluid, an attempt should be made to immediately contain the spilled liquid. All spills involving significant[8] amounts of PCB-containing materials should be reported to the Coast Guard National Response Center (telephone: 800-424-8802) and local authorities within 24 h. Spill clean up should begin with 48 h of discovery. All spilled liquid found to contain PCBs, materials used to contain the liquid, and materials used during cleanup of the spill including protective clothing, should be placed in sealed and marked containers approved by CFR, Title 49: 178.80, 178.82, and 178.115 [9] and disposed of in an approved manner (chemical landfills or incineration). Soil saturated with PCB-containing liquid should also be collected and removed. Solid surfaces should be wiped dry using rags, paper towels, etc, and, if needed, cleaned with approved solvents like kerosene, trichloroethane, etc. Protection equipment should be used by personnel cleaning up the spill.

Small leaks should be wiped clean after the cause of the leak has been removed. The surfaces affected should be washed with an approved solvent and wiped dry. Any soil or other contaminated material should be collected, placed in approved marked containers, and disposed of as in the case of spills.

CAUTION — Spills or leaks associated with fires may contain hazardous substances due to the fire. In such cases, additional handling precautions may be required. This guide does not cover such conditions.

7. Labeling and Record Keeping

7.1 Categories of Transformers to be Determined (from CFR, Title 40, Part 761 [7], Preamble II C.1)

7.1.1 PCB Transformers.

PCB transformers are those that contain 500 ppm or greater PCBs. Transformers originally designed to use concentrated PCBs usually have a nameplate indicating that they contain PCB askarel. Such transformers must be assumed to be PCB transformers. Also, a transformer must be assumed to be a PCB transformer if any one of the following conditions exist:

1) There is reason to believe that the transformer was designed to use PCB askarel or was ever filled with such fluid;
2) The transformer’s dielectric fluid has been tested and found to contain 500 ppm or greater PCBs; or
3) The transformer does not have a nameplate or there is no information available to indicate the type of dielectric fluid in it.

7.1.2 PCB-Contaminated Transformers.

PCB-contaminated transformers are those that contain 50 ppm or greater PCBs, but less than 500 ppm PCB. This category includes transformers that were designed to use PCB-free mineral oil dielectric fluids, but now contain from 50 ppm to less than 500 ppm PCBs because of contamination that occurred in manufacturing or servicing. All mineral oil transformers that do not fit Category A above must be assumed to be PCB-contaminated transformers unless tested and found to contain less than 50 ppm PCBs.

[8]Section 311 (Oil and Hazardous Substances Liability), of the Clean Water Act [10] specifies 10 lbs of PCB as the maximum weight that does not have to be reported. However, local regulations may vary from this mount.

7.1.3 Non-PCB Transformers.

Non-PCB transformers are those that contain less than 50 ppm PCBs. No transformer may ever be considered to be a non-PCB transformer unless its dielectric fluid has been tested or otherwise verified to contain less than 50 ppm PCBs.

7.2 Items to be Labeled (from [7]: 761.40(a) through (e)).

It is a legal requirement that each of the following items shall be marked as illustrated in Fig 1 or 2. (PCB capacitors are covered by regulations but not by this guide.)

1) PCB container
2) PCB transformer
3) PCB article containers
4) PCB storage area
5) PCB transport vehicle (containing more than 99.4 lbs of liquid PCB or one or more PCB transformers)

The marking of PCB-contaminated electrical equipment is not required.

7.3 Label (Marking) Format.

The following formats shall be used for marking:

1) Large PCB mark—M_L (see Fig 1)
   (from [7]: 761.45(a)).
2) Small PCB mark—M_S (see Fig 2)
   (from [7]: 761.45(b)).

The mark shown in Fig 2 shall only be used if the item to be marked is too small to accommodate the mark in Fig 1.

7.4 Location of Label (from [7]: 761.40(h)).

All labels required must be placed in a position on the exterior of the PCB item or transport vehicle so that the marks can be easily and safely read by persons inspecting or servicing the marked PCB item or transport vehicle.

7.5 Record Keeping (from [7]: 761.180)

7.5.1 Who Must Comply.

Failure to keep proper records is a violation of the law. Substantial penalty can be imposed for violation of TSCA; each day the violation continues is considered a separate violation. Since July 2, 1978, an inventory must be kept concerning the status of PCB items. The requirements apply to each facility owner or operator who has on his premises one or more PCB transformers or at least 45 kilograms (99.4 lbs) of PCBs, or both.

These records will form the basis for a required annual document prepared by each facility for the previous calendar year. It should have been available on July 1, 1979, and each succeeding July 1, thereafter. For multiplant companies with scattered locations, one record for the entire corporation could be maintained at a central location. The law requires that records are to be maintained in the individual company's own file, subject to request of copies or on-site EPA inspection. At the time of inspection EPA representatives will show appropriate credentials, along with written notice of the facility to be inspected.

7.5.2 What Data Required (from [7]: 761.180(a)(1) to (3))

1) Total number of PCB transformers and total weight in kilograms of any PCB liquids contained in transformer.
2) Location of PCB items.
3) Total weight in kilograms of PCBs and PCB items in containers including identification of container contents such as liquids (total weight means excluding the weight of the containers).
4) The dates when PCBs and PCB items are removed from service, are placed into storage for disposal, and are placed into transport for disposal.
5) The quantities of the PCBs and PCB items shall be recorded. Use nameplate information to determine PCB weight requirements. The weight of PCB can also be determined by calculation, provided the calculations are based on valid assumption. For this purpose, the weight of pure PCB can be assumed to be approximately 12.5 lbs/gal. Known or presumed concentrations can be used to calculate the weight of fluid in oil-filled units contaminated with 500 ppm PCBs or more, using approximately 7.33 lbs/gal as the weight of pure uncontaminated mineral insulating oil. Annual reports must be kept for at least five years after a facility ceases to own or operate PCB-related items in the prescribed quantities.

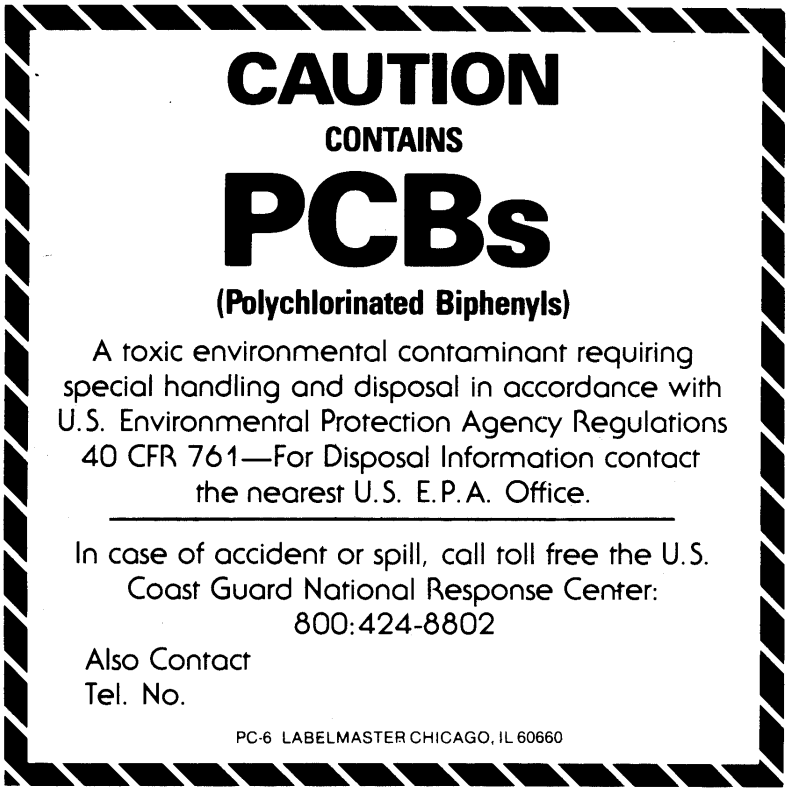

Figure 1— Large PCB Mark—M_L

Figure 2— Small PCB Mark—M_S

7.6 Labeling for Shipment Under Department of Transportation Regulations.

The Department of Transportation (DOT) lists PCB as an ORM-E substance, a material that is an “other regulated material,” not included in any other class. The DOT presently considers PCB as a hazardous material when its reportable quantity (RQ) is equal to or greater than 10 lbs [9]. When 10 lbs or more are shipped, the container must be marked with a label designating “Polychlorinated Biphenyls,” its DOT classification (ORM-E), its DOT identification number (UN 2315), and the letters “RQ” (Reportable Quantity). This label must be displayed with the standard PCB label (see Figs 1 and 2).

Over 10 lbs reportable quantity follows EPA's definition of a reportable spill when near a waterway [11].

The large PCB labels shall have black letters and stripes on a white or yellow background and shall be sufficiently durable to equal or exceed the life (including storage for disposal) of the PCB article, PCB equipment, or PCB container. The size of the mark shall be at least 15.25 cm (6 in) on each side. If the PCB article or PCB equipment is too small to accommodate this size, the mark may be reduced in size proportionately down to a minimum of 5 cm (2 in) on each side (from [7]: 761.45(a)).

The small PCB labels shall have black letters and stripes on a white or yellow background and shall be sufficiently durable to equal or exceed the life (including storage for disposal) of the PCB article, PCB equipment, or PCB container. The mark shall be a rectangle 2.5 by 5 cm (1 in by 2 in). If the PCB article or PCB equipment is too small to accommodate this size, the mark may be reduced in size proportionately down to a minimum of I by 2 cm (0.4 by 0.8 in) (from [7]: 761.45(b)).

8. Transportation

The federal requirements, under TSCA, are limited to the labeling requirements as covered in Section 6 of this guide and in CFR, Title 49: 178.80, 178.82, 178.102, and 178.118 for liquids, and 178.80, 189.82, and 178.115 for solids [9]. There are no federal regulations prohibiting the transporting of PCB or PCB-contaminated electrical equipment for repair or relocation; however, the transport vehicle must be marked. There are regulations covering the equipment and the vehicle for disposal. In many cases, the state and local regulations are more stringent than the federal requirements.

In addition to the above TSCA requirements, the DOT has marking and shipping document requirements based on PCB being classified as a hazardous substance in CFR, Title 40, Part 116 [6], and a reportable quantity (RQ) is established in Part 117 [6] of the same regulation. These DOT requirements are covered in CFR, Title 49, Part 172 [8].

Many states also have specific requirements that regulate the documentation requirements and the common carrier permits for transportation within the state.

The above regulations, with the exception of the labeling requirements, are primarily directed to the disposal activities. Movement of these materials inside of one's own plant has little regulatory guidance.

It is recommended to have a documented spill and cleanup plan before any movement of equipment or liquids takes place. The necessary equipment, such as shovels, rakes, absorbent and adsorbent materials, personal protective equipment, and empty containers, should be available beforehand.

9. Storage for Disposal

PCBs or PCB items stored for disposal must be in an area that meets the following criteria:

1) Adequate roof and walls to prevent rain water from reaching the stored PCBs and PCB items.
2) An adequate floor that has continuous curbing with a minimum 6 in high curb. The floor and curbing must provide a containment volume equal to at least two tunes the internal volume of the largest PCB article or PCB container stored therein or 25% of the total internal volume of all PCB articles or PCB containers stored therein, whichever is greater.
3) No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area.
4) Floors and curbing constructed of continuous smooth and impervious materials, such as Portland cement, concrete, or steel, to prevent or minimize penetration of PCBs.
5) Not located at a site that is below the 100-year flood water elevation.

10. Disposal

The methods of disposal of a transformer or insulating liquid, or both, is dependent upon its EPA classification. These fall into three general categories:

1) Nondetectable to less than 50 ppm PCBs (referred to as non-PCB transformers)
2) 50 ppm to less than 500 ppm PCBs (referred to as PCB-contaminated transformers)
3) 500 ppm and greater PCBs (referred to as PCB transformers)

10.1 Non-PCB Transformer Disposal

The first category, less than 50 ppm PCBs, is presently regulated by both federal and state regulations. However, the only restrictions placed on this classification is the prohibition by TSCA of the use of waste oil containing any detectable concentration of PCB as a sealant, coating, or dust control agent. Other regulations administered by EPA, such as the Clean Water Act [10] and the Marine Protection, Research, and Sanctuaries Act [12], can be used to regulate low concentrations of PCBs. State regulations may also place more stringent requirements on this category. Fluid from this category of electrical equipment may also be reused in other equipment. Since all untested or unidentified transformers are assumed to be “contaminated” by EPA definition (CFR, Title 40, Part 761 [7]), a test for the presence of PCBs is necessary to establish the proper classification. After removal from service, the drained or undrained transformer can be disposed of in a routine manner.

10.2 PCB-Contaminated Transformer Disposal.

The second category, 50 ppm to less than 500 ppm PCBs, is also presently regulated by both federal and state authorities. At this time a number of state regulations are more restrictive than the federal regulations.

10.2.1

Fluid from the second category of electrical equipment can be disposed of by incineration in a high-efficiency boiler (see CFR, Title 40: 761.60(a)(2)(iii) [7]) that has been judged by EPA to be equal to the 99.9% efficient as specified in the regulations (see CFR, Title 40: 761.60(e) [7]). A number of chemical reclamation processes, approved by EPA for PCB removal, are currently available to reduce transformer oils from the 50-500 ppm concentrations to less than 2 ppm. Some of these chemical PCB removal processes are capable of producing liquids that may be suitable for use as reclaimed oil. In some cases, this chemical PCB removal process of the oil allows the reclassification of some PCB transformers to a contaminated or non-PCB classification. Depending on the chemical process used, the residual by-product may or may not require special disposal.

10.2.2

Other alternatives for disposal of fluids in the less than 500 ppm range are:

1) *Incineration in an Annex I Incinerator*. Details of this incinerator can be found in CFR, Title 40:761.40 [7].
2) *Chemical Waste Landfill*. Details of this type of landfill can be found in CFR, Title 40: 761.4117]. Locations and details of approved sites are available from any EPA regional office. The major restriction on burial in a chemical waste landfill is that the material to be buried is not an ignitable waste. Essentially this limitation relates to flash points less than 80 °C (140 °F) as determined by ASTM D93-80 [1] or by ASTM D3278-82 [4] or equivalent. The fluid should also be stabilized to reduce its liquid content or increase its solid content so that a non flowing consistency is achieved to eliminate the presence of free liquids prior to final disposal in a landfill. It should be noted that while most insulating liquids are not ignitable as described above, many fluids that are used for flushing of PCB transformers may prove to be ignitable. Chemical waste landfills come under state regulations, and liquid burial that conforms to the above EPA requirements may not be permitted.

10.2.3

While the fluid drained from a PCB-contaminated transformer is regulated, the tank, core, and coil assembly can be disposed of in the same manner as a non-PCB tank, core, and coil assembly after draining all free-flowing liquids from the transformer.

10.3 PCB Transformer Disposal

The third category, 500 ppm or greater PCB, is strictly regulated. Both the fluids, as well as the core and coils of a drained and flushed unit, must be disposed of per the regulations.

All PCB askarel transformers fall into this category and a number of oil-filled units have also been found to contain 500 or greater ppm PCBs and must be treated in the same manner as an askarel unit unless steps are taken to reduce the PCB concentration to less than 500 ppm range or lower.

Present regulations require that the dielectric fluids drained from this class equipment and the required flushing fluids be disposed of by incineration in an approved incinerator (referred to earlier) or a PCB removal process approved by CFR, Title 40, Part 761 [7]. A number of chemical reclamation processes are commercially available but from a practical standpoint are limited to concentration of approximately 10 000 ppm PCBs, and lower, in oil. Other filtration processes are commercially available for use with other contaminated fluids. Presently, at least three EPA-approved Annex I incinerators are in operation within the United States; at least one seagoing unit is operational. EPA regional offices can furnish up-to-date information as to the locations of these types of facilities.

After draining a PCB transformer, it must be flushed before disposal in a chemical waste landfill approved by CFR, Title 40, Part 761 [7]. The flushing procedure consists of draining all free-flowing liquid, filling with solvent, allowing to stand for at least 18 h and then draining thoroughly. Solvents may include kerosene, xylene, toluene, and other solvents in which PCBs are soluble.

Figures 3 and 4 show handling and disposal options for PCB-contaminated transformer fluids and for PCB transformer fluids, respectively.

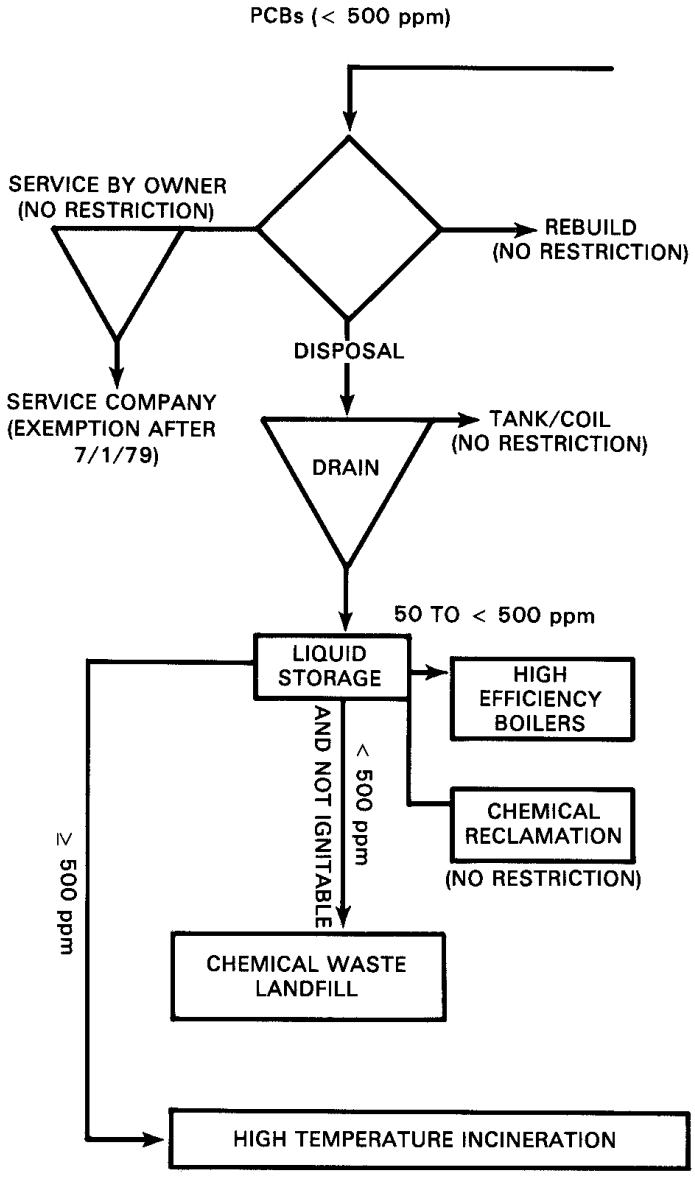

Figure 3— Handling and Disposal of PCB-Contaminated Transformer Fluids

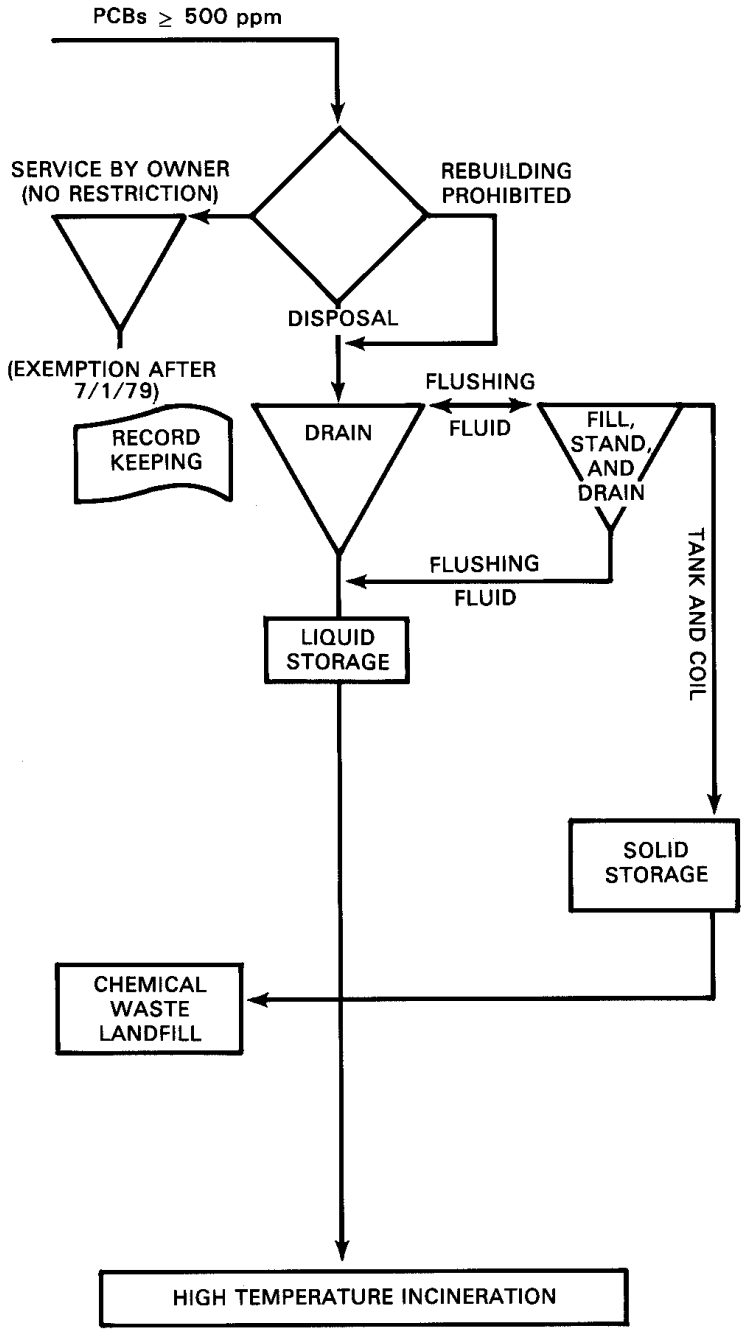

Figure 4— Handling and Disposal of PCB Transformer Fluids

11. Personnel Protection

11.1 PCBs in Oil.

Trace amounts of PCB are known to be in some dielectric mineral oil filled equipment. The levels encountered will not pose a health hazard when normal personal hygiene practices and proper precautions, normally accepted for insulating oil handling activities, are observed.

11.2 Askarel (PCB).

Commercial-grade PCB fluids, as utilized in electrical equipment, can be handled safely with strict observance of personal hygiene practices and with the use, where necessary, of proper protective equipment.

11.3 Personal Hygiene and Protective Equipment.

Whenever personnel must come in direct contact with PCB fluids, the following work practices are desirable:

1) To prevent skin contact with PCBs, personnel should be required to wear and use PCB-resistant protective clothing and equipment.
2) Upon leaving the area, personnel should be required to remove such protective clothing and equipment and place it in impervious containers pending either decontamination or disposal.