CCME

Canadian Council of Ministers of the Environment
Le Conseil canadien des ministres de l'environnement

Guidelines for the Management of Wastes Containing Polychlorinated Biphenyls (PCBs)

CCME-TS/WM-TRE008
Manual EPS 9/HA/1 (revised)
September 1989

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GUIDELINES FOR THE MANAGEMENT OF WASTES CONTAINING POLYCHLORINATED BIPHENYLS (PCBs)

Industrial Programs Branch
Environmental Protection
Conservation and Protection
Environment Canada

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Ce rapport est aussi disponible en français sous le titre "Guide pour la gestion des déchets contenant des biphényles polychlorés (BPC)", à l'adresse ci-dessous.

For additional copies of this report, please contact your provincial environment ministry or write to:

CCME Secretariat
4905 Dufferin Street
Downsview, Ontario
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PREFACE

The primary purpose of this manual is to recommend environmentally sound practices for the management of wastes containing polychlorinated biphenyls (PCBs). Procedures for decommissioning and decontamination, storage, transportation, disposal, labelling and recordkeeping, and emergency preparedness for PCB-contaminated equipment and containers, as well as for solid and liquid wastes are covered.

Regulations governing generation, storage, transportation and disposal of PCB wastes and emergency response planning are generally administered by the provinces for wastes containing PCBs that are managed within the provinces. The user of this manual is advised to contact the relevant provincial authority having jurisdiction and comply with the applicable provincial regulations.

For inter-provincial shipments of wastes containing PCBs, the appropriate provincial and federal transportation regulations shall apply.

PRÉFACE

Le guide a pour but principal de recommander des méthodes écologiques de gestion des déchets contenant des biphényles polychlorés (BPC). Il traite des procédures à suivre pour la mise hors service, la décontamination, le stockage, le transport, l'élimination, l'étiquetage, la tenue de registres et de plans de mesure d'urgence, dans le cas des équipements et des contenants contaminés par les BPC ainsi que des déchets contaminés solides et liquides.

Les règlements portant sur la production, le stockage, le transport et l'élimination des déchets contenant des BPC de même que sur la planification des interventions d'urgence sont en général appliqués par les provinces de qui la gestion de ces déchets relève. L'utilisateur du guide devra communiquer avec l'autorité provinciale compétente et se conformer aux règlements provinciaux applicables.

Dans le cas des envois interprovinciaux de déchets contenant des BPC, les règlements provinciaux et fédéraux portant sur leur transport s'appliquent.

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Many people were involved in the development of this manual, which is based on a report prepared for Environment Canada by M.M. Dillon Limited. The project was supervised by an Environment Canada committee consisting of A. Burgess, H. Dibbs, and J. Armstrong. Significant contributions were provided by members of the Waste Committee of the Canadian Council of Ministers of the Environment (CCME) as well as by Environment Canada's headquarters staff and by staff in Environment Canada's regional offices. In addition, comments and suggestions from the Occupational Safety and Health Branch of Labour Canada, and from the Environmental Health Directorate of Health and Welfare Canada were incorporated in the manual.

Special acknowledgements are also due to electric utility companies and industrial associations for reviewing drafts of this manual and providing comments, recommendations, and background information.

This report is a revised edition of the Environment Canada report EPS 9/HA/1. It provides a general updating of the manual as well as specific recommendations of the CCME Waste Committee and the major requirements of Environment Canada's Storage of PCB Waste Interim Order.

1 INTRODUCTION

1.1 Purpose

The purpose of this manual is to recommend environmentally sound practices for the management of wastes containing polychlorinated biphenyls (PCBs). It is intended for the guidance of PCB waste generators in the industrial and commercial sectors and the federal government and for provincial authorities in developing their own guidelines and regulations. With the exception of the specific federal responsibilities described in the following section (1.2), the management of hazardous wastes, including PCBs, falls mainly under provincial jurisdictions. Where provinces have regulations pertaining to the management of PCBs, the users of this manual must obtain copies of such regulations from the appropriate authority.

This manual is not intended to address all aspects of PCB waste management but rather to provide basic recommendations and practices (particularly for those wastes containing more than 50 ppm of PCBs) in order to promote good management of PCB wastes in a consistent manner across Canada.

To a large extent, the effectiveness of the regulations under the *Canadian Environmental Protection Act* (CEPA) restricting the use of PCBs depends on the adoption and implementation of effective PCB waste management practices. To assist in developing these practices and in response to a request for coordination from the provincial environment departments, Environment Canada undertook to develop this manual. The manual deals with solid and liquid PCB wastes and addresses the decommissioning, storage, transportation and disposal of PCB-contaminated equipment and containers, the labelling of PCB wastes for record keeping at storage and disposal facilities, and emergency procedures for spills or fires involving PCBs.

1.2 Federal Legislative Mandate

The federal government has responsibility for wastes within federal facilities and has specific responsibilities for the management of PCBs in accordance with the mandate prescribed by the following federal legislation:

- *Canadian Environmental Protection Act*;
- *Fisheries Act*;
- *Ocean Dumping Control Act*; and
- *Transportation of Dangerous Goods Act*.

The adoption of the *Canadian Environmental Protection Act* by the federal government on June 28, 1988, gives the federal government the legislative power to protect human health and the environment from the risks associated with the use of toxic substances. The *Act* establishes a comprehensive system for managing toxic chemicals throughout their life cycle, from development to production, transport, use, storage and disposal.

Under the *Act*, where the Minister believes that: 1). a substance is not adequately regulated; and 2). immediate action is required to deal with a significant danger to the environment or to human life or health; the Minister may make an interim order in respect of the substance and the order may contain any provision that may be contained in a regulation under the *Act*.

Under the *Act*, two Interim Orders have been made respecting the management of PCBs:

1) The Interim Order Respecting the Storage of Wastes Containing PCBs (September 16, 1988) (19). The requirements of this Order along with amendments dated February 20, 1989, (20) have been reflected in this manual.

2) Interim Order Respecting Chlorobiphenyls (February 20, 1989) (21). This Order includes all the requirements of the original regulations Nos. 1, 2, 3 under the *Environmental Contaminants Act* with some modifications. This Order is in the process of being replaced by a regulation under CEPA.

The main PCB manufacture, process, use, offer for sale as import restrictions covered by in the Interim Order Respecting Chlorobiphenyls are:

Prohibition

- prohibits the use of PCBs in the operation of any product, machinery or equipment, other than electrical transformers and capacitors that existed in Canada before July 1, 1980; heat transfer equipment, hydraulic equipment, electromagnets and vapour diffusion pumps that were designed to use PCBs and were in use in Canada before September 1, 1977; and machinery or equipment for the destruction of PCBs. It prohibits the importation or manufacture of any product, machinery or equipment containing PCBs as a constituent; the use of PCBs in the servicing or maintenance of any product, machinery or equipment other than electromagnets and electrical transformers and associated electrical equipment; and the use of PCBs as new filling or as make-up fluid in electromagnets and electrical transformers and associated electrical equipment.

Concentration in Products

- the concentration of PCBs that may be contained in any liquid in products, machinery or equipment referred to under "Prohibition" that are manufactured,

imported or offered for sale in Canada shall not exceed 50 parts per million by weight of the liquid. This concentration limit does not apply where a product is: offered for sale as a necessary and integral part of a building, plant or structure; imported for the destruction of the PCBs contained in that product; or offered for sale for destruction or storage awaiting destruction of the PCBs contained in that product.

Concentrations or Quantities that may be Released

- the concentration of PCBs in any liquid that may be released into the environment, except where subsection 36(3) of the *Fisheries Act* applies, in the course of a commercial, manufacturing or processing activity shall not exceed 50 parts per million, except in an application to a road surface where the maximum concentration is 5 parts per million.

- the quantity of PCBs that may be released in the course of the operation, servicing, maintenance, decommissioning, transporting or storage of any of the products, machinery or equipment referred to under "Prohibition" or any receptacle or material containing the prescribed products, machinery or equipment shall not exceed one gram per day.

For a more detailed description of this Interim Order see Appendix A or contact the Commercial Chemicals Branch of Environment Canada (see Appendix F).

The *Fisheries Act*, Subsection 36(3) prohibits the deposition of deleterious substances into waters frequented by fish except as may be permitted by regulations. This *Act* applies to waters frequented by fish or waters leading to fish-frequented waters and takes precedence over Section 5 of the Interim Order Respecting Chlorobiphenyls.

Although the *Ocean Dumping Control Act* was repealed in June 1988 regulations under the *Act* still govern the disposal of PCBs at sea, including incineration, through permits and regulations which specify environmental operating requirements. These regulations are currently being rolled over to come under the jurisdiction of the *Canadian Environmental Protection Act*.

Regulations under the *Transportation of Dangerous Goods Act* (TDGA) govern the transportation of equipment and wastes containing PCBs. In this manual, these regulations are referred to as the Transportation of Dangerous Goods (TDG) Regulations.

1.3 PCB Waste Definition

For the purpose of this report, PCB wastes are defined as any PCB liquid, PCB solid, or PCB equipment that have been taken out of service for the purpose of disposal. Only those wastes containing greater than 50 ppm PCBs are addressed (with the exception of the few instances where current federal or provincial regulations specify lower permissible concentrations).

This limit of 50 ppm does not mean that wastes with lower PCB concentrations may not in some instances be of concern, for example, wastes released to an environmentally-sensitive area. It is recommended that provincial authorities be contacted for advice on disposal of wastes in this category on a case-by-case basis.

The following specific definitions are pertinent:

PCBs — Chlorobiphenyls that have the molecular formula $C_{12}H_{10-n}Cl_n$, where n is greater than 2. (In Ontario, the definition includes all chlorobiphenyls, $n \geq 1$. All other provinces adhere to the federal definition).

Askarel — A generic name for synthetic electrical insulating dielectric materials which, when decomposed by an electric arc, evolve only non-explosive gases or gaseous mixtures. Mixtures containing PCBs and chlorinated benzenes (primarily tri- and tetrachlorobenzene) are the most common examples of askarels. For the purpose of this manual "askarel" means mixtures containing PCBs in excess of 30% by weight.

PCB waste — Any PCB liquid, PCB solids, or PCB equipment that have been taken out of service for the purpose of disposal.

PCB equipment — Any manufactured item, other than PCB packaging, which contains PCB liquids or PCB solids and whose surfaces have been in direct contact with PCBs. Examples of PCB equipment include transformers, capacitors, heat transfer systems, vapour diffusion pumps, electromagnets and hydraulic systems.

PCB-contaminated Oil — Oil containing PCBs in any concentration (e.g., transformer mineral oil contaminated with PCBs).

PCB liquid — Any liquid containing more than 50 ppm by weight of PCBs.

PCB packaging — Any receptacle or enveloping material used to contain or protect PCB wastes.

PCB solid — Any material or substance other than a PCB liquid that contains or is contaminated with PCBs at a concentration greater than 50 ppm by weight of PCBs.

Descriptions of common types of PCB wastes are provided in Appendix B. A list of procedures for the analysis of PCBs in various matrices is given in Analytical Chemistry of PCBs by Mitchell D. Erikson, Butterworth Publishers, 1986. For lists of commercial laboratories capable of analyzing PCBs in various matrices contact federal or provincial environment offices see Appendix F. Environment Canada gives detailed information on chemical and physical properties, fire properties, human health, and environmental toxicities (4).

1.4 Availability of Storage and Destruction Facilities

At present, in Canada, with the exception of the Senneterre facility in Quebec, there are no commercial storage facilities for any type of PCB waste; the only storage option available for the owners of such waste is secure storage at the owner's site. Similarly, with the exception of the Swan Hills incinerator facility, the only PCB destruction processes available in Canada are chemical processes for the decontamination of low-level PCB-contaminated oil. A number of these processes have been licensed by and are being used in several provinces. Development of PCB destruction facilities (high-temperature incineration) similar to that at Swan Hills and capable of destroying all types of PCB wastes is actively underway in other provinces.

The Swan Hills incinerator facility is licensed for the high-temperature destruction of all types and concentrations of PCB wastes and is actively destroying such wastes. The use of mobile high-temperature destruction units are being planned by the federal government as well as by some provinces. Under certain circumstances, PCB wastes can be exported for disposal.

2 DECOMMISSIONING AND DECONTAMINATION

When PCB equipment becomes redundant, fails or is retrofilled, it must be carefully removed from service (decommissioned). Part of this process will be the draining and/or decontamination of the equipment to ensure that the equipment and the PCB liquids are safely stored, transported, or disposed of in an environmentally acceptable manner.

2.1 Decommissioning

2.1.1 Purpose of Decommissioning. PCB equipment may be removed from service for a number of reasons, including:

- transfer for re-installation at another location;
- transfer to safe storage;
- retrofilling for re-use (primarily equipment with low-level PCB contamination); and
- disposal.

Depending on the degree of contamination, size of equipment, transportation regulations, and disposal methods, draining and/or decontamination can take place at the point of removal from service, at some other location prior to transportation, or at the disposal site. Similarly, retrofilling could be accomplished with the equipment remaining in place, or at another location.

2.1.2 Notification and Approval. Notification and approval procedures required by provincial authorities should be followed when decommissioning involves generation of PCB wastes. Regulatory requirements for the handling, storage, and disposal of PCB equipment vary from province to province and it is therefore necessary to become thoroughly acquainted with all applicable provincial regulations prior to decommissioning of equipment. A brief summary of provincial regulations applicable to PCB waste management is given in Appendix E. It is also necessary to comply with the federal Interim Order Respecting Chlorobiphenyls during decommissioning, handling and storage procedures.

When transport of PCB-containing equipment or wastes away from the site is intended, the appropriate provincial and/or federal regulations relating to the transportation of dangerous goods and/or hazardous wastes must be observed. The requirements of these regulations are described in Chapter 5 of this report.

2.1.3 Planning and Mobilization. After reviewing all requirements, the next tasks are the preparation of a detailed plan of action and the mobilization of the necessary human and material resources to implement the plan in a safe and efficient manner.

All persons assigned to handle PCB equipment should be thoroughly instructed in the proposed procedures, particularly with respect to safety precautions, the use of safety equipment and the applicability of federal and provincial regulations.

The area where decommissioning will take place must be carefully examined with respect to containment of potential PCB spills, ventilation and working space available. All necessary safeguards should be taken to prevent the escape of PCB waste to adjacent areas.

The type and condition of the PCB equipment and the volume of PCB liquid involved in each case will dictate the extent of precautionary measures to be taken to ensure containment of PCB spills and to facilitate cleanup operations. The willful release to the environment of PCBs from any one piece of equipment during maintenance, decommissioning, or storage must be limited to one gram per day [3].

Where transformers are located in separate equipment rooms or vaults the Canadian Electrical Code requires that the rooms be equipped with either a gravity or a forced air ventilation system having direct exhaust to, and air intake from, the outside. These rooms should also have ample ventilation and holding capacity in accordance with design criteria given in Sections 3.3.1 and 3.3.2. Before proceeding with the decommissioning of equipment, the performance of the ventilation system (for enclosed areas) and the integrity of the liquid containment system should be checked and any deficiencies rectified.

Transformers, capacitors or other PCB equipment located in open manufacturing areas, or other locations with uncontrolled access, present additional problems. Suitable curbs, barriers and/or metal pans should be provided to prevent the escape of PCBs in case of spills during handling operations. Also, floor drains should be plugged and air ducts leading to other parts of the building should be closed.

The extent of other preparatory work depends on the condition of the equipment involved. Prior to movement, liquids should be removed from equipment where cracks or leaks are apparent. Any leaked fluid should be cleaned up immediately using the sorbent materials listed in Chapter 7.

The area of work should be appropriately identified and unauthorized persons prohibited from entering the area.

2.1.4 Protective Clothing and Apparatus. Routine precautions should be observed while handling liquids containing PCBs. The protective clothing to be worn will vary with individual circumstances, such as concentration, quantity of PCBs and whether in solid or liquid form. Where workers may come in direct contact with askarel, protective clothing impervious to PCBs should be worn. Gloves, boots, disposable coveralls, bib-type aprons, and eye protection (face shields or chemical safety goggles) should be worn as necessary. Materials used to protect against dermal exposure to PCBs are compared in Table 1.

TABLE 1 MATERIALS USED FOR PROTECTION FROM DERMAL EXPOSURE TO UNDILUTED PCBs [5]

Highly Recommended (provides protection for over one hour)	Recommended (provides protection for one hour)	Limited use or Not Recommended (provides protection for less than one hour)
Butyl Rubber		
Neoprene	Chlorinated Polyethylene	Styrene Butadiene Rubber
Nitrile Rubber		Natural Rubber
Polyvinyl Alcohol		
Viton		
Saranex		
Teflon		

Where PCBs are in closed containers such as capacitors, transformers, tanks or drums, or are entrapped in solid substances or equipment, and there is no direct contact with PCBs, special clothing and apparatus may not be necessary, e.g., if a lift-truck operator is moving a drum or a palleted piece of PCB equipment.

As a general rule, the handling of hot liquids should be avoided. If the temperature of the liquid is above 55°C, a full-face, self-contained breathing apparatus should be worn for other than brief periods of exposure.

Federal and provincial regulations pertaining to the wearing of protective clothing and equipment must be observed at all times. For additional guidance on personnel protection refer to references 4, 5, and 6.

2.1.5 Decommissioning Procedures. Electrical equipment to be decommissioned should first be disconnected from the power supply by qualified personnel.

Record keeping: Before removal of any decommissioned equipment, a complete record of the equipment should be made, including nameplate data, serial numbers, dates of decommissioning and shipment, destination of equipment, and names of decommissioning personnel, as well as the Environment Canada label identification number, where applicable.

Capacitors: Sealed capacitors should be placed into 205-L, No. 18-gauge steel drums fitted with removable steel lids and gaskets made of PCB-resistant material, such as nitrile rubber, cork, or Teflon. Other leakproof containers providing protection equivalent to that of steel drums and meeting Transportation of Dangerous Goods Regulations and provincial requirements may be used for storing or transporting capacitors. Capacitors should be stored with the terminals up to prevent leakage from the capacitor bushings. As many capacitors as space allows may be placed in each drum. Drums or containers smaller than 205-L may be used when the size or quantity of capacitors does not justify the larger container.

Leaking capacitors should be drained, then placed in individual heavy duty polyethylene bags before storing in drums. These drums should be packed with sorbent material to absorb PCBs which may escape from the bags.

Drums should be sealed and labelled as described in Chapter 4. They are now ready for storage or transportation.

Non-leaking capacitors that are too large to fit into a 205-L drum should be wrapped in heavy gauge polyethylene and crated for transfer to the storage area. Leaking capacitors should be drained and stored over drip pans containing sufficient absorbent to absorb any remaining liquid. The requirements for off-site transportation are described in Chapter 5.

Transformers: Small transformers may be stored or transported in leakproof containers, without draining, in a manner similar to that for capacitors.

For on-site storage, transformers need not be drained providing they are structurally sound and all cooling tubes, valves and gauges are sealed and protected from damage and the weather, and spill containment is provided as described in Chapter 3.

Where large askarel transformers are being stored pending transportation or disposal, the askarel should be removed and stored in double-bung No. 16-gauge steel

drums. The requirements for transportation of PCB transformers are described in Chapter 5.

Polychlorinated biphenyl liquids may be stored in tanks rather than drums providing the tanks are above ground and are sound, properly labelled, regularly inspected, protected from the weather, and spill containment is provided.

Wherever possible, PCB liquids should be transferred by pumping, rather than pouring, to minimize splashing and spillage. Centrifugal-type pumps, having all wetted surfaces made of stainless steel, should be used. The shaft seal should be an external carbon ring type to eliminate exposure of the packing material to the deteriorating effects of PCBs. Valves should be brass or stainless-steel lined. Hoses should be flexible metal or lined with tetrafluoroethylene or silicone polymers, and drip trays should be placed under all pumps, valves and hose couplings.

Other equipment: PCB equipment such as hydraulic equipment, electromagnets, vapour diffusion pumps and heat transfer equipment should be removed from service only by qualified personnel. Care must be taken to prevent loss of liquid during this operation.

Pending ultimate disposal, the drained equipment should be put into storage in drums or wrapped in polyethelene, similar to the procedure for capacitors. Alternatively, the equipment could be appropriately decontaminated for re-use or metal recovery. Transportation requirements are described in Chapter 5.

2.1.6 Site Cleanup. Equipment removal should be followed by a thorough cleanup of the site. In general, the cleanup will include:

- absorbing spills (see Chapter 7 for procedures and applicable sorbents);
- wiping the affected area with solvents and rags; and
- placing all contaminated materials in steel drums for disposal.

Tools, pumps and equipment used in decommissioning and site cleanup should be dedicated to the handling of PCBs and labelled as such and thoroughly decontaminated at the completion of each cleanup project.

2.2 Decontamination

Decontamination is a process whereby PCBs are removed from equipment, mineral oil or other materials. Equipment (such as a transformer) is usually decontaminated to meet provincial requirements for disposal in an environmentally safe manner, or to allow it to be used or sold as a non-PCB unit. Decontaminated equipment and mineral

oil may be recycled, sold or disposed of. Polychlorinated biphenyl handling equipment, such as containers, pumps, hoses, is decontaminated so that it can be re-used for handling other materials, or disposed of.

2.2.1 Decontamination by Solvent Extraction.

Equipment: Decontamination procedures vary considerably depending upon the degree of contamination of the equipment and the purpose for which it is being decontaminated, e.g., for a given end purpose, equipment containing askarels will require more sophisticated procedures than equipment containing contaminated mineral oil.

Askarel equipment: Although scrapping for metal recovery is considered the most environmentally acceptable method of disposing of electrical equipment, the technologies available for decontamination of askarel equipment, other than high-temperature incineration, are still uncertain as to overall effectiveness and cost. Several commercial methods are offered in Canada; however, their use has been limited and their application to specific decontamination projects must be decided on a case-by-case approach. Potential users must consider such parameters as degree of decontamination; type and size of electrical equipment; energized or de-energized operation required; and equipment to be scrapped or re-used (cost of equipment replacement versus cost of decontamination).

An appraisal of commercial and near-commercial PCB treatment/destruction facilities is provided in an Ontario Research Foundation consultant's report The Evaluation of Mobile and Stationary Facilities for the Destruction of PCBs (7).

The most widely used technology, in Europe and the U.S.A., for the destruction of askarel liquids or askarel-contaminated wastes is that of high-temperature incineration. In Canada, the only high-temperature incinerator approved for the destruction of PCB wastes is located at Swan Hills, Alberta. Others are in the planning stage in several provinces.

For non-electrical askarel-filled equipment, decontamination by triple rinsing is considered suitable for metal recovery.

Contaminated mineral oil equipment: After draining, equipment (including transformers) that contained mineral oil contaminated with PCBs in concentrations less than 500 ppm may be refilled with clean oil for reuse. Scrapping for metal recovery is considered acceptable where all free liquid is removed from the hulk by an approved method. The metal recovery operation must meet all appropriate federal and provincial

health and environmental regulations. The drained oil must be treated as a PCB liquid waste; however, through chemical processes (see Section 6), the oil can usually be decontaminated and disposed of through licensed waste handlers or recyclers.

Containers: Askarel-contaminated containers, such as drums or tanks, should be decontaminated by triple rinsing with an appropriate solvent (see Chapter 7). The container should be filled with enough solvent to coat the sides of the container when it is tipped and rotated. A solvent volume of approximately 10% of the total container volume has been found to be a useful amount for this rinsing procedure, but a smaller volume may be sufficient as long as there is enough solvent to coat all surfaces of the container. The bottom and sides of the container should be thoroughly rinsed with the solvent and then drained. When containers are too large, or of a design that cannot be tipped and rotated, a method equivalent to rinsing should be used, e.g., the use of a mop or a pressure nozzle.

Containers that held PCB-contaminated mineral oil or solvent should be rinsed in a manner appropriate to the degree of contamination and the intended use of the empty container or to the disposal method.

Solvent Disposal: Solvents used for PCB decontamination should be disposed of as PCB waste when they contain more than 50 ppm (by weight) of PCBs. If, however, several PCB articles are being decontaminated, it is acceptable to use rinse solvent contaminated with greater than 50 ppm PCB as the first rinse where this will reduce the amount of PCB-contaminated liquid ultimately produced (i.e., when the article being rinsed is more highly contaminated).

2.2.2 Retrofilling. Retrofilling involves the removal of PCBs from a piece of equipment followed by their replacement with an alternative non-PCB fluid [8]. The purpose of this process is to permit the reclassification by the appropriate authorities of the piece of equipment as a non-PCB unit either for safety reasons, such as when the equipment is located in a food processing plant, or for sale [2].

Retrofill procedures: All retrofill procedures involve similar techniques regardless of the equipment that is being retrofilled. The equipment is drained, decontaminated and refilled with an appropriate replacement fluid. The amount of decontamination and chemical analysis required will vary with the type of equipment, the degree of contamination and, the purpose of decontamination.

PCB-contaminated mineral oil equipment: This equipment (including transformers) can usually be decontaminated to the required level simply by replacement of the

oil. Where the mineral oil is highly contaminated, e.g., where a transformer oil contains PCBs in concentrations above 500 ppm, two or more changes (or rinsings) may be required to reduce the level of contamination to below 50 ppm. When transformers are refilled it will be necessary to operate for several weeks to establish equilibrium before draining a second time.

Another method of decontamination that is being increasingly used is an "in situ" process where the decontamination unit is connected directly to the transformer, which may be energized or de-energized, and the oil is continuously recycled through the unit until the PCB concentration of the oil has been reduced to acceptable limits.

Askarel equipment (other than electrical): Triple rinsing, prior to retrofilling with a non-PCB fluid, is recommended for this type of equipment.

Askarel electrical equipment: Retrofilling of askarel transformers is a sophisticated procedure and should only be done by trained personnel. The success of retrofilling such transformers is highly dependent on the internal design of the transformer case and core, the electrical operating conditions, and the experience of personnel carrying out the procedure. Although very little data are available on the success of retrofilling askarel transformers, several companies in Canada and the U.S. have guaranteed that it can be done to required standards. It should be noted that, after retrofilling, the power ratings of transformers usually have to be downgraded due to the lower heat transmission characteristics of the replacement fluid (Table 2). In some cases, due to the complexity of a transformer's configuration, it may not be technically or economically feasible to remove PCBs to a level below the 50 ppm [9].

TABLE 2 PROPERTIES AND COSTS OF REPLACEMENT FLUIDS FOR PCBs

Properties	PCB Replacement Fluid				
	Silicone Fluid	Aliphatic Hydrocarbons	Chlorinated Benzenes	Poly-α -olefins	SF_6*
Minimum dielectric strength (kV)	35	44	32	40	2.4 (relative to nitrogen = 1)
Thermal conductivity (W/(m • °C) @25°C)	15.1 x 10^{-2}	13 to 13.4 x 10^{-2}	6.7 x 10^{-2}		14 x 10^{-2}
Specific heat (kJ/(kg • °C) @25°C)	1.53	1.93	1.59	2.09	0.67
Viscosity (cm^2/s) at:					
-40°C	3.0				
-17.8°C	1.50			83.0	0.305
20°C			0.034		
25°C	0.50	3.5	0.025		
50°C		0.85			
100°C	0.16	0.15	0.008	0.13	
150°C	0.1				
Pour point (°C)	-55	-30	-30	-48	
Specific gravity at					
15.6°C				0.86	
20°C			1.39		5
25°C	0.960	0.877			
Thermal coefficient of expansion ($cm^3/cm^3/°C$)	10.4 x 10^{-4}	7.5 to 8.5 x 10^{-4}	8 x 10^{-4}	4 x 10^{-4}	-
Fire point (°C)	365	310 to 312	none to 210°C(b.p.)	315 to 321	-
Rate of heat release (kW/m^2)					
- convective	53 to 66	538 to 546	370	564	-
- radiant	25 to 26	361 to 441	238	414	
Cost ($/L, July, 1985)	7.23	4.70	3.12	4.46	-

* Sulphur hexafluoride (in the form of liquefied gas).

3 STORAGE

Since there are currently only limited PCB disposal facilities in Canada, storage of PCB wastes is usually the only alternative. The siting, construction, and operation of a PCB storage facility should comply with all federal and provincial environmental, occupational health and safety requirements, as well as with any applicable municipal by-laws and codes. Storage sites may require permits from appropriate provincial authorities.

Transfer of PCB equipment or waste to secure storage should take place as soon as possible after equipment is removed from service or a PCB waste is generated. Between the time of generation of the waste and its placement in storage, all due care should be taken to prevent accidental release of PCBs. In the case of PCB equipment, security during interim storage should at least be equivalent to that provided while the equipment was in service.

Polychlorinated biphenyl storage facilities may be built in various sizes. Regardless of size, the same basic concerns should be addressed whether the facility will house a single out-of-service PCB transformer on existing premises or whether it will be a commercially operated facility storing thousands of kilograms of PCBs. In any case, precautions should be taken to minimize the risk of accidental release of PCBs, and contingency measures, such as spill containment, fire control, and emergency response training for personnel, all appropriate to the degree of hazard, should be in place to deal effectively with an emergency should it occur.

In the design of storage facilities, consideration should be given to the quantity and type of PCB equipment or waste to be stored and the frequency of its receipt or transfer. Facilities designed to store only solids, such as empty transformers, do not require as elaborate spill containment as those storing PCB liquids because there is less possibility of PCB leakage. Good judgement, based on individual needs and type and degree of hazard presented, should always be exercised in siting, choosing materials of construction, designing and operating storage facilities. Provincial and federal authorities will provide advice and council when planning PCB waste storage facilities.

3.1 Siting

A PCB storage facility should be located close to the point of generation of the PCB waste. This is to minimize the distance the PCB waste is transported and thereby decrease the risk associated with transportation. It is realized that this is not

always practical for owners of many PCB-containing units spread over a large area. These owners, such as utilities, may prefer centralized storage facilities.

In all cases, PCB storage facilities should be separated from processing and manufacturing activities and only personnel responsible for the operation of the PCB storage facility should be allowed into the storage area. It is recommended that PCB wastes be stored indoors. However, if outdoor storage is unavoidable, special precautions must be taken to ensure that all equipment and containers are weatherproofed and that a collection system is provided for rain water which could be contaminated with PCBs.

3.2 Access to Site

Access to a PCB storage area should be restricted to authorized personnel. No other waste should be stored within the area and no manufacturing or other activity should be undertaken. A PCB storage facility may be housed in an occupied building but it should be isolated from other activities. If an isolated room is not available, the facility should be enclosed by a 2-m-high woven mesh fence, or equivalent, with lockable gates. The fence should be clearly labelled to warn people of the presence of PCBs. Personnel protection equipment and cleanup kits for PCB spills should be placed within easy access of the storage area.

3.3 Design

3.3.1 Ventilation. Indoor storage of PCBs provides protection from the weather, permits the control of temperature, and improves the security of the storage. All storage areas should be adequately ventilated and are subject to the regulations and guidelines of the appropriate provincial and federal occupational safety and health agencies. If a mechanical ventilation system is used, it should be controlled by a switch outside the storage room and be energized for several minutes prior to entry. Air intake and exhaust outlets for ventilation systems should be on the building exterior.

3.3.2 Containment. Storage areas should be designed to ensure that PCBs will not be released to the environment. Floors on which PCB liquids are stored should be made of steel, concrete, or similar durable material and equipped with continuous curbing. Concrete should be sealed with a PCB-resistant sealant, such as a two-component amine-cured epoxy paint similar to Plasite 7122 (Corrosion Services Company Ltd.), Flakeline 600 (Ceilcote Canada Ltd., Toronto) or Valspar 78TC (Valspar Ltd., Toronto). It is recommended that the sealant coating be inspected periodically to check its integrity. The curbing for multi-equipment or container storage should be designed to accommodate

twice the liquid content of the largest piece of equipment or container or 25% of the total volume of PCB liquid at the location, whichever is larger. For single-unit storage, accommodation for 125% of the container's volume is acceptable. A 15-cm-high curbing will fulfill the above specifications in most instances, but the curbing may be designed to any height provided it will contain the PCB liquid to the specifications previously outlined. All floor drains, pumping systems and sumps leading from the PCB storage location should be sealed to prevent the spread of PCBs from the storage area in the event of a spill. No curbing is required where only solid waste is stored.

3.3.3 Prevention of Water Contamination. Storage facilities should be located and engineered so that PCBs will not be released in the event of flood, storm, or runoff from fire fighting. Storage facilities that have outdoor tanks and piping should have the means to manually divert storm water runoff from the site to a holding pond in the event of an emergency. If a PCB release does occur, the runoff collected in these containment systems should be prevented from entering the drainage system until it has been established that the concentration of PCBs does not exceed acceptable limits specified by the appropriate authorities.

3.3.4 Containers. Polychlorinated biphenyl solids should be stored in containers made of steel or other materials that provide sufficient durability and strength to prevent such solids from being released into the environment, affected by the weather, or contaminated from external sources. Containers for PCB liquids should meet the same requirements but be made out of metal.

Drums used to contain PCB solids should be of a capacity not greater than 205 litres, be made of steel having a gauge of 18 or heavier, and have a removable steel lid with a gasket of PCB resistant material. Drums used to contain PCB liquids should be of a capacity not greater than 205 litres, of double bung design, and made of steel having a gauge of 16 or heavier.

Overpacks may be used: (a) to consolidate two or more smaller containers or packages for convenience in handling or storage; (b) as additional security for single containers; or (c) as the only container if the overpack offers a degree of security equivalent to that mentioned above for containers and drums.

3.4.5 Outside Storage. Any PCB equipment containing PCBs or PCB liquids stored outside, besides meeting floor and containment requirements, should be covered by a weatherproof roof or barrier that protects the equipment or liquids and the curbing or drip pans under them.

Solids including drained PCB equipment and containers may be stored outside without being covered by a roof or other secondary covering providing the drained equipment and containers and containers of solids are structurally sound and sealed from the weather.

Bulk containers such as large international shipping containers or approved commercially manufactured metal storage containers or structures may be used for either primary or secondary containment for outdoor storage.

3.4 Operation of Storage Facility

Polychlorinated biphenyl wastes should be packaged so as to ensure that the potential for leakage or spills is kept to a minimum (e.g., small pieces of equipment, such as ballasts or capacitors, should be stored in drums or equivalent containers). The containers should be clearly labelled (see Chapter 4) and marked with the date of entry to storage. Drums or other portable containers of PCBs and PCB equipment should be placed on skids or pallets. Sufficient space should be left between stored containers and equipment to permit inspection and allow the safe movement of vehicles such as forklifts. Drums or other containers of PCB liquids that are stacked should be separated from each other by pallets and not stacked more than two containers high. Higher stacking may be utilized providing intermediate shelving or special bracing, strapping, or other proven storage systems are employed. Askarels should be segregated from combustibles such as Varsol rinsing fluid, oil, soaked rags, and contaminated mineral oil. PCB wastes should be stored so as to avoid the contamination of other materials in the event of a fire, leak, spill or other discharge.

Large-capacity PCB storage facilities should have a central receiving area where PCB equipment and wastes are loaded and unloaded from transport vehicles. This receiving area should also have a PCB-impervious floor and a containment system to properly control any spills during loading or unloading. The containment system could take the form of impervious dykes or grated drainage trenches connected to an isolated sump. This type of receiving area and containment system should be considered for a large centralized storage facility receiving mainly PCB liquids.

3.5 Fire Protection

The owner or operator of a PCB storage site should develop a fire control and emergency procedures plan in consultation with the local fire department. Indoor sites should be provided with a fully operative fire alarm system and suitable portable or flood

type fire extinguishers, such as: chemical foam, carbon dioxide, or nitrogen gas. An updated inventory of wastes and their location should be provided to the local fire department. Materials for cleanup should be readily available at or near the site.

Where a storage site is equipped with a mechanical exhaust system that exhausts into a building, the system must be provided with a smoke sensory control to stop the fan and close the damper(s) in the event of a fire.

3.6 Maintenance and Inspection

Personnel working at the facility should be made clearly aware of and understand current PCB waste management procedures including the use of personnel protection equipment and cleanup techniques. Training measures proposed should be made available to regulatory environmental and labour authorities to give them the opportunity to review and comment on their content.

The storage site should be inspected each month with particular attention to PCB equipment, floors, drains, drainage systems, fire prevention apparatus, personnel protection equipment, security fences. Any equipment or container found to be leaking PCBs should be repaired or replaced and any contaminated area cleaned up.

4 LABELLING AND RECORD KEEPING

This chapter covers labelling and record-keeping recommendations for in-use and out-of-service PCB equipment, and for PCB liquid and solid waste.

The purposes of labelling are:

- to provide immediate identification of PCB equipment and PCB wastes;
- to alert company officials that the labelled equipment or waste requires special handling and disposal considerations;
- to alert personnel to the presence of PCBs in the event of a spill or leakage;
- to assist company, provincial and federal officials in maintaining PCB inventories; and
- to assist with record keeping.

The purpose of record keeping is to keep track of PCB equipment and wastes until the PCBs are disposed of.

All equipment and wastes that contain PCBs at concentrations greater than 50 ppm should be labelled. Some owners may find it prudent to also label equipment and wastes that contain PCBs at concentrations of less than 50 ppm even though, strictly speaking, they are not defined as PCB wastes. The reason for this is that spills or leakages could conceivably result in high cleanup costs under certain circumstances and because federal regulations specify the maximum permissable concentration of PCBs in oils for dust control at 5 ppm [3]. In addition, several provinces regulate PCBs in concentrations less than 50 ppm.

The labelling of in-service equipment is voluntary; however, it is strongly recommended by Environment Canada and, to date, industry has cooperated fully. Additional guidance on the labelling of in-service equipment is provided in reference [10].

Where PCB users have developed their own labelling and reporting procedures, the labels and procedures should incorporate the functions of the system described in this chapter.

Under the Transportation of Dangerous Goods Regulations, safety marking is mandatory for the offering for transport and transportation of PCB wastes and equipment. The Transportation of Dangerous Goods Regulations are discussed in Chapter 5.

4.1 Labelling of In-service Equipment

The proper labelling of in-service PCB equipment will ensure that it is correctly identified when it enters the waste stream [10]. The PCB label also alerts

people to the presence of PCBs in the equipment and assists in inventory control while in-service, and later, during handling, storage, and disposal.

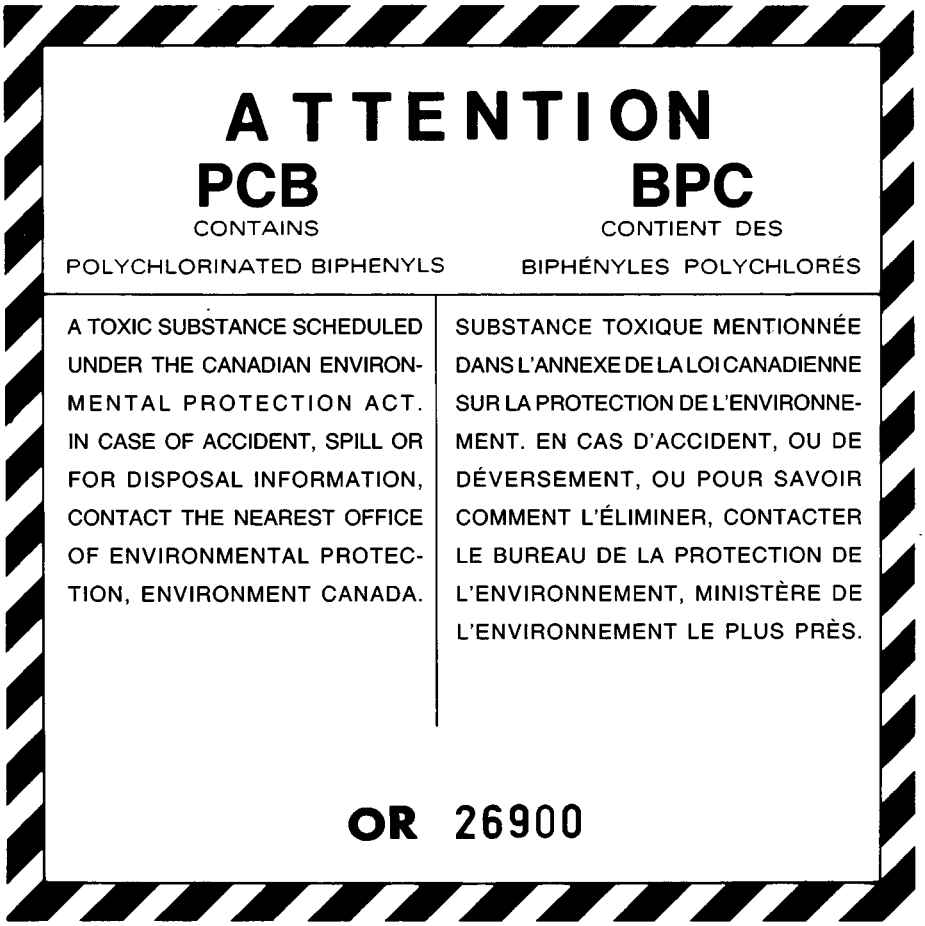
4.1.1 Askarel Equipment. Environment Canada recommends four labels for PCB equipment (Figures 1, 2, and 3). The first two (Figure 1) are serialized and have an Environment Canada registration number at the bottom. These numbers allow Environment Canada to keep track of the amounts and locations of askarel equipment and liquids. All askarel equipment of sufficient physical size to take a label should be labelled with one of the two serialized labels.

The label shown in Figure 1a) measures 15 x 15 cm and should be used on large askarel equipment such as transformers. Once affixed, the label should only be removed if the equipment has been decontaminated and Environment Canada is satisfied that the PCB concentration is less than 50 ppm.

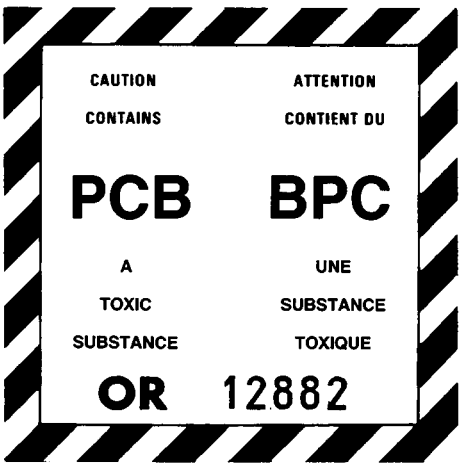
The label shown in Figure 1b) measures 7.6 x 7.6 cm and should be used for small items, such as capacitors, where size permits. Where a number of smaller pieces of PCB equipment are found together, such as a capacitor bank, one label may be used for the entire group; however, when a capacitor is removed from the bank for disposal, it should be labelled. Equipment that contains small PCB articles, for example a radio transmitter that contains PCB capacitors, does not have to be labelled.

A non-serialized version of the 15 x 15 cm label is shown in Figure 2. It is to be used as a general warning label and should be placed in a clearly visible position at the entrances to locations where PCB equipment is found. Some examples of these locations are fenced storage compounds, electrical rooms and transformer vaults.

4.1.2 PCB-contaminated Equipment. The PCB concentration in PCB-contaminated equipment (e.g., a PCB-contaminated mineral oil transformer) is much lower than that found in equipment using askarels. Nevertheless, if the PCB concentration is greater than 50 ppm, this equipment poses a potential hazard and is subject to the same regulations that apply to equipment containing askarels. When it is suspected that a piece of equipment may be contaminated with PCBs, and an activity is to be carried out to which the regulations apply, then the fluid contained in the equipment should be tested. If PCBs are found, a PCB warning label for contaminated equipment should be placed on the equipment. This label (Figure 3) has space for entering: the PCB concentration, date of analysis, company name, and the signature of an authorized company official. This label,



a) Label for Large Equipment



b) Label for Small Equipment

FIGURE 1 LABELS FOR PCB EQUIPMENT

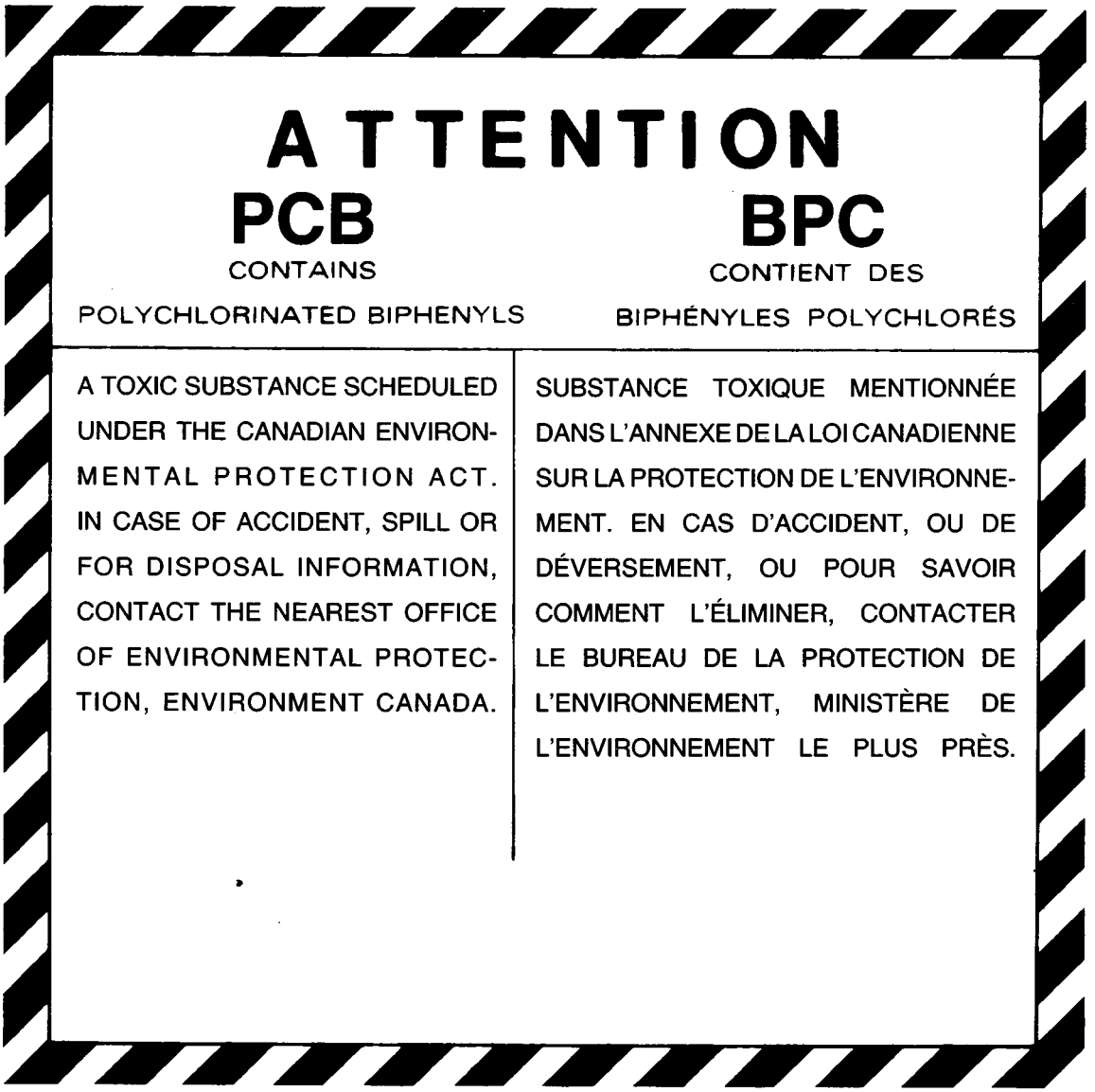


FIGURE 2 PCB GENERAL WARNING LABEL

ATTENTION

CONTAMINATED WITH PCBs (POLYCHLORINATED BIPHENYLS)	CONTAMINÉ PAR BPCs (BIPHÉNYLES POLYCHLORÉS)
THE CONTENTS OF THIS EQUIPMENT ARE CONTAMINATED WITH PCBs, A TOXIC SUBSTANCE SCHEDULED AND REGULATED UNDER THE CANADIAN ENVIRONMENTAL PROTECTION ACT. IN CASE OF ACCIDENT, SPILL OR FOR DISPOSAL INFORMATION, CONTACT THE NEAREST OFFICE OF ENVIRONMENTAL PROTECTION, ENVIRONMENT CANADA.	LE CONTENU DE CET APPAREIL EST CONTAMINÉ PAR DES BPCs, UNE SUBSTANCE TOXIQUE ANNEXÉE ET RÉGLEMENTÉE EN VERTU DE LA LOI CANADIENNE SUR LA PROTECTION DE L'ENVIRONNEMENT. EN CAS D'ACCIDENT, OU DE DÉVERSEMENT, OU POUR SAVOIR COMMENT L'ÉLIMINER, CONTACTER LE BUREAU LE PLUS PROCHE DE LA PROTECTION DE L'ENVIRONNEMENT, MINISTÈRE DE L'ENVIRONNEMENT.

PCB CONCENTRATION (parts per million)
CONCENTRATION DE BPC (parties par million) _____

DATE ANALYZED
DATE D'ANALYSE _____

COMPANY NAME
NOM DE LA COMPAGNIE _____

AUTHORIZED COMPANY OFFICIAL
AGENT OFFICIEL AUTORISÉ _____

FIGURE 3 PCB WARNING LABEL FOR CONTAMINATED EQUIPMENT

or an appropriate equivalent, should also be used to identify drums, tanks or packaging where contaminated mineral oils, rinsing fluids, or other low level PCB-contaminated wastes are stored.

4.1.3 Drums Containing High Concentration PCBs. Drums or other containers containing PCB liquids in concentrations above 10 000 ppm (1%) require special identification to alert people to separate these liquids from low-level wastes in the storage area and also that special disposal requirements (usually by incineration) may be necessary. These containers should be labelled with the non-serialized 150 x 150 mm label as shown in Figure 2.

4.2 Labelling of PCB Waste

All labels applied to in-service equipment according to the recommendations given previously should be left on that equipment when it becomes waste material, unless liquids have been decontaminated to less than 50 ppm of PCBs. Additional safety marking requirements for PCB wastes, pursuant to the Transportation of Dangerous Goods Regulations, are described in Chapter 5.

4.3 Record Keeping and Retention

4.3.1 Record Keeping for In-service Equipment. Environment Canada maintains an inventory of all askarel and PCB-contaminated equipment that has been labelled. During inspections, this equipment may be identified, checked against the inventory list, and have its status updated if necessary. The Environment Canada office in the appropriate region should be informed whenever an organization alters the status of a piece of PCB equipment, e.g., if it is taken out of service, re-located, stored, decontaminated, or disposed of. See Appendix F for a list of Environment Canada offices where notification can be made.

4.3.2 Record Keeping in Storage and Disposal. Each owner or operator of a facility for the storage of PCB wastes should keep records which include:

- an inventory of each item of PCB waste and the quantity of PCB therein;
- the date and source of PCB waste transferred to storage and the date and destination of waste leaving storage;
- a description of the PCB waste, including the quantity and concentration of PCBs, nameplate description where available;
- identification number for the PCB waste (this can be the identification number from the label described in Section 4.1);

- name of carrier of PCB waste;
- name of recipient or shipper of PCB waste;
- date and quantity of PCBs spilled as a result of a leak or accident and cleanup procedures adopted; and
- dates and details of inspections by Environment Canada, the owner and provincial authorities.

The owner or operator of a disposal facility should maintain records in a manner similar to that for a storage facility with the inclusion of information on:

- the quantity of PCB wastes disposed of and the method(s) used;
- quantities and disposal methods for residues produced; and
- monitoring data appropriate to the particular disposal method(s) used (see Appendices C and D).

Owners of PCB equipment or PCB wastes should retain a record of their inventory for five years after removal or disposal of the last of their PCBs. During that time, the annual inventory reports will confirm the disposal of the PCBs and will enable the provinces and Environment Canada to verify the reduction and eventual exhaustion of the PCB inventory. This recommendation also applies to owners and operators of storage and disposal facilities.

This maintenance of records will parallel the requirements of the Transportation of Dangerous Goods Regulations except that, under the regulations, documents related to transportation are required to be kept for only two years.

4.3.3 Reporting Requirements. Each owner or operator of a storage site should provide the appropriate regulatory authority with an inventory of all wastes stored at the site. Periodic updates of wastes transferred into or out of the site along with complete descriptions of the wastes should also be provided. All records kept at the site should be available for review and examination by authorized inspectors.

5 TRANSPORTATION

The federal Transportation of Dangerous Goods Regulations, and complimentary provincial legislation, specify standards and requirements for the safe handling and transporting, by all modes of transportation within Canada, of dangerous goods and/or hazardous wastes. The federal regulations apply to all domestic consignments by air, marine and rail transportation, and to all inter-provincial, transborder (Canada and the U.S.A.) by road and rail, and international (Canada and another country by aircraft or by ship) consignments. Provincial regulations apply to road consignments within a province. The federal and provincial regulations also cover safety markings, documentation, packaging, safety and emergency reporting requirements, and training of personnel. Under the TDG regulations, PCBs or articles containing PCBs have a primary classification number of 9.1, a subsidiary classification number of 9.2, and a Product Identification Number (PIN) of 2315.

Under provincial hazardous waste legislation, it may also be necessary for the consignor (generator), carrier, and consignee (receiver) involved in the transportation of PCB wastes and equipment to obtain approvals or licenses which may specify further contractual responsibilities for these parties.

Another federal regulation applicable to the transportation of PCBs is the Interim Order Respecting Chlorobiphenyls (February 20, 1989) which specifies that the maximum quantity of PCBs that may be released to the environment during the transportation of transformers, capacitors, heat transfer and hydraulic equipment, electromagnets and vapour diffusion pumps, or any package containing PCB equipment, is one gram per day for any one piece of equipment or any one package of equipment.

5.1 Definitions

The following definitions are from the amendment (SOR/86-526, Canada Gazette II, May 28, 1986) of the *Transportation of Dangerous Goods Act* and apply to all road and rail PCB transportation-related activities subject to the regulations.

Electrical Equipment - means a piece of equipment that:

a). contains a PCB mixture;

b). is used in the transmission or distribution of 60 Hz, 25 Hz or high voltage direct current (HVDC) electrical power;

c). is designed to perform a function other than solely to contain the PCB mixture; and

d). is normally leak-free while in service.

PCB Article - means any article that contains a PCB mixture, but does not include electrical equipment, a packaging or a container.

PCB Mixture - means a mixture containing PCBs in a concentration greater than 50 parts per million by weight.

Serviceable Electrical Equipment - includes electrical equipment that:

a). may show evidence of leakage;

b). is temporarily out of service for the purpose of maintenance, repair or relocation; and

c). is not in temporary storage for the purpose of disposal.

Larger Container - means a container with a capacity greater than 454 L.

5.2 Exemptions

The recent amendments to the Transportation of Dangerous Goods Regulations provide a regulatory scheme for the transportation of PCB materials, equipment, and articles contaminated with PCBs and provide certain exemptions for small-quantity samples, articles and wastes, and some types of electrical equipment containing PCBs. Securely packaged (including absorbent) samples, solids in quantities less than 10 kg gross weight and liquids when their net quantity is the lesser of 2 L or 2 kg are exempt. When a waste is a PCB mixture, or a PCB article or electrical equipment containing a PCB mixture, it is also exempt if the quantity of PCB mixture is not greater than 500 g. PCB articles in leak-free condition and containing not greater than 500 g of PCB mixture are exempt from all regulation.

Certain electrical equipment is exempt from most regulatory requirements, (except those requirements for dangerous occurrence reporting), provided specific conditions of transport are met. In particular, equipment never designed to operate with PCBs, but nonetheless contaminated with PCBs, is treated in this fashion if it is being transported for servicing, relocation or for use as an emergency replacement. This situation applies to all such equipment only if it contains less than 500 L of PCB liquid and is in leak-free condition.

The additional conditions for transportation for this type of equipment and those for all other PCB mixtures, articles, and equipment are discussed in Section 5.4.

5.3 Safety Marking and Documentation

Polychlorinated biphenyls in containers or articles, or equipment containing PCBs, when offered for transport, must be labelled as shown in Figures 4 and 5, and the containers, articles or equipment must clearly show the shipping name and the PIN number.

When PCBs are to be transported in a large container or transport unit a Class 9 placard (Figure 6) must be displayed. An exception to this rule is for PCB goods (i.e., not PCB wastes) in road vehicles travelling solely on land and when the gross quantity of PCB goods is less than 500 kg. No such exception applies for PCB wastes.

Under the Transportation of Dangerous Goods Regulations, three documentation requirements affect shipments of PCB wastes. Consignments of PCB waste destined for or imported from any international location are subject to a 60-day advance notification requirement (Figure 7). This notification must contain specific information, including the identity of all parties involved in the shipment (including a confirmation of generator/receiver contractual arrangements), a description of the waste, the quantity involved, the packaging and means of transport, the ports of entry and/or exit, and the approximate date of shipment of the consignment. Such a notification can cover a series of consignments over a twelve month period if estimated shipping dates for each consignment in such a series are given. However, seven days before the intended shipping date of the second and each subsequent consignment in a series, the shipper must again notify both Transport Canada and Environment Canada. The Canadian party must also forward to Environment Canada and Transport Canada a letter confirming that arrangements have been made by the Canadian party, when dealing with a party outside Canada, to receive completed copies of the Waste Manifest. Environment Canada will issue a letter of acknowledgement which must accompany imported or exported waste along with the Manifest. In transit shipments differ slightly in that the actual Notification must accompany the shipment. Interprovincial shipments differ in that PCB shipments require a 30-day advance Notification and seven days prior to the shipment arrangements must be made for an inspection of the consignment by the appropriate authority.

Before dangerous goods that are PCB mixtures or articles or equipment containing PCBs are transported, the consignor must prepare and sign a shipping document and deliver it to the initial carrier. When the consignment is waste PCB mixtures or

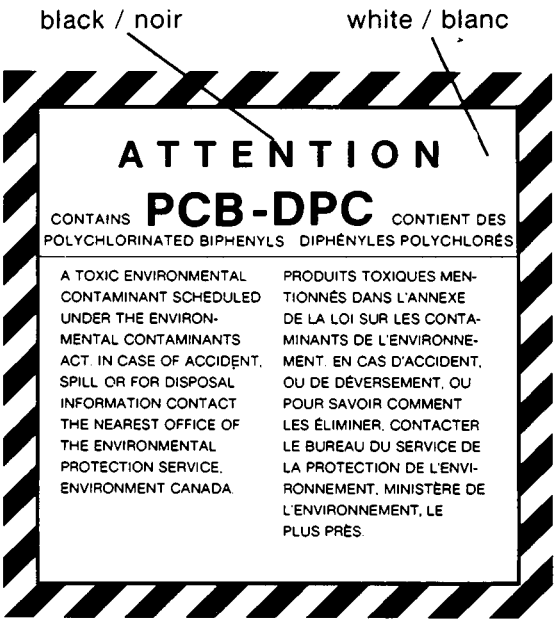


FIGURE 4 TDGA PCB LABEL (being revised by Transport Canada)

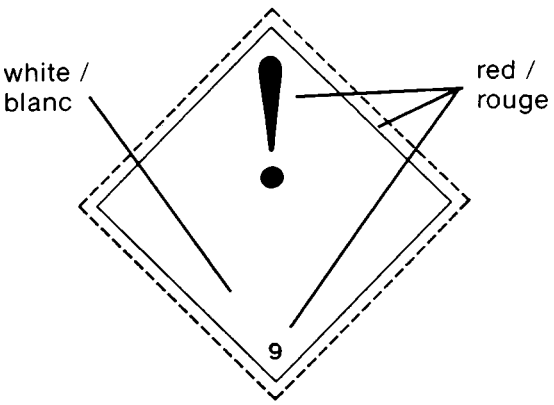


FIGURE 5 TDGA CLASS 9 LABEL

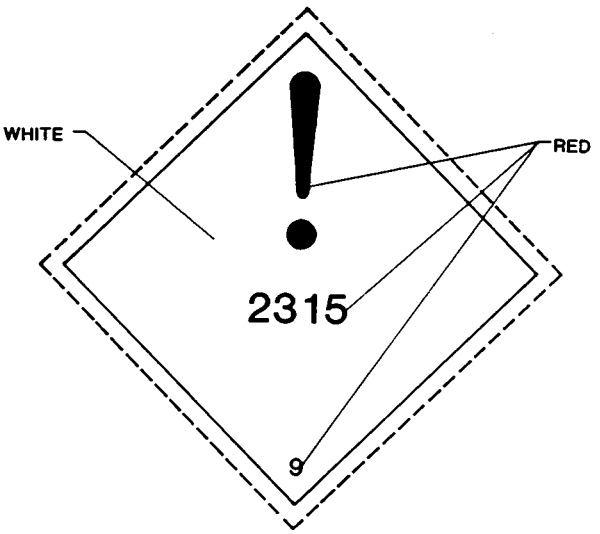


FIGURE 6 TDGA CLASS 9 PLACARD

SCHEDULE IV
(Sections 4.20.1 and 4.20.2)
FORM 2

NOTIFICATION
PRÉAVIS

ANNEXE IV
(Articles 4.20.1 et 4.20.2)
FORMULE 2

CONSIGNOR (GENERATOR)
EXPEDITEUR (PRODUCTEUR)

Provincial ID No. - N° d'id. provincial

Company Name - Nom de l'entreprise | Tel. No. (Area Code) N° de tél. (ind. rég.)

Mailing Address Adresse postale: | City - Ville | Prov. | Postal Code - Code postal

Shipping Site Address - Adresse du lieu d'expédition

City - Ville | Prov. | Postal Code - Code postal

CONSIGNEE (RECEIVER)
DESTINATAIRE (RÉCEPTIONNAIRE)

Provincial ID No. - N° d'id. provincial

Address - Adresse | City - Ville | Prov. | Postal Code - Code postal

Receiving Site Address - Adresse du lieu de destination

City - Ville | Prov. | Postal Code - Code postal

Notification Reference No.
N° de référence
20785

Shaded areas are for interprovincial waste PCB shipments only.
Espaces ombragés sont réservés aux envois interprovinlaux de déchets de PCB seulement.

CARRIER
TRANSPORTEUR

Modes of Transport
Modes de transport

Provincial ID No. - N° d'id. provincial

Company Name - Nom de l'entreprise | Tel. No. (Area Code) - N° de tél. (ind. rég.)

Address - Adresse

City - Ville | Prov. | Postal Code - Code postal

Length of Stay in Transit Country(ies):
Durée du séjour dans les pays de transit:

Handling Method in Transit Country(ies):
Méthode de manutention dans les pays de transit:

METHODS OF DISPOSAL - MÉTHODES D'ÉLIMINATION 1) 2) 3) 4)

First Shipment - Premier envoi											
Date of Departure - Date de départ			Estimated Date of Arrival - Date d'arrivée prévue			Province(s) or Country(ies) of Transit Province(s) ou pays traversé(e)(es)(s)	Point of Entry or Exit Port d'entrée ou de sortie	Highway Used Route utilisée PCB only - PCB seul.
Yr. - An	Mo. - Mois	Day - Jour	Yr. - An.	Mo. - Mois	Day - Jour			

Multiple Shipments: Including _____ shipments to be completed by: _____ (Y/M/D) with a total quantity of: _____ L or _____ kg.

Envois multiples: Nombre d'envois _____ à être transportés pour le _____ (A/M/J) d'une quantité totale de: _____ L ou _____ kg.

Shipping Name of Waste Appellation réglementaire du déchet	Waste Identification Identification du déchet		Quantity per Shipment Quantité par envoi	Units L or / ou kg Unités	Classification	Packing Group Groupe d'emballage	PCB - only PCB - seul. Concentration	PCB - only PCB - seul. Units (specify) Unités (preciser)	Packaging/ Container Emballage/ Conteneur Number Nombre	Packaging/ Container Emballage/ Conteneur Codes int. ext.
	N° Provincial No. (Québec - Ontario only - seulement)	TDG/PIN TMD/NIP								
1)										
2)										
3)										
4)										

Special Handling / Emergency Instructions
Manutention spéciale / Instructions d'urgence

Attached ☐ Annexées

Below ☐ Ci-dessous

Consignor / Consignee Certification: I declare that arrangements have been made to receive and dispose of the consignment of waste.
Déclaration de l'expéditeur / destinataire: Je déclare que des dispositions ont été prises pour la réception et l'élimination de l'envoi de déchets.

Name of authorized Person (print) - Nom de l'agent autorisé (caractères d'imprimerie) | Signature | Date Yr. - An | Mo. - Mois | Day - Jour

Copy 1 (white) - Transport Canada for Inter-Provincial Consignment (PCB)
Transport Canada for International and Transborder Consignment(s)

Copie 1 (blanche) - Transports Canada, envoi inter-provincial (BPC)
Transports Canada, envoi(s) international(aux) et transfrontalier(s)

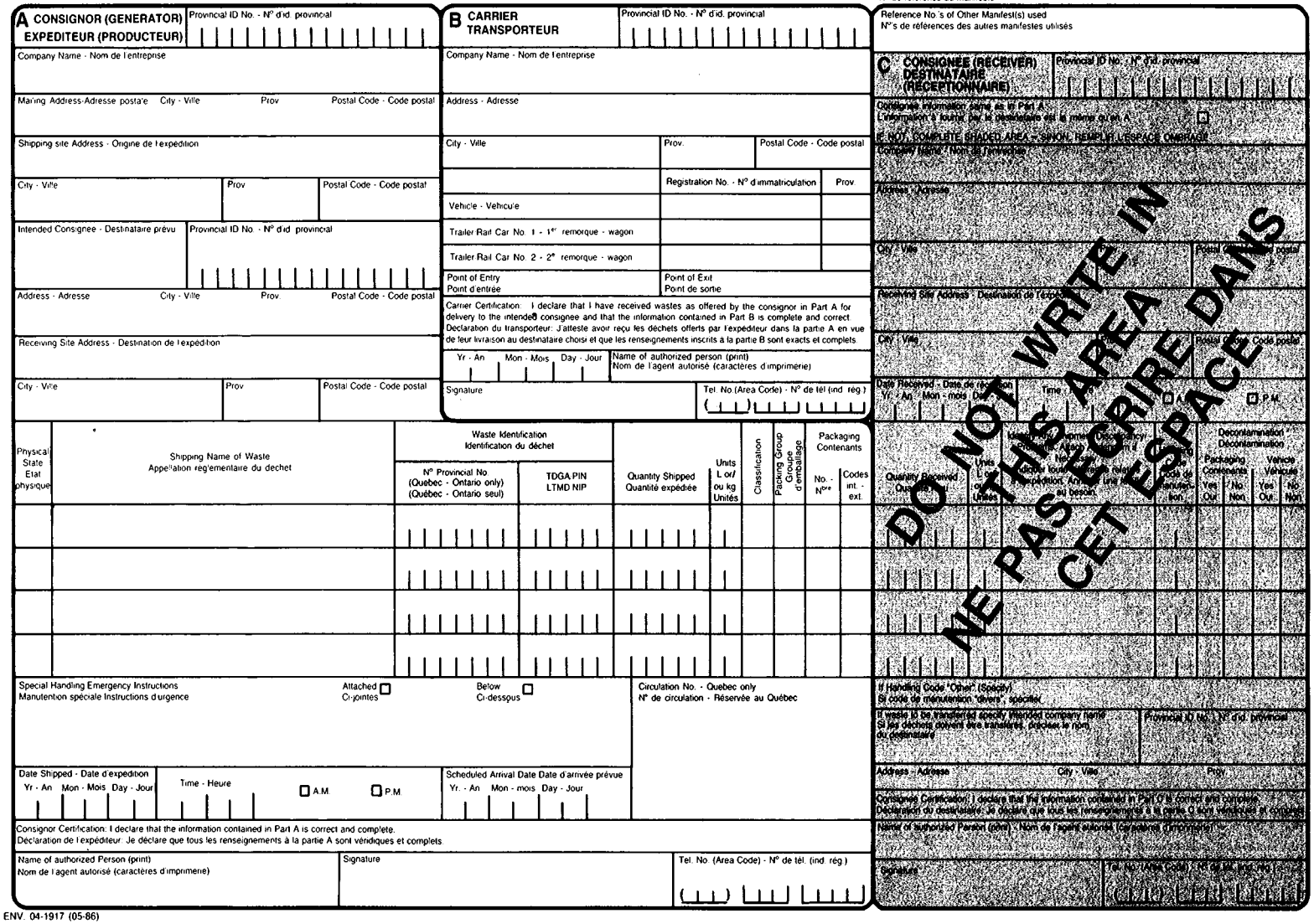
FIGURE 7 NOTIFICATION FORM

MANIFEST-MANIFESTE

THIS MANIFEST CONFORMS TO ALL FEDERAL AND PROVINCIAL TRANSPORT AND ENVIRONMENTAL LEGISLATION REQUIRING MANIFESTING.

CE MANIFESTE EST CONFORME AUX LÉGISLATIONS FÉDÉRALE ET PROVINCIALE SUR L'ENVIRONNEMENT ET LE TRANSPORT, REQUÉRANT UN MANIFESTE.

Manifest Reference No. / N° de référence du manifeste: 9004376-1



ENV. 04-1917 (05-86)

Copy 1 (white) **Mailed by Consignor (Generator) to Province of Consignee (Receiver) - Postée par l'expéditeur à la province du destinataire** Copie 1 (blanche)

FIGURE 8 TDGA WASTE MANIFEST

waste articles or equipment containing PCBs, a manifest form (Figure 8) is required for each shipment. Completion of part A of the form is the responsibility of the consignor (generator) and Part B of the carrier. The manifest form then accompanies the shipment during transport to the consignee (receiver) who must check the shipment on receipt for any discrepancies and ensure that it matches the description on the manifest before completing Part C of the manifest. The required distribution of the various copies of the manifest for intra- or interprovincial shipments is shown in Figure 9 (11). The distribution of copies for import and export shipments is shown in Figure 10. Written directions for the distribution of manifest copies for the three types of shipments are included in Appendix H.

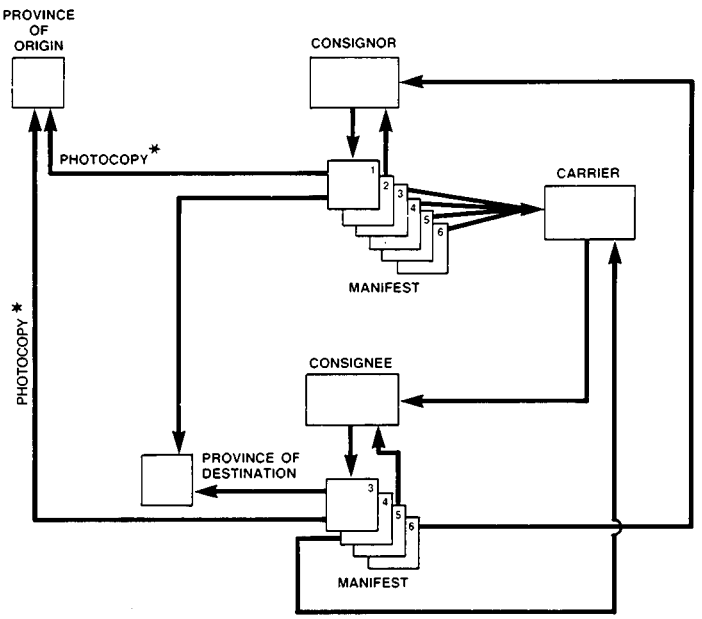
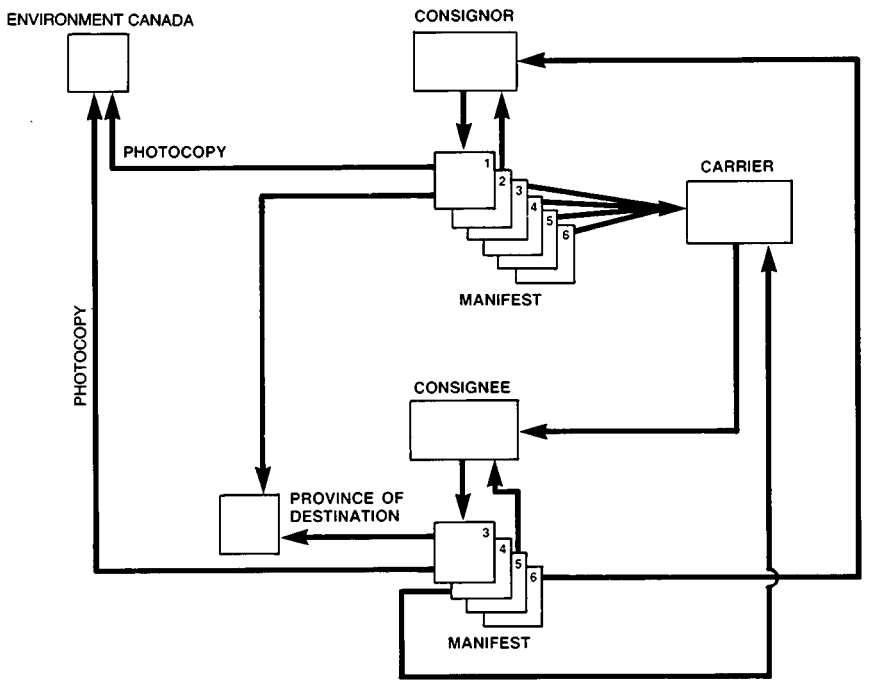


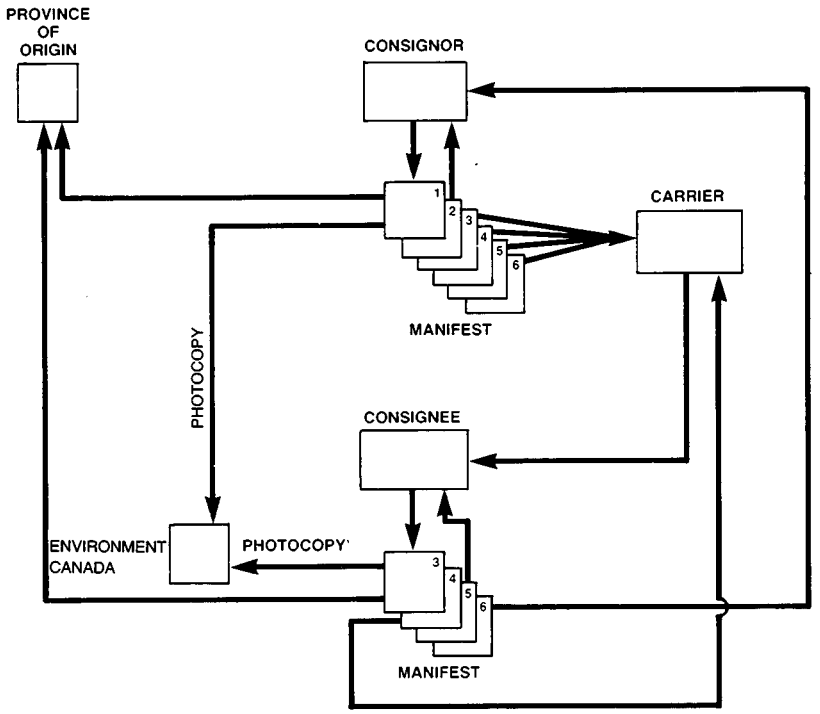
FIGURE 9 DISTRIBUTION OF MANIFEST COPIES (inter- and intraprovincial shipments) *When the province of origin and destination is different.

For PCB equipment, the manifest's Special Handling Section should include the Environment Canada (EC) inventory number so that, by exchange of information between the provincial environment ministries and Environment Canada, the EC inventory can be updated.

There is one additional documentation requirement. In the event of a spill of 50 kg or more of a PCB mixture during transportation-related activities, a Dangerous Occurrence Report Form (Figure 11) must be completed as required by the Transportation of Dangerous Goods Regulations.



IMPORT OF WASTE



EXPORT OF WASTE

FIGURE 10 DISTRIBUTION OF MANIFEST COPIES (import and export)

Transport Canada / Transports Canada

TRANSPORTATION OF DANGEROUS GOODS

DANGEROUS OCCURRENCE REPORT

AS REQUIRED UNDER THE TRANSPORTATION OF DANGEROUS GOODS REGULATIONS (SECTION 9.14)

TRANSPORT DES MARCHANDISES DANGEREUSES

RAPPORT SUR UN CAS DE DANGER

PRESCRIT EN VERTU DU RÈGLEMENT SUR LE TRANSPORT DES MARCHANDISES DANGEREUSES (ARTICLE 9.14)

1. TYPE OF DANGEROUS OCCURRENCE — GENRE DE CAS DE DANGER
(CHECK ALL APPLICABLE BOXES) (COCHEZ TOUTES LES CASES APPLICABLES)

☐ SPILL / ÉPANCHEMENT ☐ LEAK / FUITE ☐ CONTAMINATION:
☐ EXPLOSION ☐ FIRE / INCENDIE
A ☐ HUMAN / DES PERSONNES B ☐ PROPERTY / DES BIENS C ☐ ENVIRONMENT / DE L'ENVIRONNEMENT

2. DATE OF DANGEROUS OCCURRENCE — DATE DU CAS DE DANGER
Y — A M D — J

3. TIME OF DANGEROUS OCCURRENCE (24 HR. SYSTEM)
HEURE DU CAS DE DANGER (SUR 24 HEURES)

4. LOCATION OF DANGEROUS OCCURRENCE (BE SPECIFIC)
LIEU DU CAS DE DANGER (PRÉCISEZ)

5.
☐ RESIDENTIAL AREA / ZONE RÉSIDENTIELLE ☐ COMMERCIAL AND RESIDENTIAL AREA / ZONE COMMERCIALE ET RÉSIDENTIELLE
☐ URBAN CORE AREA / CENTRE-VILLE ☐ INDUSTRIAL AREA / ZONE INDUSTRIELLE ☐ RURAL AREA / ZONE RURALE

6. DANGEROUS OCCURRENCE HAPPENED: — LE CAS DE DANGER S'EST PRODUIT DURANT:
☐ DURING TRANSPORT / LE TRANSPORT ☐ DURING HANDLING (SPECIFY) / LA MANUTENTION (PRÉCISEZ) ..... ☐ DURING TEMPORARY STORAGE / L'ENTREPOSAGE TEMPORAIRE
☐ OTHER (SPECIFY) / AUTRE (PRÉCISEZ) .....

7. COMPLETE A OR B — REMPLIR A OU B

(A) DANGEROUS OCCURRENCE DURING TRANSPORT
(A) CAS DE DANGER DURANT LE TRANSPORT

(1) MODE OF TRANSPORT — MODE DE TRANSPORT
☐ ROAD / ROUTIER ☐ RAIL / FERROVIAIRE
☐ AIR / AÉRIEN ☐ MARINE / MARITIME

(2) TYPE OF VEHICLE — GENRE DE VÉHICULE

(3) CARRIER (NAME AND ADDRESS) — TRANSPORTEUR (NOM ET ADRESSE)

POSTAL CODE — CODE POSTAL

OR / OU

(B) DANGEROUS OCCURRENCE DURING HANDLING OR TEMPORARY STORAGE
(B) CAS DE DANGER DURANT LA MANUTENTION OU L'ENTREPOSAGE TEMPORAIRE

(1) FACILITY — INSTALLATION
TERMINAL: ☐ AIR / AÉRIEN ☐ RAIL / FERROVIAIRE ☐ ROAD / ROUTIER
PORT: ☐ ON SHORE / AU QUAI ☐ ON SHIP / À BORD D'UN NAVIRE
☐ WAREHOUSE / ENTREPÔT ☐ BULK STORAGE PLANT / INSTALLATION D'ENTREPOSAGE EN VRAC
☐ OTHER (SPECIFY) / AUTRE (PRÉCISEZ) .....

(2) FACILITY (NAME AND ADDRESS) — INSTALLATION (NOM ET ADRESSE)

POSTAL CODE — CODE POSTAL

8. CONSIGNOR — EXPÉDITEUR
NAME — NOM
ADDRESS — ADRESSE
POSTAL CODE — CODE POSTAL

9. ORIGIN OF CONSIGNMENT — POINT D'ORIGINE DE L'ENVOI

10. DESTINATION OF CONSIGNMENT — POINT DE DESTINATION DE L'ENVOI

16-0013 (2-85)

Canada

FIGURE 11 DANGEROUS OCCURRENCE REPORT FORM (Front)

11. DANGEROUS GOODS INVOLVED IN THE OCCURRENCE WERE:
LES MARCHANDISES DANGEREUSES EN CAUSE DANS LE CAS DE DANGER ÉTAIENT:

☐ IN BULK / EN VRAC ☐ PACKAGED / DANS DES COLIS ☐ IN CONTAINERS / DANS DES CONTENEURS

P.I.N. NIP	CLASSIFICATION	SHIPPING NAME — APPELLATION RÉGLEMENTAIRE	TYPE OF PACKAGE GENRE DE COLIS	TOTAL MASS OR VOLUME OF SHIPMENT MASSE OU VOLUME TOTAL DE L'ENVOI	MASS OR VOLUME OF ESTIMATED LOSS MASSE OU VOLUME DES PERTES ESTIMATIVES

12. DESCRIBE THE EVENTS LEADING TO, DURING AND RESULTING FROM THE DANGEROUS OCCURRENCE
DÉCRIVEZ LES CIRCONSTANCES AYANT CONDUIT AU CAS DE DANGER ET CELLES QUI PRÉVALAIENT DURANT ET APRÈS LE CAS DE DANGER

13. NUMBER OF DEATHS
NOMBRE DE DÉCÈS

14. NUMBER OF INJURED PERSONS REQUIRING HOSPITALIZATION
NOMBRE DE BLESSÉS QUI ONT DÛ ÊTRE HOSPITALISÉS

15. EVACUATION OF SURROUNDING AREA
ÉVACUATION DES ENVIRONS

☐ YES / OUI ☐ NO / NON

16. EMERGENCY RESPONSE PERSONNEL AT SITE OF DANGEROUS OCCURRENCE
PERSONNEL D'INTERVENTION D'URGENCE SUR LES LIEUX

☐ POLICE ☐ FIRE DEPARTMENT / SERVICE D'INCENDIE ☐ OTHER / AUTRE

17. COMMENTS AND ADDITIONAL INFORMATION — COMMENTAIRES ET RENSEIGNEMENTS SUPPLÉMENTAIRES

18. PERSON COMPLETING THIS FORM — FORMULE REMPLIE PAR:

NAME — NOM

TITLE — TITRE

ADDRESS — ADRESSE

TELEPHONE — TÉLÉPHONE
AREA CODE / CODE RÉG. ( )

I CERTIFY THAT THIS INFORMATION IS ACCURATE TO THE BEST OF MY KNOWLEDGE.
J'ATTESTE QUE LES RENSEIGNEMENTS CI-DESSUS SONT EXACTS AU MEILLEUR DE MA CONNAISSANCE.

SIGNATURE

DATE

SEND TO: TRANSPORT DANGEROUS GOODS, TDGA / T, TRANSPORT CANADA,
ENVOYEZ À: TRANSPORT DES MARCHANDISES DANGEREUSES, TDGA / T, TRANSPORTS CANADA, OTTAWA, ONT. K1A 0N5

FIGURE 11 DANGEROUS OCCURRENCE REPORT FORM (Back)

Depending upon provincial requirements, additional information may be required for shipments of waste PCB mixture and waste articles/equipment containing PCBs.

5.4 Packaging

To avoid problems under normal transportation conditions, the Transportation of Dangerous Goods Regulations require that articles containing a PCB mixture be securely enclosed in a leak-proof container suitable for PCBs.

Polychlorinated biphenyl mixtures not contained in articles or equipment must be packaged in suitable liquid-tight containers that conform to relevant specifications in Rules 40, 41 or 54 of CFC 6000 (Canadian Freight Classification CFC 6000 January 1979, Canadian Freight Association).

Serviceable electrical equipment that is exempt under the conditions described in Section 5.2 must be transported in its normal operating position. Serviceable electrical equipment used as emergency replacement for stationary equipment must also be permanently mounted on a railway or road vehicle. This type of equipment, if it is drained, must have any remaining PCB mixture contained in the base below the drain opening. When transportation occurs by road vehicles, the equipment must be inspected by the carrier every two hours or every 200 km, whichever is more frequent.

All other serviceable electrical equipment (i.e., that not exempt in Section 5.2 and that containing greater than 500 L PCB mixture) and PCB electrical equipment, either in use or waste, must be transported in the following manner. The equipment must first be drained to the greatest extent possible over 48 hours before all orifices are capped or sealed. The equipment is then protected by a means of containment that will prevent any escape of remaining liquid; sufficient absorbent material is placed inside the containment to absorb the remaining liquid; and finally, the entire equipment plus containment is covered to protect against the weather.

One final type of packaging for transport may be necessary. The regulations presently offer an alternative method for transporting electrical equipment, when it is impossible or inadvisable to drain the equipment before transport. In such instances, transportation can proceed if the equipment is placed in a leakproof container. If complete containment is not feasible, the equipment must be placed in a drip pan with a capacity of 125% of the nameplate capacity of the equipment; the drip pan must be filled with sufficient absorbant material to absorb 110% of the equipment's capacity; and the entire equipment and drip pan must be covered to protect against the weather.

When packaging PCB liquids for transport (e.g., askarel, PCB-contaminated mineral oil, solvent flushings, or water), the liquids should be pumped rather than poured into containers, leaving a 7- to 10-cm air space for liquid expansion; full open head containers must not be used.

5.5 Safety During Transport

All containers and vehicles should be inspected for mechanical defects and leaks; any leaks must be cleaned up using sorbents and/or solvents listed in Chapter 7.

According to the Transportation of Dangerous Goods Regulations, no person shall handle, offer for transport or transport PCBs or articles containing PCBs, including waste, unless he is trained to do so, or is performing those activities under the direct supervision of a trained person. A person is considered suitably trained:

i). when his employer

   a). is satisfied that the person has received adequate training in the aspects of the handling, offering for transport or transporting of dangerous goods related to the duties that he proposes to assign to the person, and

   b). issues to the person a Certificate of Training that indicates

      - the date the person completed an initial training in the handling, offering for transport or transporting of dangerous goods,
      - the date the person completed each subsequent training in the handling, offering for transport or transporting of dangerous goods, if any, and
      - the aspects of the handling, offering for transport or transporting of dangerous goods for which the person was trained; or

ii). when the person is the holder of a certificate, license or authorization recognized under:

   a). the Ships' Deck Watch Regulations,

   b). *The Pest Control Products Act*,

   c). the Regulations No. 0-8, Uniform Code of Operating Rules, or

   d). the *Atomic Energy Control Act*.

   and the certificate, license or authorization relates, at least in part, to the aspects of handling, offering for transport or transporting of dangerous goods that are applicable to his assigned duties.

In the case of an incident involving PCBs, transportation personnel must be fully aware of the requirement to notify the appropriate provincial/territorial emergency authority at the emergency telephone numbers listed on the waste manifest (Figure 7). Information on dealing with PCB releases can also be obtained from a 24-hour hotline

service called CANUTEC operated by Transport Canada, which can be reached at (613) 996-6666.

The appropriate provincial environmental authority should be informed of spills and cleanup measures being taken. Environment Canada should also be contacted where they are considered by the provincial authority to have the best information on emergency and spill cleanup procedures.

6 DISPOSAL OF PCBs

6.1 General

A critical issue in the management of PCB waste is the PCB concentration or mass at which a material is defined as a PCB waste. The main criterion defined by the federal government is any waste material containing more than 50 ppm PCBs. This does not mean that PCB wastes that do not meet its criterion should be disposed of indiscriminately or routinely go to municipal landfills. Low-concentration or small-quantity PCB wastes should be addressed individually and disposed of in accordance with provincial regulations or requirements.

A specific federal restriction on the release of PCBs in concentrations lower than 50 ppm is given in the Interim Order Respecting Chlorobiphenyls (February 20, 1989) the maximum concentration of PCBs in oil applied to a road surface is limited to 5 ppm. This limit was imposed because of the potential for contamination of surface water and sediments from runoff from roads. Some provinces have lower limits than this for road oiling or have banned it completely.

Although there is a 0.5 kg exemption on PCB mixtures for transportation purposes (see the May 26, 1986, amendments to the Transportation of Dangerous Goods Regulations) as a general principle, small items coming within this category, such as capacitors sometimes found in home appliances, electronic equipment and fluorescent light fixtures [12], should not be ignored but should be segregated and collected, stored and disposed of in a manner that is as environmentally acceptable as the requirements for larger items.

As previously mentioned, except for the incinerator installation at Swan Hills, Alberta, and several mobile chemical treatment units for decontaminating low-level, PCB-contaminated mineral oil, there are no commercial facilities in Canada available for the destruction of waste PCB-contaminated equipment, soils or other solids, containers or packaging or PCB-contaminated liquids.

This section on disposal is not intended to be all embracing and additional information and evaluations on specific commercial or near-commercial PCB treatment/destruction technologies is provided in reports such as those by the Ontario Research Foundation [7] and Kupchanko [13]. High temperature incineration has a proven track record in the destruction of all types of PCB waste.

A summary of disposal technologies for the various types of PCB wastes most frequently encountered is given in Table 3, and brief descriptions of these technologies follow.

TABLE 3 DISPOSAL TECHNOLOGIES FOR VARIOUS PCB WASTES

Waste Type [a]	Typical PCB Content	Disposal Option: Liquid Injection Incinerator	Rotary Kiln Incinerator	High Efficiency Boiler [c]	Material Recovery	Approved Landfill	Municipal Landfill [d]	Sodium - based Processes
Askarel	30 to 70%	●	○					
Decontamination Flushing (Concentrated)	1 to 10%	○	○					
Decontamination Flushings	<1%	○	○	○				
Mineral Oil	<1%	○		○	○			○
Retrofilling Fluids	100 to 1000 ppm	○		○	○			
Major Equipment [b]	<500 ppm				●	○		
Major Equipment [b]	≤50 ppm				●		○	
Large Capacitors	>0.5 kg		●					
Small Capacitors	≤0.5 kg		●			○		
Maintenance Waste	varies		●					
Packaging	varies		●					
Waste Lubricating Oil	10 to 500 ppm	○		○				○
Soil, Demolition Spoils and PCB Destruction Residues	>50 ppm		●			○		
Dredging Spoils	varies		●			○		
Aqueous Waste	µg/L to mg/L	○		○				

Recommended Possible Options — where no option is recommended, the best option must be determined case-by-case, depending upon such variables as degree of contamination, costs, and availability of option.

a See Appendix B for broader descriptions of wastes.
b Drained equipment.
c Limited to PCB concentrations <500 ppm.
d Not recommended, although unregulated small PCB capacitors in light ballasts, electronic equipment and appliances, and small quantity PCBs in equipment, soils or residues are sometimes disposed of here.

6.2 Technologies

6.2.1 Liquid Injection Incinerators. These incinerators burn a support fuel and accept PCB liquid wastes as part of their total fuel requirements. Although they are not designed to accept solids, some ash is usually manageable so that pumpable sludges can be incinerated. The incinerator should be fitted with a gas scrubbing system to remove by-product hydrogen chloride from the flue gas. Liquid injection incineration is currently the preferred technology for the destruction of high-concentration PCB fluids, such as askarels, and may also be used for aqueous wastes from which PCBs cannot be economically removed. The U.S. Environmental Protection Agency (U.S. EPA) combustion criteria and related operating conditions and controls for PCB liquid injection incinerations are given in Appendix C. Proposed Canadian regulations respecting mobile systems

for the destruction of PCBs by thermal means that are operated on federal lands are also given in Appendix C.

Kokoszka and Kuntz [14] have summarized the advantages and disadvantages of this destruction technology. The advantages of liquid injection incinerators include the ability to handle a variety of liquid wastes, no moving parts in the combustion chamber, the capability of operating over a wide range of feed rates, and low maintenance cost. The disadvantages include plugging and corrosion of burners due to incompatible fluids, the need for liquids to have low enough viscosities not only to be pumped but also to be atomized in the burner, and the need for sophisticated instrumentation to maintain the required combustion efficiency because these incinerators are highly sensitive to changes in waste composition and flow.

6.2.2 Rotary Kiln Incinerators. This type of incinerator is recommended for wastes containing mainly solid materials and, in many cases, the wastes (e.g., capacitors) will be shredded before entering the kiln. Provision should be made to prevent the escape of vapour-phase PCBs during shredding. This can be accomplished by hooding, operational sequencing of gates, and providing an air flow through the system that becomes the combustion air source. Large quantities of solid residues are produced; the major portion is usually dropped out after the rotary kiln section and the remainder is removed by the emission control system. The residence time of solids in the kiln is usually about 30 minutes. The gases from the rotary kiln are passed into a second incineration zone, which is typically a liquid injection incinerator. Operating conditions for this type of incinerator are given in Appendix C.

Some advantages of rotary kiln incinerators are the capabilities to handle solids and liquids, either separately or in combination, to handle large containers, and to adjust residence time for solids by varying the rotational speed of the kiln [14]. Some disadvantages are that the units have a relatively high capital cost; emission control is necessary for particulate and hydrogen chloride; and the seals on the kiln ends and feed chute may leak [14].

6.2.3 High Efficiency Boilers. Many companies or utilities that have PCB wastes also own high efficiency industrial boilers which are used for steam and/or electricity generation. These boilers, fired by oil, coal or natural gas, often approach the time and temperature regimes of liquid injection incinerators. Energy recovery and decreased transportation of PCB wastes provide an incentive to use these boilers to destroy PCBs. However, the boilers are often limited in their capability to destroy PCBs by their lack of

hydrogen chloride emission control systems, marginal time-temperature conditions or boiler metallurgy (chloride resistant) (15). As a result, the use of high efficiency boilers is restricted to liquid wastes containing less than 500 ppm PCBs. The U.S. EPA criteria for the use of a high efficiency boiler are given in Appendix D.

6.2.4 Dechlorination Using Sodium-based Processes. Sodium-based dechlorination processes can be used to decontaminate mineral oil containing up to a few thousand parts per million PCBs; the upper concentration limit is set by process costs in each case. In this process, the sodium reagent reacts with the chlorine atoms on the PCB molecule to form sodium chloride, and the biphenyl part of the PCB molecule polymerizes to form a non-chlorinated polymer (polyphenylene); the mineral oil is unchanged. Sodium chloride and polyphenylene are the wastes from this process. The PCB-free mineral oil can be reused or disposed of as a non-hazardous waste. Dechlorination of PCBs by sodium reagents must be conducted in a nitrogen or other inert atmosphere to prevent the fire hazard created when hydrogen is generated by reaction of the sodium reagent with any moisture in the oil. Sodium-based dechlorination processes cannot be used to treat PCBs in oil containing significant amounts of water (16). Proposed regulations respecting mobile systems for the chemical treatment of PCBs that are operated on federal lands are given in Appendix C.

Sodium-based processes are recommended for treatment of PCB-contaminated mineral oil because the systems can be brought directly to the PCB source, and the decontaminated mineral oil can be reused.

6.2.5 Disposal Priorities

Recovery of suitably decontaminated articles or liquids for scrap metal or for re-use, such as: transformers, hydraulic equipment, heat exchanger equipment, and mineral oils, should be given first priority. Incineration should be given second priority. Landfilling of PCBs is usually not an alternative and is banned by most provinces.

7 EMERGENCY PREPAREDNESS AND PROCEDURES

Emergencies involving PCBs can occur with equipment in-service, in storage, during transport, or at a disposal facility. These emergencies may take the form of:

- a leak or spill of PCB liquid;
- the catastrophic failure of a piece of in-service equipment;
- the accidental breach of a container of PCBs; and
- fires.

Of these four emergency situations, fires involving PCBs may have the most serious consequences because they generate large quantities of oily soot which may be contaminated with PCBs, polychlorinated dibenzofurans (PCDFs) and polychlorinated dibenzo-*p*-dioxins (PCDDs). The latter are often referred to as "furans" and "dioxins". This soot could be extremely hazardous to human health and is very difficult to remove during cleanup (15). Polychlorinated dibenzofurans originate from the combustion of PCBs, while PCDDs originate from the combustion of chlorobenzenes which are an askarel constituent.

The precautions outlined in the sections of this manual dealing with the design and operation of PCB storage and disposal facilities as well as following the requirements of the Storage of PCB Wastes Interim Order (20) can help prevent most emergencies.

7.1 Emergency Preparedness through Emergency Planning

All companies operating storage or disposal facilities or transporting PCBs should develop and implement a fire and emergency action plan. This plan should be developed in conjunction with the local fire department and should provide information on:

- emergency actions that should be taken in the event of a PCB spill or fire;
- personal protection equipment that should be used during an emergency response;
- corporate personnel who can be contacted on a 24-hour basis to supervise emergency actions; and
- regulatory notification requirements detailing who must be notified in the event of an emergency, both provincially and federally.

The degree of planning and preparation required for a specific emergency plan will vary with the quantity and concentrations of PCBs involved, e.g., a slightly contaminated mineral oil transformer located at an outdoor substation would require a

less sophisticated emergency plan than a similar transformer containing askarel located in a commercial or industrial building. All the elements of emergency planning should be considered and a degree of preparedness decided upon prior to any action being taken with respect to any PCB equipment or waste.

All personnel working with PCBs should become familiar with the contents of the emergency plan. It is recommended that employees be trained in use of the plan, preferably through emergency drills. As well, employees should be trained in the use of personal protection equipment, spill control kits, and fire extinguishers. They should also be made aware of the hazards of PCBs.

7.2 Emergency Procedures for PCB Spills

Spills of PCB liquid must be acted upon and cleanup operations commenced as soon as possible after detection. In an emergency or cleanup situation, an assessment should first be made of all possible hazards associated with the situation so that appropriate safety procedures and protective equipment may be used.

7.2.1 General Spill Cleanup Procedures. Spill cleanup procedures presented in this section address spills of PCB liquids such as askarel, decontamination flushings, and contaminated mineral oil. Spills of PCB-contaminated solid materials have less tendency to spread and are considerably easier to clean up than spills of liquids. Cleanup procedures for spills of PCB solids are discussed briefly at the end of this section. The special case of cleanup of spills of PCB-contaminated aqueous materials is presented in Section 7.3.

The following steps are recommended for the cleanup of PCB liquids:

- stop source of spill if possible;
- control further spread of the spill;
- notify authorized personnel of the spill and cleanup intentions;
- if workers or the public are at risk the provincial environment and health authorities as well as Environment Canada should be notified;
- consult with the provincial environment authority on the cleanup procedures;
- remove the PCBs from the surface where they have spilled; and
- obtain samples from the contaminated surface and test for the completeness of the cleanup.

Spread control: Immediate action should be taken to limit the spread of contamination by using dykes and drain plugs, as available, by removing articles that are not yet contaminated, and by any other action that can be readily undertaken.

Notification: Immediate notification of the appropriate authorities is required to ensure that they are informed about the PCB spill and that all cleanup resources are made available. For a spill on private property, authorized personnel identified in the facility's emergency plan should be contacted to respond to the spill emergency or give cleanup advice to on-site personnel. On-site personnel should assess the situation and contact other emergency agencies (fire or police) as warranted. The provincial environmental authority should be informed of all spills and the cleanup measures being taken. Environment Canada should also be contacted if information on emergency and spill cleanup procedures is needed. Transportation accidents involving PCB spills should be reported to local police and fire departments, and appropriate provincial/territorial authorities at the telephone numbers given on the TDG Waste Manifest.

Spill removal: PCB liquids should be removed from the contaminated area to as large an extent as possible using pumps and sorbent materials.

Sorbents: Some of the materials available in Canada and capable of absorbing PCBs and PCB-contaminated mineral oil are:

- sawdust
- vermiculite
- activated charcoal
- Oclansorb (Hi-Point Peat Ltd.)
- Imbiber beads (Dow Chemical Canada Inc., Sarnia)
- Hy-Dry (Tennier Absorbent Products Ltd., Hamilton)
- Diasorb (Diamond Shamrock Canada Inc., Cleveland)
- Stay-Dry (Waverly Mineral Products Co., Philadelphia)
- Oil-Dry (Waverly Mineral Products Co., Philadelphia)
- Conwed (C-I-L Inc.)
- 3-M matting (3M Canada Inc.)
- Graboil (R.B.H. Cybernetics (1970) Ltd.)

These materials all absorb PCBs to create a "quasi-solid" product that can be swept or shovelled into a container for disposal. Adequate supplies of sorbent material should be kept close to PCB equipment at all times. Other spill cleanup equipment including pumps and barrels should also be readily available.

Decontamination solvents: After the liquid PCBs have been removed through the use of sorbents or pumps, the affected surfaces must be thoroughly decontaminated.

Surfaces that do not absorb PCBs, such as steel or PCB-resistant concrete, should be decontaminated by thoroughly rinsing with a solvent, such as Varsol, turpentine, No. 1 fuel oil, or kerosene, until the PCBs are removed. PCB-contaminated solvents and cleaning rags should be disposed of as a PCB waste. Materials that absorb PCBs, such as wood, asphalt, concrete, soil and sediments, should be examined to determine the depth of PCB penetration. The contaminated surface layer should be decontaminated or physically removed to meet provincial requirements. The material removed should be dealt with as a PCB waste when it contains more than 50 ppm PCB. Less contaminated material should be handled and disposed in a manner acceptable to provincial authorities.

7.2.2 Specific Cleanup Procedures. As mentioned previously, PCBs spilled onto concrete or into a containment system can be removed using pumps (if the liquid is pumpable) or sorbents. Spills onto soil or into water require more complex cleanup techniques.

Specific control actions for spills into containment systems, onto concrete or asphalt, soil, and into water, are given in the following (10). These control action plans are not intended to be all inclusive or to be applicable or adequate in all situations. For instance, to assess the threat to groundwater quality in the event of a large PCB spill on soil, provincial authorities may require extensive monitoring to determine the degree and extent of contamination and rate of migration. On the other hand, a small spill may not require such actions as building a dyke, taking core samples or pumping into drums. The purpose of the plans is to highlight the main actions that should be considered for spills in typical settings. Recommended national criteria are being developed for concentrations of PCBs in various media and will be published separately.

Spills into containment systems:

Notify authorized personnel and appropriate authorities of spill and cleanup intentions.

Take precautions to avoid personal contamination (see Section 7.2.3).

Pump PCB liquids into drums. If impossible to pump, soak up PCB liquids with sorbents such as those listed in Section 7.2.1.

Wipe area clean with rags and appropriate solvent, such as Varsol, turpentine, No. 1 fuel oil, or kerosene.

Dispose of all contaminated cleanup materials and waste PCB liquid.

Spills on concrete or asphalt:

Control the spread of the spill.

Notify authorized personnel and appropriate authorities of spill and cleanup intentions.

Take precautions to avoid personal contamination (see Section 7.2.3).

Plug or dyke all drains to sewers and ditches.

Soak up PCB liquids with sorbents of the type listed in Section 7.2.1.

Wipe area clean with rags and appropriate solvent, such as Varsol, turpentine, No. 1 fuel oil, or kerosene.

Take core samples to determine penetration and need to excavate.

If necessary remove contaminated surface material and handle as PCB waste.

Dispose of contaminated materials and waste PCB liquid.

Spills on soil:

Control the spread of the spill by building dykes to contain the PCB liquids.

Notify authorized personnel and appropriate authorities of spill and cleanup intentions.

Take precautions to avoid personal contamination (see Section 7.2.3).

Pump PCB liquids to drums. If impossible to pump, soak up PCB liquids with sorbents such as those listed in Section 7.2.1.

Dispose of contaminated cleanup materials and waste PCB liquid.

Take core samples to determine penetration and need to excavate.

If necessary remove contaminated soil and handle as PCB waste.

If requested by the local regulatory authority monitor wells and other waters in proximity of spill for PCB contamination.

Spills into water bodies:

Notify authorized personnel, downstream water filtration plants, and appropriate authorities of spill and cleanup intentions.

Take precautions to avoid personal contamination (see Section 7.2.3).

Dam area if possible and close off to vessels in navigable waters.

Use dredges to collect contaminated sediment.

Dispose of contaminated materials as PCB waste.

PCB-solid spills:

Spills of PCB solids should be removed by shovelling or scooping the solid into drums, followed by wiping the contaminated area, where possible, with a solvent.

The drummed solid waste and contaminated cleaning materials should be disposed of as PCB waste.

Spill control kit:

Equipment and materials for the cleanup of PCB spills, such as sorbents, pumps, solvents, cleaning rags, plugs for blocking drains, and portable dykes, should be stored together as a PCB "spill control kit" within easy access of a PCB storage area. All persons authorized to work in a PCB storage or disposal area should be familiar with the location of the "spill control kit" and be thoroughly trained in its use. They should also be familiar with methods of packaging and handling of PCB-contaminated waste generated in the cleanup.

7.2.3 Personal Safety Equipment and First Aid

Cleanup personnel should take care to avoid contact with PCBs and volatile cleaning solvents. Protective equipment, appropriate to the degree of hazard of a specific spill, should be worn at all times and must comply with the appropriate federal and provincial regulations. It is recommended that the following protective equipment and clothing be available, all of which should be made of PCB-resistant materials (see Table 1).

- disposable coveralls that completely cover arms and legs;
- gloves with high gauntlets that completely cover hands and wrists;
- boots and splash aprons;
- tight-fitting chemical resistant goggles or full face shield; and
- clothing of heat-resistant materials when working with hot liquids.

If exposure to hot PCB liquid (>55°C) or volatile cleaning solvents is anticipated for more than short intervals during cleanup, it is recommended that self-contained breathing apparatus be worn. References 5 and 6 guidance on protective clothing and equipment.

During spill cleanup, it is recommended that the cleanup area be well ventilated to minimize exposure to PCB vapour or volatile solvents. Cleanup personnel should take care to avoid splashing PCB liquids and should decontaminate or dispose of all protective equipment and clothing that have been contaminated with PCBs. Workers should remove contaminated protective equipment before leaving the spill area in order to limit the spread of PCBs from the area.

If a person is exposed to PCBs during a cleanup or in any other situation, the appropriate Labour and Health officials should be notified and the first aid treatments shown in Table 4 followed.

TABLE 4 FIRST AID FOR EXPOSURE TO PCB LIQUIDS

Exposure Type	First Action	Second Action
PCB liquids on skin	Wash thoroughly with soap and water.	See physician if rash develops.
PCB liquid in eyes	Flush eyes with gentle stream of lukewarm water for 15 minutes keeping eyelids apart.*	See physician.
PCB/chlorobenzene liquids swallowed	Do not give victim anything to drink, rinse out mouth with water.	Write down details about the swallowed liquid and take victim to hospital emergency or physician immediately.
Strong PCB/ chlorobenzene fumes, e.g., vapour from PCBs and chlorobenzenes	Get victim into fresh air.	If discomfort does not clear up, take victim to physician.

* An on-site eye wash station should be provided where PCBs are handled frequently.

7.3 Emergency Procedures for Fires Involving PCBs

Although PCBs are classified as non-flammable liquids, they will burn at elevated temperatures. As a result, PCB liquids should be stored in isolation from other flammable materials (such as oils, coal, wood products and compressed gases). Fires involving PCBs are smoky and yield large amounts of black oily soot. This soot may be contaminated with PCBs, PCDFs and, if chlorobenzenes are present in the PCB fluid, PCDDs (17).

Polychlorinated biphenyl fires are typically "small" and are easily extinguished with chemical foam, nitrogen flood, or carbon dioxide. Water should not be used as an extinguishing agent as contaminated water is very difficult to contain in an emergency situation and could spread contamination. In the case of PCB fires in electrical equipment, always disconnect the equipment from its power source before attempting to extinguish the fire.

Because most of the contamination resulting from a fire involving PCBs is not from PCB liquid release, but from contaminated soot, the transport of soot during the fire must be minimized. This can be accomplished by:

- extinguishing the fire as soon as possible; and
- shutting down the ventilation system in the fire area.

The automatic ventilation shut-off, where available, should be triggered by the fire alarm system in the PCB location. Unnecessary personnel working in the area of a PCB fire should leave immediately. The local fire department and company PCB-response personnel should always be kept up-to-date on the location of PCB equipment and PCB storage on a particular property so that they are fully aware of the special hazards in the event of a fire.

Recommendations to prevent contamination by PCDFs in fires involving electrical equipment containing PCBs are given in an Environment Canada report (17).

Response to PCB fires falls into two distinct phases: a). extinguishing the fire; and b). cleanup of surfaces contaminated with PCB liquid and soot which may be contaminated with PCBs, PCDFs, and PCDDs. Polychlorinated biphenyl fires should be extinguished as soon as possible. Firemen should always be advised that they are dealing with a fire involving PCBs.

7.3.1 Protective Clothing. Firemen should ensure that all skin is covered to prevent exposure to smoke containing PCBs. The following protective clothing and equipment should be worn by all personnel entering the fire area:

- polyethylene/canvas jacket and pants,
- rubber boots,
- gauntlet gloves, and
- self-contained breathing apparatus such as that produced by Mine Safety Appliances Company or a Scott Airpak.

Protective clothing that cannot be decontaminated should be disposed of immediately after the fire, and all responding firemen should shower thoroughly to remove any soot that may have contacted uncovered skin. If a fireman develops a skin rash after the fire, he should go for a medical checkup.

7.3.2 Cleanup Procedures. Once the fire has been extinguished, the amount of surface contamination (PCBs, PCDFs, PCDDs) from the PCB soot should be determined and, if necessary, cleanup procedures undertaken. These procedures are similar to those recommended for surfaces contaminated with PCB liquid. A three-step procedure should be followed:

- first, remove soot immediately from surfaces with a high efficiency vacuum;

- wash surfaces next with an industrial strength anionic cleaner, such as Triton X-100 and water; and
- finally, wash surfaces with one of the decontamination solvents recommended in Section 7.2.1.

Care should be taken to prevent the release of PCBs, PCDFs and PCDDs to the environment. Contaminated soot, water and cleansers should be collected and disposed of as PCB waste. In large-scale cleanups, PCB-contaminated water can also be treated for removal of PCBs by filtration through activated carbon filters (17) or reverse osmosis (18). The water should be continuously recycled until the PCB concentration meets provincial and municipal minimum requirements for release to the sewer system. Cleanup personnel should remove contaminated clothing, shower and then enter an uncontaminated "clean area" to change into street clothes. Air leaving the contaminated area should be exhausted through a high efficiency filtration system (17). Spent filters from air and water treatment systems should be handled as a PCB solid waste. This waste, along with discarded clothing and cleanup materials should be stored securely to await destruction by incineration.

Cleanup personnel should wear protective clothing and self-contained breathing apparatus at all times during the cleanup procedure. The protective clothing should be:

- light-weight because of the activity required in the cleanup process;
- PCB resistant; and
- either easy to decontaminate or discardable.

Fires involving PCBs should be reported to local and provincial environmental authorities as well as to Environment Canada, and these agencies should also be kept informed of the progress of the cleanup. Because of the special hazard and toxicity of PCDFs and PCDDs, surfaces must be decontaminated to extremely low levels of these contaminants. Cleanup personnel should consult the regulatory authorities identified previously to determine the required level of decontamination and the testing methods required to determine it. Washing should be repeated until the surface contamination is reduced to the required level.

7.4 Emergency Response to a Transportation Accident

Spills or fires involving PCBs during transportation should be responded to in the manner described in Sections 7.2 and 7.3. During transportation, a spill control kit should be readily available. Personnel responsible for transport vehicles (conductors or

drivers) should be thoroughly trained on what actions to take in the event of a PCB spill. The "Special Handling/Emergency Instruction" section of the manifest form should be read and understood by the conductor or driver before transportation commences.

In the event of an emergency involving a spill, the PCB leak should be contained inside the vehicle if possible. Plastic sheets should be placed under the vehicle to prevent PCB contamination of the ground underneath. The special actions spelled out in the manifest should be followed and the driver or conductor should then call the appropriate emergency telephone number given on the manifest.

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