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Guidelines for PCBs and PCB-containing equipment packaging, and transportation



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1. FOREWORDS

PCBs are very stable compounds which are characterized by an extremely low flammability and a very high dielectric coefficient. Due to these properties, PCBs were mainly used as dielectric in transformers and other electrical equipment. Therefore, PCBs does not represent directly a fire or explosion hazard, which in a sense make their transportation and packaging less problematic than other hazardous substances.

However, PCBs are extremely toxic and persistent; if exposed to fire or high temperature. PCBs may easily generate the more toxic dioxins and dibenzo-furans (PCDD/Fs), Due to their persistence, toxicity, and long-range mobility. The release of PCBs caused by an accident during transportation, loading or unloading may result in long term and global harm to the environment and the human health.

PCBs hazardous waste are classified as like pure PCB's oil

1. Dielectric oil contaminated by PCB's
2. Electrical equipment containing PCB's.
3. And in some cases PCB's contaminated soil

And are therefore subjected to the national and international obligations concerning the transport of hazardous waste.

However PCBs electrical equipment may be not a waste; The Stockholm convention allows the use of PCBs electrical equipment which is "*intact and non-leaking equipment and only in areas where the risk from environmental release can be minimized*" until 2028. Therefore the transportation of PCB's containing equipment occurs locally for different purposes rather than disposal.

This guidance document has been prepared with the main purpose to provide practical indications, compliant with the national Indian regulation and the international conventions, for the packaging and transportation of waste and electrical equipment containing PCBs in India. This activity is part of the UNIDO/GEF project "Environmentally Sound Management and Final Disposal of PCBs in India" (hereinafter the "India PCBs project")

2. INTERNATIONAL CONVENTIONS ON POPS AND HAZARDOUS WASTE

2.1. STOCKHOLM CONVENTION

India is a Party to the Stockholm Convention on Persistent Organic Chemicals. The Stockholm Convention on POPs explicitly requires to identify, label and remove from use equipment containing more than 10 per cent PCBs and volume greater than 5 litres, to identify, label and remove from use equipment containing more than 0.05 per cent (0.05 ppm) PCB and volumes

greater than 5 liters, and to identify and remove from use equipment containing more than 0.005 percent (0.005 ppm) PCB and volumes greater than 0.05 liters..

Definition of PCBs. The Stockholm Convention sets the following definition of PCBs under annex C (Unintentional Production):

- (a) "Polychlorinated biphenyls" means aromatic compounds formed in such a manner that the hydrogen atoms on the biphenyl molecule (two benzene rings bonded together by a single carbon-carbon bond) may be replaced by up to ten chlorine atoms;

No specific requirements on packaging and transportation of PCBs equipment and PCBs waste have been set by the Stockholm Convention.

2.2. BASEL CONVENTION

The main objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" based on their origin and/or composition and their characteristics, as well as two types of wastes defined as "other wastes" (household waste and incinerator ash; article 1 and annex II).

The provisions of the Convention center around the following principal aims: (i) the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal; (ii) the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and (iii) a regulatory system applying to cases where transboundary movements are permissible.

India is a Party to the Basel Convention on transboundary movement of hazardous wastes.

Article 1 of the convention ("Scope of Convention") outlines the waste types subject to the Basel Convention. Subparagraph 1 (a) of that Article sets forth a two-step process for determining whether a "waste" is a "hazardous waste" subject to the Convention: first, the waste must belong to any category contained in Annex I to the Convention ("Categories of Wastes to be Controlled"), and second, the waste must possess at least one of the characteristics listed in Annex III to the Convention ("List of Hazardous Characteristics").

Annex I of the convention lists the waste to be controlled, of which the following are PCBs containing waste:

- **Y10.** Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)
- **Y45.** Organo halogen compounds other than substances referred to in this Annex (e.g., Y39, Y41, Y42, Y43, Y44)

Some other waste listed in Annex I may contain PCBs under certain circumstances:

- Y6 Wastes from the production, formulation and use of organic solvents
- Y8 Waste mineral oils unfit for their originally intended use
- Y9 Waste oils/water, hydrocarbons/water mixtures, emulsions
- Y11 Waste tarry residues arising from refining, distillation and any pyrolytic treatment
- Y12 Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish
- Y13 Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives
- Y14 Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known
- Y18 Residues arising from industrial waste disposal operations.
- Y39 Phenols; phenol compounds including chlorophenol.
- Y41 Halogenated organic solvents.
- Y42 Organic solvents excluding halogenated solvents.
- Y45 Organohalogen compounds other than substances referred to in this Annex (e.g., Y39, Y41, Y42, Y43, Y44)

List A of Annex VIII describes wastes that are “*characterized as hazardous under Article 1 paragraph 1(a) of this Convention*” although “*designation of a waste on Annex VIII does not preclude the use of Annex III (hazard characteristics) to demonstrate that a waste is not hazardous*” (Annex I, paragraph (b)). List B of Annex IX lists wastes which “*will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic*”. The following Annex VIII waste categories in particular are applicable to PCBs, PCTs or PBBs:

- A1180 Waste electrical and electronic assemblies or scrap containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III;
- A3180 Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), polychlorinated terphenyl (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more

2.3. UN ADR

The "Agreement concerning the International Carriage of Dangerous Goods by Road" (ADR Rules) . (Established by the United Nations Economic Commission for Europe) commonly known as ADR,

represents the standard international reference for packaging, transportation and consignment of hazardous goods.

India is not a contracting party of ADR. It's an agreement between the States, and there is no overall enforcing authority. In practice checks are carried out by Contracting Parties, may result in legal action by national authorities against offenders.

ADR applies to transport operations performed on the territory of at least two Contracting Parties. However, Annexes A and B (the technical part) of ADR have also been adopted by some Contracting Parties (all the EU Member States) as the basis for regulation of the carriage of dangerous goods by road within and between their territories (Directive 2008/68/EC on the inland transport of dangerous goods). A number of non-EU countries have also adopted Annexes A and B of ADR as the basis for their national legislation.

Whenever detailed standards on the transportation of PCBs are not established by local regulation, annexes A and B of the ADR rules may represent a suitable technical reference.

ADR rules establish standards, requirements and technical specification on:

- Classification of goods, including classification criteria and relevant test methods;
- Use of packaging (including mixed packing);
- Use of tanks (including filling);
- Consignment procedures (including marking and labeling of packages and placarding and marking of means of transport as well as documentation and information required);
- Use of means of transport (including loading, mixed loading and unloading).
- Emergency procedures;
- Checking of the transported goods;
- Training.

Under the ADR rules, hazardous goods are classified in 9 classes and several subclasses. PCBs are classified in Class 9 (Miscellaneous dangerous substance and articles). The following subclasses also apply to PCBs:

1. M2: substance and apparatus which, in the event of fire, may form dioxins;
2. M6: Pollutant to the aquatic environment, liquid

The ADR rules specify the maximum total quantity per transport unit which can be transported adopting simplified provisions. However, for PCBs these simplified provisions do not apply. The ADR rules also specify procedures for loading and unloading, as well as the requirement for the transporter and the transportation vehicle.


The ADR rules also set procedures to be followed in case of accidents, including the type of information which has to be passed to the relevant authorities.

2.4. GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS (GHS)

The Globally Harmonized System was initiated at the UN Conference on the Environment and Development in Rio de Janeiro in 1992. The "Globally Harmonized System of Classification and Labeling of Chemicals (GHS)", gives the information about the types of hazard, and gives the proper information about the labels and safety data sheets.

The main aim of these systems is to provide safety measures to the peoples to protect their health and environment during handling. It also provides a basis rules and regulations on chemicals at national, regional and worldwide level. In Table 1, GHS classification and hazard phrases for PCBs are reported.

Table 1. GHS classification and hazard phrases for PCBs

Substance Identification:	Name: polychlorobiphenyls; PCB	CE Number: 215-648-1 CAS Number: 1336-36-3
Hazard classification and category codes:	STOT RE 2* Aquatic Acute Aquatic Chronic	May cause damage to respiratory system through prolonged or repeated exposure. Hazardous to the aquatic environment, chronic and acute
Hazard statement (code)	H373** H400 H410	H373: May cause damage to respiratory system through prolonged or repeated exposure. H400: Very toxic to aquatic life H410: Very toxic to aquatic life with long lasting effect
Pictogram and sign warning codes	GHS08 GHS09 Wng	
Hazard statement (code)	H373 ** H410	H373: May cause damage to respiratory system through prolonged or repeated exposure.
Supp. Hazard Statement		
Specific Concentration Limit	STOT RE 2 H 373: C ≥ 0,005%	
Note	C	The supplier must state on the label whether the substance is a specific isomer or a mixture of isomers.

India currently uses a combination of lists and laws to classify chemicals and govern their storage and handling, including the law concerning the Manufacture, Storage and Transport of Hazardous Chemical Rules of 1989, which is not confirm to GHS.

The Ministry of Environment and Forests, Government of India has published the Hazardous Substance (Classification, Packaging and Labeling) (draft) Rules, 2011 for public information to submit objections or suggestions within 60 days starting from 8th July, 2011. They have received

suggestions and objections put up in the meeting of the constituted Expert Committee held on 2nd and 18th February, 2012. It is learnt that the Committee may further hold meetings in the month of March-April for finalization of the draft rules. After submission of the final draft by the Committee to the Ministry, an internal meeting may be called. In this process, the Government of India may take 5-6 months to promulgate the final rules.

Some of the salient points of India's new GHS draft rules are:

- Responsibilities in the supply chain will be prescribed;
- All dangerous goods will have to have a UN number and proper shipping name according to their assigned hazard classification and composition;
- Suitable labelling and packaging will have to be used, along with updated safety data sheets;
- People engaged in the handling, storage and transport of dangerous goods will have to be trained.

3. INDIAN LEGISLATION

3.1. THE HAZARDOUS WASTE RULES

Conditions for the transportation, export and import of hazardous waste are also established under the Hazardous Waste Rules, Chapter IV.

Import and Export Of hazardous waste:-

The Ministry of Environment And Forest shall be the nodal Ministry to deal with the trans-boundary movement of the hazardous wastes and to grant permission for transit of the hazardous wastes through any part of India.

1. No import of the hazardous wastes from any country to India for disposal shall be permitted.
2. The import of hazardous waste from any country shall be permitted only for the recycling or recovery or reuse.
3. The export of hazardous wastes from India may be allowed to an actual user of the wastes or operator of a disposal facility with the Prior Informed Consent.

The Hazardous Waste rules requires that hazardous waste are packaged and labeled *"based on the composition in a manner suitable for safe handling, storage and transport as per the guidelines issued by the Central Pollution Control Board from time to time"* (Chapter VI, article 19) chapter VI, article 19. States that

1. The occupier or operator of the treatment , storage and disposal facility or recycler shall ensure that the hazardous waste are packed and labeled , based on the composition in a

manner suitable for safe handling , storage and transport as per the guidelines issued by the Central Pollution Control Board from time to time.

2. The labeling and packaging shall be easily visible and be able to withstand physical conditions and climatic factors.

Article 20 of the Hazardous Waste Rules establishes that *“The transport of the hazardous wastes shall be in accordance with the provisions of these rules and the rules made by the Central Government under the Motor Vehicles Act, 1988, and other guidelines issued from time to time in this regard.”*

Transportation from a State to another State in India is also subjected to special rules (Chapter VI, article 20):

1. The transporter of the hazardous wastes shall be in accordance with the provisions of these rules and the rules made by the Central Government under the Motor Vehicle Act. 1988 and other guidelines issued from time to time in this regard.
2. The occupier shall provide the transporter with the relevant information regarding the type of hazardous wastes and measures to be taken in case of emergency and shall mark the hazardous wastes containers.
3. In case of transport of hazardous wastes for the final disposal to a facility for treatment, storage and disposal existing in a State other than the State where the hazardous waste is generated , the occupier shall obtain ‘No objection Certificate’ from the State Pollution Control Board of the both states.
4. In case of transportation of hazardous wastes through a State other than the State of origin or destination, the occupier shall intimate the concerned State Pollution Control Boards before he hands over the hazardous wastes to the transporter.

For the movement within the country, hazardous wastes are subjected to the Manifest System (Chapter VI, article 21).

Article 21 states that,

1. The occupier shall prepare six copies of the manifest comprising of color code indicated below and all six copies shall be signed by the transporter.
2. The occupier shall forward copy 1(white) to the State Pollution Control Board, and in case the hazardous wastes is likely to be transported through any transit State, the occupier shall prepare an additional copy each for intimation to such State and, forward the same to be concerned State Pollution Control Board before he hands over the hazardous wastes to the transporter.
3. No transporter shall accept hazardous wastes from an occupier for transport unless it is accompanied by copies 3 to 6 of the manifest.

4. The transporter shall submit copies 3 to 6 of the manifest duly signed with date to the operator of the facility along with the waste consignment.
5. Operator of the facility upon completion of treatment and disposal operations of the hazardous waste shall forward copy 5 to the State Pollution Control Board and copy 6 to the occupier and the copy 3 shall be retained by the operator of the facility.

Copy number with color code	Purpose
Copy 1(White)	To be forwarded by the occupier to the State Pollution Control Board or Committee.
Copy 2(Yellow)	To be carried by the occupier after taking signature on it form the transporter and the rest of the four copies to be carried by the transporter.
Copy 3(Pink)	To be retained by the operator of the facility after signature.
Copy 4(Orange)	To be returned to the transporter by the operator of facility/recycler after accepting waste.
Copy 5(Green)	To be returned by the operator of the facility to State Pollution Control Board /Committee after treatment and disposal of waste.
Copy 6(Blue)	To be returned by the operator of the facility to the occupier after treatment and disposal of hazardous waste /materials.

Under the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008, Schedule II, waste containing 50 ppm or more of PCBs are considered hazardous waste of class A.

Under rule Schedule VI of the Hazardous Waste rules, the import and export of waste, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl's (PCB) and/or polychlorinated terphenyls, (PCT) and/or polychlorinated naphthalene (PCN) and/or polybrominated biphenyl's (PBB) or any other polybrominated analogues of these compounds is prohibited.

3.2. THE “MOTOR VEHICLE ACT” (1988) AND THE “CENTRAL MOTOR VEHICLE RULES”, (1989)

The Motor Vehicle Act was issued in 1988 to consolidate and amends the law relating to motor vehicles and the “Central Motor Vehicle Rules” is firstly issued in 1989, which represents the practical rules about driving, licensing, motor vehicle registration traffic rules, insurance, penalties, etc. Some of the more important provisions of Motor Vehicles Act which are relevant to the transportation of hazardous good include:

- a) (a)Stricter procedures relating to grant of driving licences and the period of validity thereof;
- b) Enabling provision for updating the system of registration marks;
- c) Liberalised schemes for grant of stage carriage permits on non nationalised routes, all-India Tourist permits and also national permits for goods carriages;
- d) Provision for payment of compensation by the insurer to the extent of actual liability to the victims of motor accidents irrespective of the class of vehicles;
- e) Maintenance of State registers for driving licences and vehicle registration;
- f) Constitution of Road Safety Councils.

Rules 134 to 137 of the CMVR establish the regulation for the transportation of hazardous goods. These rules contain information about the specification relating to the vehicle transporting the hazardous goods, instructions for the drivers carrying dangerous goods, obligation of reporting accidents, classification of substances and hazardous goods. There rules are reported in Table 2 as follows.

Table 2. Rules 134 to 137 of the Central Motor Vehicles Rules. (Rule 137 is summarized).

<p>Rule 134. Emergency Information Panel.</p> <p>1. Every goods carriage used for transporting any dangerous or hazardous goods shall be legibly and conspicuously marked with an emergency information panel in each of the three places indicated in the Table below so that the emergency information panel faces to each side of the carriage and to its rear and such panel shall contain the following information, namely:—</p> <ol style="list-style-type: none"> i) the correct technical name of the dangerous or hazardous goods in letters not less than 50 millimetres high; ii) the United Nations class number for the dangerous or hazardous goods as given in Column 1, Table 1 appended with rule 137, in numerals not less than 100 milimetres high; iii) the class label of the dangerous or hazardous goods of the size of not less than 250 millimetres square; iv) the name and telephone number of the 	<p>R-135 Drivers to be instructed.</p> <p>The owner of every goods carriage transporting dangerous or hazardous goods shall ensure to the satisfaction of the consignor that the driver of the goods carriage has received adequate instructions and training to enable him to understand the nature of the goods being transported, by him, the nature of the risks arising out of such goods, precautions he should take while the goods carriage is in motion or stationary and the action he has to take in case of any emergency.</p> <p>Rule 136 Report of accidents by Driver to Police Station.</p> <p>The driver of a goods carriage transporting any dangerous or hazardous goods shall, on the occurrence of an accident involving any dangerous or hazardous goods transported by this carriage, report forthwith to the nearest police station and also inform the owner of the goods carriage or the</p>
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emergency services to be contacted in the event of fire or any other accident in letters and numerals that are not less than 50 millimetres high and the name and telephone number of the consignor of the dangerous or hazardous goods or of some other person from whom expert information and advice can be obtained concerning the measures that should be taken in the event of an emergency involving such goods.

2. The information contained in sub-rule (1) shall also be displayed on the vehicle by means of a sticker relating to the particular dangerous or hazardous goods carried in that particular trip.]
3. Every class label and emergency information panel shall be marked on the goods carriage and shall be kept free and clean from obstructions at all times.

transporter regarding the accident.]

Rule 137 Display of Class Labels.

Rules 137 provide the classification of hazardous goods to be transported. UN Class from 1 to 8 are listed in table I; criteria for classifying hazardous goods are listed in table II. Table III contains the list of Hazardous Goods, which however do not include PCBs.

Figure 1. Position of the Emergency Information Panels as from the Rule 134

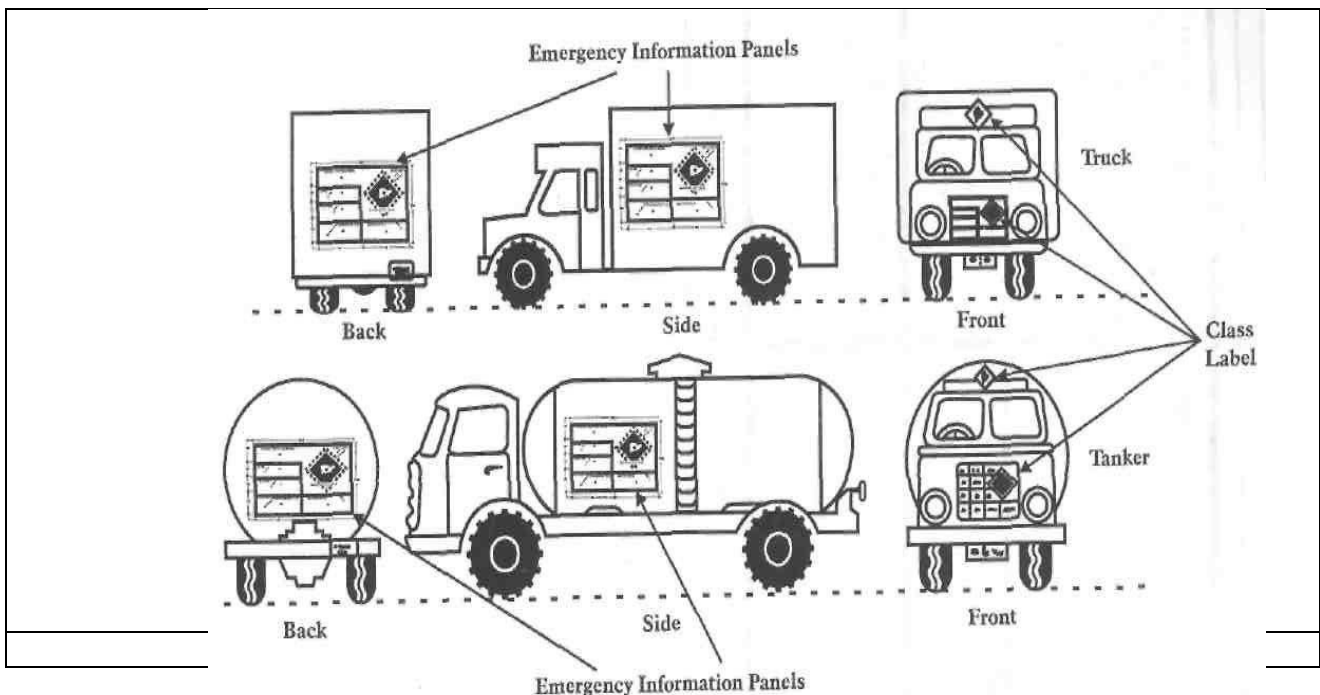
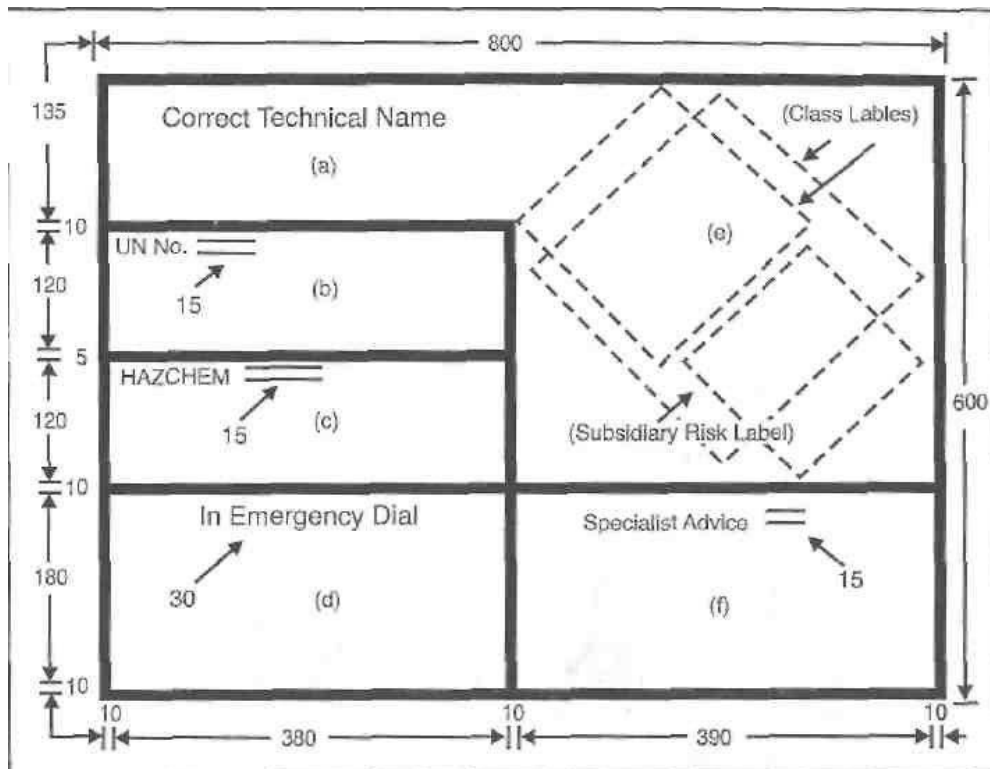


Figure 2 Content of the Emergency Information Panels as from the Rule 134



3.3. RELATIONSHIP BETWEEN HAZARDOUS WASTE RULES AND CENTRAL MOTOR VEHICLE RULES

The hazardous waste rules requires that Hazardous waste must be packaged and labeled. “Based on the composition in a manner suitable for safe handling, storage and transport as per the guidelines issued by the Central Pollution Control Board from time to time” (Chapter VI, article 19).

In addition, Article 20 of the Hazardous Waste Rules establishes that *“The transport of the hazardous wastes shall be in accordance with the provisions of these rules and the rules made by the Central Government under the Motor Vehicles Act, 1988, and other guidelines issued from time to time in this regard.”*

Furthermore, PCBs are not classified as hazardous goods under the classification scheme established by the Central Motor Vehicles Rules. This because:

- Table 1 of the rule 137 contains the first 8 UN ADR classes, but not class 9 (Miscellaneous dangerous substances and articles) to which PCBs pertain;
- None of the criteria listed in Table II of rule 137 fits PCBs features;
- PCBs are not listed among the hazardous goods listed in Table III.

Therefore, although the CMVR establish important rules for the transportation of hazardous goods, apparently these do not apply to PCBs containing equipment or waste. A decision relating to PCB’s should be adopted under the Power of regional Transport authority of Article 79 of MVA established that a;

“Regional Transport Authority may, on an application made to it under section 77, grant a goods carriage permit to be valid throughout the State or in accordance with the application or with such modifications as it deems fit or refuse to grant such a permit.” The conditions for the issuance of that permit *“may include conditions relating to the packaging and carriage of goods of dangerous or hazardous nature to human life”*.

For filling the gap of technical requirements for packaging and transporting of PCBs under the India PCB project, which are currently missing, a possible solution could be to adopt the Central Motor Vehicle Rules for hazardous goods, integrated by the ADR rules, as a voluntary demonstration scheme.

It has also to be noted that, in the current situation, for equipment containing PCBs which is not a waste (like PCBs contaminated transformers transported for maintenance) neither the provisions under the Hazardous Waste Rules or the provisions for the transportation of hazardous goods under the Motor Vehicles act or Central Motor Vehicles Rules would apply.

Even in this case, it is proposed to adopt, under the India PCBs project, a voluntary amendment of the current legislative framework, so that PCBs containing equipment can be classified as hazardous goods and subjected to provisions for hazardous goods under motor vehicle act and Central Motor Vehicle Rules.

A graphical summary of the proposal amendment is reported in Figure 3 and Figure 4

Current Situation

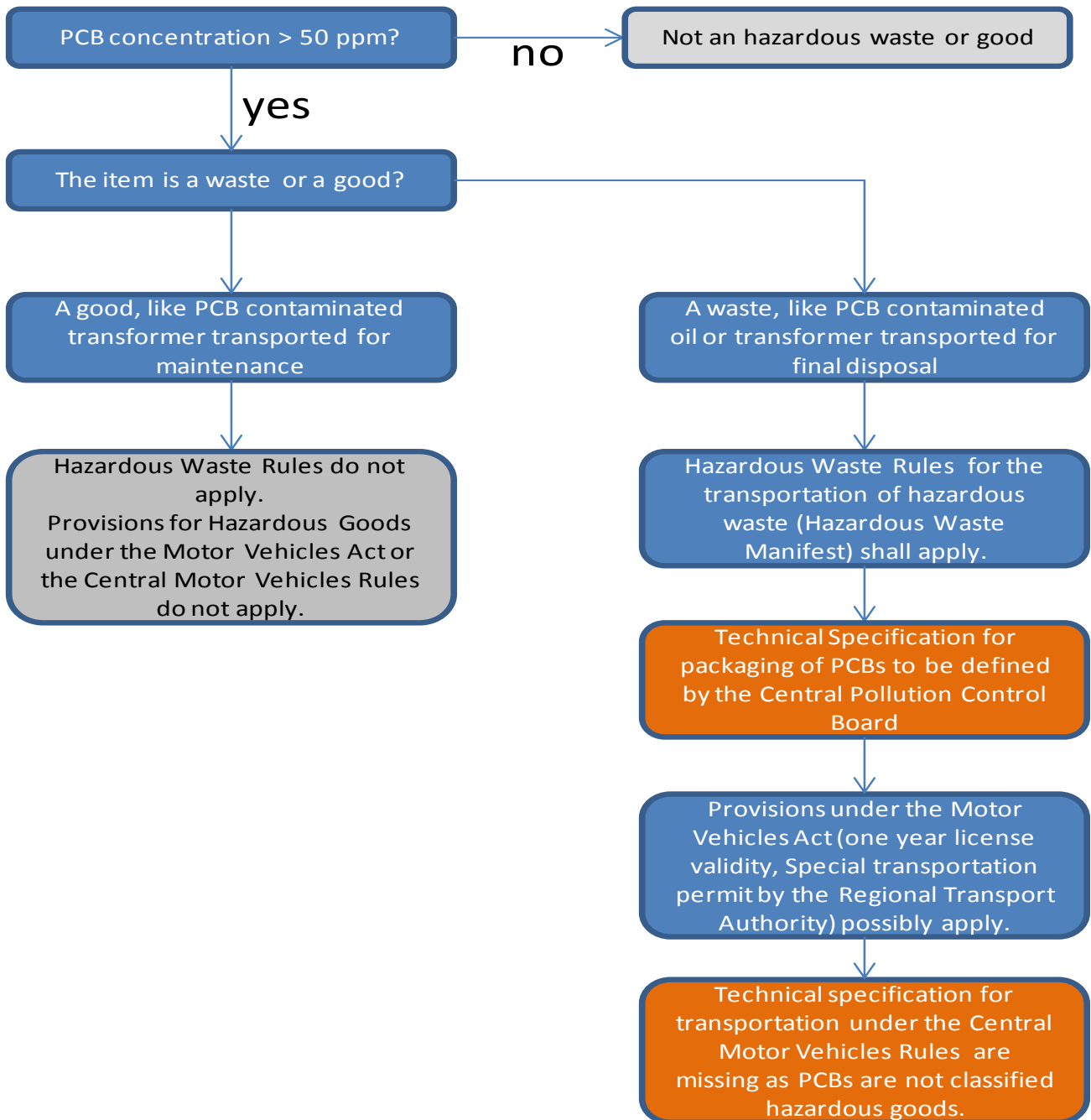


Figure 3. Application of the Hazardous Waste rule and the Motor Vehicles Act. Current situation.

Proposed amendmend under PCB project

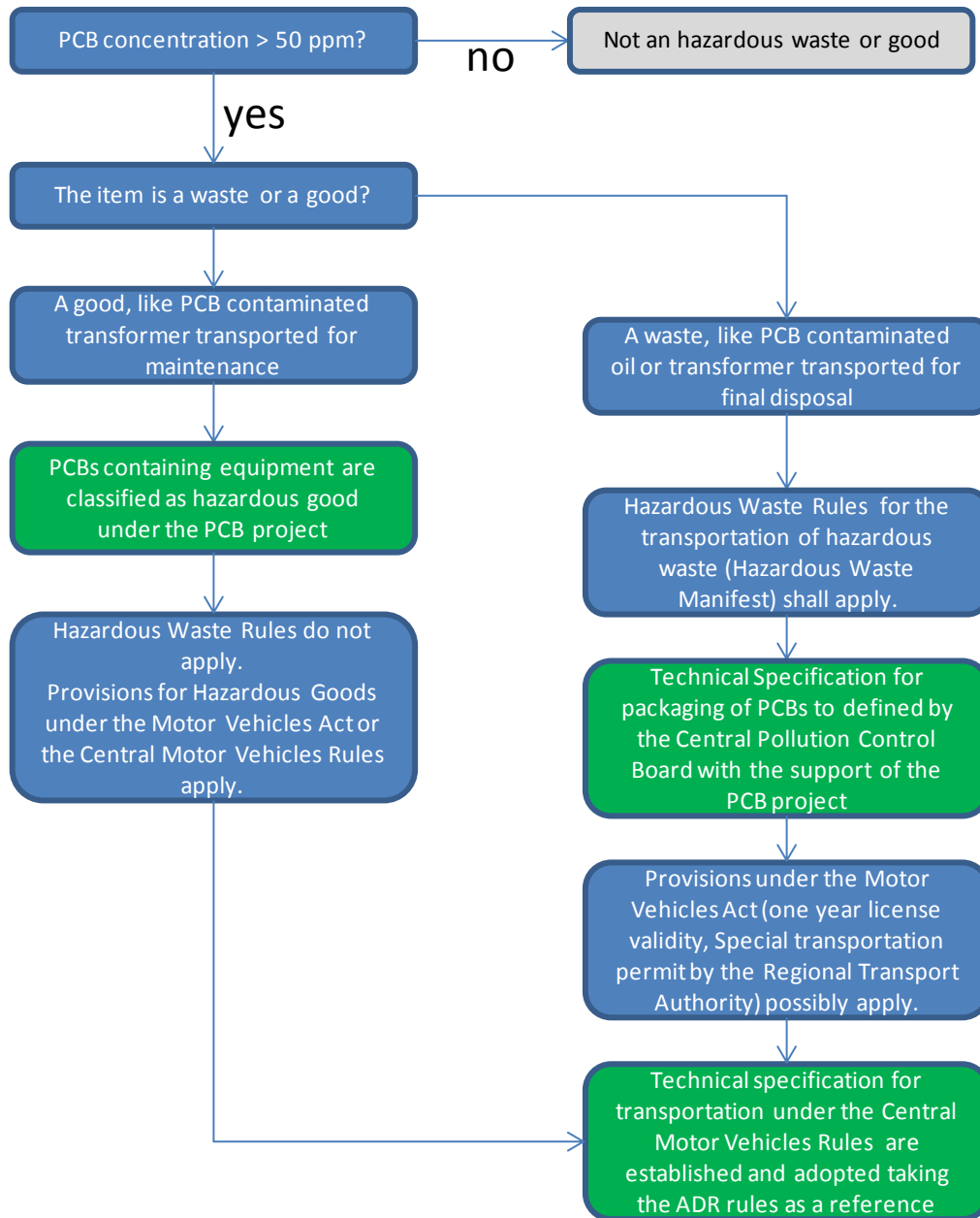


Figure 3. Application of the Hazardous Waste rule and the Motor Vehicles Act. Proposed amendmend under the PCB project.

4. HAZARD CLASSIFICATION FOR PCBs

To prevent from the risk of PCB's some measures we should be adopted in packaging and transportation of hazardous substances and PCB's particular.

The hazard properties of PCBs are summarized below.

Chemical identification. Poly Chlorinated Biphenyls (CAS number 1336-36-3) are a class of chlorine substituted biphenyls, with 209 possible isomers. Usually, PCBs are found in commercial mixtures made by several PCBs isomers differing from their level of chlorine substitution. For instance, the Aroclor mixtures may contain PCBs with an average chlorine content (as weight percentage) ranging from 10% (for the Aroclor 1210) to 68% (for the Aroclor 1268).

Chemical and physical properties. Depending on the level of chlorination, the molecular weight of PCBs ranges from 188.72 (for the Chloro-Biphenyl) to 498.72 for the fully chlorine-substituted Decachloro Biphenyl. Several physical and chemical properties of PCBs vary with the level of chlorination.

- **Water solubility:** PCBs are non-polar compounds. Their non-polar nature makes them only slightly soluble in water. In general the water solubility of PCBs is very low and decreases with the increase of chlorine substitution. It ranges from an order of magnitude of 1 mg/L for dichloro biphenyls, to an order of magnitude of around 0.01 mg/L for the pentachloro biphenyls.
- **Vapor pressure:** the vapor pressure of PCBs is very low and decreases with the increase of chlorine substitution. It ranges from around 1.5×10^{-6} - 4.2×10^{-6} for dichlorinated biphenyls to 2.9×10^{-11} - 6.9×10^{-8} for hexachlorinated biphenyls.
- **Lipophilicity.** PCBs adsorb readily to organic compound. The Octanol / Water partition coefficient (KOW) is very high and increase with the increase of chlorine substitution. Experimental values ranges from a log KOW of 5.55 for PCB 40 (tetra-chlorinated biphenyl) to a log KOW of 7.52 for PCB 207 (Nonachloro Biphenyl).
- **Flammability.** PCBs are known for their very low flammability and chemical stability to high temperatures.
- **Electrical conductivity.** PCBs are known for being excellent dielectric compound, due to the almost null value of electrical conductivity.

Toxicity. Evidence of PCB toxicity was found in experimental animals: the toxic effects include skin disorders, weight loss, endocrine and reproductive disorders, carcinogenesis (liver carcinoma), etc. A number of studies investigating the carcinogenicity of PCBs highlighted their low genotoxicity: therefore they are thought to be cancer-promoting rather than cancer-initiator agents. No clear evidence was found with respect to the correlation between exposure to environmental levels of PCBs and cancer risk to humans or animals.

PCB mixtures show a wide range of toxic effect. Coplanar PCBs, also called "dioxin-like" PCBs, have toxic effect which are similar to those caused by 2,3,7,8-tetrachlorodibenzo-p-dioxin. For this category of PCBs, relative toxicities of dioxin-like compounds in relation to the reference

compound (2,3,7,8-tetrachlorodibenzo-p-dioxin, 2,3,7,8-Cl₄DD) were determined on the basis of experimental studies.

PCBs classification and hazard phrases under the GHS are reported in Table 1

5. PACKAGING OF PCBs

5.1. PURE PCB OIL AND MINERAL OIL CONTAMINATED BY PCBs

Dielectric oil and other fluids containing more than 50 ppm of PCBs are to be considered hazardous waste. Therefore, their transport in India is subjected to the Indian Hazardous Waste Rules (including the provisions concerning hazardous waste manifest). Under the PCBs project, it is proposed that pure PCBs oil and mineral oil containing PCBs is subjected to the rules 134 to 137 of the Central Motor Vehicle Rules.

Under ADR, mineral oil containing polychlorinated biphenyls or terphenyls, or polyhalogenated biphenyls or terphenyls, shall always be classified under class 9.

Under ADR, PCB liquid are classified with the UN number 2315. For this class of compounds, the ADR norms prescribe the following packaging requirements:

Table 3. ADR requirements for packaging of liquid PCBs

Un No.	Name and Description	Class	Classification code	Packaging Group	Labels	Special provisions	Limited and excepted quantity		Packaging			Portable tanks and bulk containers	
							1L	E2	Packing Instructions	Special Packing Provisions	Mixed Packing Provisions	Instructions	Special provision
2315	Polychlorinated Biphenyls, Liquid	9	M2	II	9	305	1L	E2	P906 IBC02		MP15	T4	TP1

Packing Instructions and special provisions as from the ADR rules are as following.

P906: For liquid and solids containing or contaminated with PCBs, poly-halogenated biphenyls and terphenyls: packaging in accordance to P001 (see table below):

Table 4. Technical specifications for the packaging of liquid PCBs – Single Packaging.

Single packagings	Maximum capacity for packing Group II
Drums Steel, non removable heads (1A1) Steel, removable heads (1A2) Aluminum, non removable heads (1B1) Aluminum, removable heads (1B2) Metal other than steel or aluminium, non removable heads (1N1) Metal other than steel or aluminium, removable heads (1N2) Plastic, non removable heads (1H1) Plastic, removable heads (1H2)	450 L
Jerricans Steel, non removable heads (3A1) Steel, removable heads (3A2) Aluminum, non removable heads (3B1) Aluminum, removable heads (3B2) Plastic, non removable heads (3H1) Plastic, removable heads (3H2)	60 L

Table 5. Technical specifications for the packaging of liquid PCBs – Composite Packaging.

Composite Packaging	Maximum capacity for packing Group II
<ul style="list-style-type: none"> Plastics receptacle with outer steel or aluminium drum (6HA1, 6Hb1) Plastics receptacle with outer fibre, plastics or plywood drum (6Hg1, 6HH1, 6HD1) 	250 L
<ul style="list-style-type: none"> Plastic receptacle wit outer steel or aluminium crate or box or plastics receptacle with outer wooden, plywood, fibreboard or solid plastics box (6HA2, 6HB2, 6HCm 6HD2, 6HG2 or 6HH2) Glass receptacle with outer steel, aluminium, fibreboard, plywood, solid plastics or expanded plastics drum (6PA1, 6BP1, 6PG1, 6PD1, 6PH1 or 6PH2) or with outer steel or aluminium crate or box or with outer wooden or fibreboard box or with outer wickerwork hamper /6PA2, 6PB2, 6PC, 6PG2 or 6PD2) 	60 L

Table 6. Technical specifications for the packaging of liquid PCBs – Combination Packaging.

Combination Packaging		Maximum capacity /net mass for packing Group II
Glass 10 L Plastics 30 L Metal 40 L	Drums Steel (1A2) Aluminum (1B2) Metal other than steel or aluminium (1N2) Plastics (1H2) Plywood (1D) Fiber (1G)	400 kg
Glass 10 L Plastics 30 L Metal 40 L	Boxes Steel (4A) Aluminum (4B) Natural wood (CC1, 4C2) Plywood (4D) Reconstituted wood (4F) Fibreboard (4G) Expanded plastic (4H1) Solid plastic (4H2)	400 kg except Expanded plastics (60kg)
Glass 10 L Plastics 30 L Metal 40 L	Jerricans Steel (3A2) Aluminum (3B2) Plastics (3H2)	120 kg

IBC02: The following Intermediate Bulk Containers (IBC) can be used:

Metal (31A, 31B and 31N)

Rigid plastics (31H1 and 31H2)

Composite (31HZ1)

In addition to the above, the ADR portable tank provisions specify the applicable minimum test pressure, the minimum shell thickness (in mm reference steel), and the pressure-relief and bottom opening equipment as following:

Minimum test pressure: 1.5 bar

Minimum shell thickness: The cylindrical portions, ends (heads) and manhole covers of shells not more than 1.8 m in diameter should not be less than 5 mm thick in the reference steel or of equivalent thickness in the metal to be used. Shells more than 1.8 m in diameter shall be not less than 6 mm thick in the reference steel or of equivalent thickness in the metal to be used, except that for powdered or granular solid substances of packing group II or III the minimum thickness requirement may be reduced to not less than 4 mm thick in the reference steel or of equivalent thickness in the metal to be used.

Pressure relief: Every portable tank with a capacity more than 1900 liters and every independent compartment of a portable tank with a similar capacity shall be provided with one or more pressure – relief devices of the spring-loaded type.

Bottom opening: Bottom discharge outlets for portable tanks carrying certain solid, crystallizable or highly viscous substances shall be equipped with not less than two serially fitted and mutually independent shut-off devices. The design of the equipment shall be to the satisfaction of the competent authority or its authorized body and shall include:

- a) an external stop-valve, fitted as close to the shell as reasonably practicable, and so designed as to prevent any unintended opening through impact or other inadvertent act; and
- b) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

5.2. TRANSFORMERS, CAPACITORS AND OTHER PCBs CONTAINING EQUIPMENT

Transformers, capacitors and other PCBs containing equipment may be considered as “solid PCBs”, and are assigned with UN Number 3432. Under the ADR norms, the following packaging instructions shall apply:

Table 7. Technical specifications for the packaging of solid PCBs – Single Packaging.

Single packagings	Maximum capacity for packing Group II
Drums Steel (1A2) Aluminum (1B2) Metal other than steel or aluminum (1N2) Plastic (1H2) Plywood (1D) Fiber (1g)	400 kg
Boxes Steel (4A) Aluminum(4B) Natural wood (4C1) Natural wood (4C2) Plywood (4D) Reconstituted wood (4F) Fiberboard 4G) Expanded plastics (4H1) Solid plastics (4H2)	400 kg except Expanded plastics (60kg)
Jerricans Steel (3A2) Aluminum (3B2) Plastic (3H2)	120 kg

Table 8. Technical specifications for the packaging of solid PCBs – Composite Packaging.

Combination Packaging		Maximum capacity /net mass for packing Group II
Glass 10 kg Plastics ^a 50 kg Metal 50 kg Paper ^{a,b} 50kg Fibre ^{a,b} 50Kg ^a These inner packaging shall be sift proof ^b These inner packagings shall not be used when the substances being carried may become liquid during carriage	Drums Steel (1A2) Aluminum (1B2) Metal other than steel or aluminum (1N2) Plastic (1H2) Plywood (1D) Fiber (1g)	400 kg
	Boxes Steel (4A) Aluminum (4B) Natural wood (CC1, 4C2) Plywood (4D) Reconstituted wood (4F) Fiberboard (4G) Expanded plastic (4H1) Solid plastic (4H2)	400 kg except Expanded plastics (60kg)
	Jerricans Steel (3A2) Aluminum (3B2) Plastics (3H2)	120 kg

For transformers and capacitors and other devices: leak proof packaging which are capable of containing, in addition to the devices, at least 1.25 times the volume of the liquid PCBs or polyhalogenated biphenyls or terphenyls present in them. There shall be sufficient absorbent material in the packaging to absorb at least 1.1 times the volume of liquid which is contained in the devices. In general, transformers and condensers shall be leak-proof metal packagings which are capable of holding, at least 1.25 times the volume of the liquid present in them.

Transformers and capacitors cannot always be packaged for transportation. In this case, ADR rules specify that *“Liquid and solids not packaged in accordance with P001 and P002 (drums, boxes or jerricans) and unpackaged transformers and condensers may be carried in cargo transport units fitted with a leakproof metal tray to a height of at least 800mm, containing sufficient inert material to absorb at least 1.1 time the volume of any free liquid”*. (Part 4, Packing instruction P906), with the additional requirement that *“Adequate provisions shall be taken to seal the transformers and condenser to prevent leakage during normal conditions of carriage”*.

5.3. MARKING AND LABELLING OF PACKAGES.

The words “PCBs, Polychlorinated Biphenyls”, and the UN number corresponding to the PCBs (2315 for PCB liquids or 3432 for solid PCBs, preceded by the letters “UN”), shall be clearly and durably marked on each package.

All package markings will be readily visible and legible, and will be able to withstand open weather exposure without a substantial reduction in effectiveness.

Intermediate bulk containers of more than 450 liter capacity and large packaging will be marked on both sides.


Packages should be durably marked with the UN environmentally hazardous substance mark and with, in addition, the hazard mark specific for substances .

Information concerning the specific hazard presented by the PCBs waste / goods transported should be also contained in the label.

Emergency number to be called in case of emergency shall also be clearly marked.

In Figure 5, a proposed label for PCBs containing packages, developed on the basis of the graphical indication provided by Rule 134 of the Central Motor Vehicles Rules, and using as UN marks and labels those indicated for PCBs by the UN ADR standard is reported. Instead of the Hazchem number, which is not available for PCBs in India, the Basel Convention code Y10 is proposed.

Figure 5. Proposed label for PCBs containing packages

Poly Chlorinated Biphenyls PCB		
UN No. 2315		
HazChem Y10*		
In Emergency Dial 0091 11 123456789		
		<p>May cause damage to respiratory system through prolonged or repeated exposure.</p> <p>Very toxic to aquatic life with long lasting effect</p>

6. TRANSPORTATION OF PCBs

6.1. VEHICLE AND DRIVER REQUIREMENTS

The vehicle used for transporting PCBs shall comply with the relevant rules established under the Motor Vehicle Act and the Central Motor Vehicle Rules.

The drivers of the vehicle which is transporting the PCBs must have been passed a training course on the transportation of hazardous waste and on PCBs.

The drivers of the vehicle undertaking the transportation of PCBs should be in possess of the relevant driving license as required under the Motor Vehicle Act. It has to be noticed that under article 14 of the MVA, the driving license is *“effective for a period of one year and renewal thereof shall be subject to the condition that the driver undergoes one day refresher course of the prescribed syllabus “*

The drivers and the other persons engaged in the transportation of PCBs shall be in possess of an authorization from the State Pollution Control Board, as specified under Chapter II, article 5 of the Hazardous Wastes Rules, as well as the Grant for Carriage Permit as specified under article 79 of the Motor Vehicle Act.

In compliance with article 146 of the MVA, *“in the case of a vehicle carrying, or meant to carry, dangerous or hazardous goods, there shall also be a policy of insurance under the Public Liability Insurance Act, 1991 (6 of 1991)”*

Vehicle for the transportation of PCBs should be equipped with GPS, mobile phone and radio transmitter, so that the driver can easily communicate the position of the truck.

Vehicle for the transportation of PCBs should be equipped with the proper firefighting equipment, as well as all the equipment necessary for containing the accidental spill of PCBs, including proper PPEs.

6.2. ROUTE AND DRIVING REQUIREMENTS

Route for the transportation of PCBs should be planned in advance and communicated to the shipper and the addressee of the PCBs.

Route planning should include the positioning along the route of the following points of interest:

- Local public security;
- Hospitals;
- Fuel station (select the ones far from populated areas);
- Suitable parking lots and storage areas.

The planned route should be clearly described in the Hazardous Waste Manifest carried by the driver and any deviation from the planned route should be reported.

The driving time should be alternated by a sufficient rest time, as per relevant regulations in India.

The use of GPS is highly recommended to facilitate the planning of the trip and the communication of the position.

Areas within temporary storage terminals, temporary storage sites, vehicle depots, berthing areas and marshalling yards used for the temporary storage during carriage of PCBs shall be properly secured, well lit and, where possible and appropriate, not accessible to the general public.

7. TRAINING

The training shall be approved by the competent authority, on the basis of the submission of a detailed training programme, inclusive of the qualification of the training personnel.

The training shall be arranged in the following way:

General awareness: the personnel shall be familiar with the general requirements of the provisions for packaging and carriage of PCBs.

Function-specific training: the personnel shall receive training commensurate with their duties and responsibilities in the chain of packaging and transportation of PCBs.

Safety training: personnel shall be trained in the hazards and dangers presented by PCBs, with specific reference to the operation of packaging, filling, draining, loading, unloading.

Training for Drivers : Drivers of vehicles carrying PCBs shall attend a specific training course structured as following: safety drive rules; hazards related to the handling and transport of PCBs; emergency response: what to do in case of accident occurred during the transportation of PCBs (first aid, road safety, use of PPEs, etc.); use of positioning and radio devices; precaution to be taken during loading and unloading of PCBs; civil liability; security awareness; the hazardous waste manifest system.

8. EMERGENCY RESPONSE

In case of accidents like combustion, explosion, leakage, poisoning or stolen, loss, the driver and escorting personnel should immediately report to the local public security departments, firefighting corps if necessary, and the transport enterprises on the accident status, name of goods, harm and first-aid measures, take all possible alarming measures on site and actively cooperate with relevant departments for disposal. Transport enterprises should be immediately start emergency plans.

This means that the transportation team, before transportation, should collect the relevant contact numbers of the nearest public security departments and nearest rescue along the route, so that the intervention time in case of accident is minimized.

For the management of the emergency situation, the following practical consideration should be kept in mind.

- 1) PCBs are not flammable. However, if exposed to fire or high temperature, they can generate dioxins. Therefore, preventing contact of PCBs with fire represents a high priority.
- 2) PCBs are not flammable, however PCBs contaminated oil is flammable. The burning of highly contaminated PCBs oil represent a worst case in term of immediate danger for life coupled with long term effect danger caused by the release of Dioxins that would be generated.
- 3) PCBs do not have a high vapor pressure, and usually the direct exposure to PCBs vapors does not represent an immediate risk for life. However, due to their long term toxicity, in case of PCBs leakage proper respiratory mask should be wore.
- 4) PCBs may easily enter the body by contact with the skin. Dermal exposure to PCBs represents the most probable cause of human exposure.
- 5) PCBs cannot be easily removed by water due to their very low water solubility. However, PCBs can be easily removed by using adsorbent materials with high

organic content, like sawdust, soil with high organic matter content, organic solvents, greases.

The following PPEs shall be always available during any transportation of PCBs (one suit for any component of the vehicle crew)

- Chemical protective disposable suits providing protection to the full body against liquid chemicals / aerosols (Level B protective clothing i.e. compliant with EN14605 Liquid tight suit, EN14605 Spray tight suit, EN ISO 13982-1 Dry particle suit)
- Mask equipped with antidust filters and filters against gas / vapours (i.e. EN 149 with FFp2 and A-1 class filter)
- Safety goggles
- Heavy duty rubber gloves (neoprene or butyl)
- Reinforced safety shoes
- Overshoes
- Helmet
- Warning vest

The following additional material should be always available during transportation of PCBs:

- Adsorbent material (like sawdust)
- A shovel
- A drain seal
- First Aid Kit, including Eye rinsing liquid
- Fire Extinguishers
- Self standing warning signs.