



**TOGETHER**  
*for a sustainable future*

## OCCASION

This publication has been made available to the public on the occasion of the 50<sup>th</sup> anniversary of the United Nations Industrial Development Organisation.



**TOGETHER**  
*for a sustainable future*

## DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

## FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

## CONTACT

Please contact [publications@unido.org](mailto:publications@unido.org) for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at [www.unido.org](http://www.unido.org)



**OCCUPATIONAL HEALTH AND SAFETY MANUAL  
FOR  
MAINTENANCE OF POLY CHLORINATED BIPHENYL  
FILLED TRANSFORMER, CONTAMINATED  
TRANSFORMER OIL ANALYTICAL LABORATORIES  
AND DE-CHLORINATION PROCESS INDUSTRY**

**BY  
CENTRAL POWER RESEARCH INSTITUTE  
SADASHIVA NAGAR  
BANGALORE 560080**

## **I. INTRODUCTION**

It has been internationally recorded that around 6,300 people die as a result of occupational accidents or more than 2.3 million deaths per year due to work related diseases. So annually 317 million accidents occur on the job. Therefore long term effects on the health and safety of the human being working in the event is not full assessed. The daily cost of human is vast and the economic burden of poor occupational safety and health practices is estimated at 4 percent of global Gross Domestic Product each year.

Safety and Health at Work and the Environment, Safe Work, worldwide awareness of the dimensions and consequences of work-related accidents, injuries and diseases is an important aspect to be dealt with the agencies who are running the work systems.

## **II. INDIAN NATIONAL POLICY ON SAFET, HEALTH AND ENVIRONMENT AT WORK PLACE**

India has a national policy and following are the details. It is the responsibility of both the governmental or non governmental firms to abide by the policy guidelines and provide necessary safety, health and environmental protection or else the firm is liable to be used by the available laws for the violations.

### **1. PREAMBLE**

- 1.1. The Constitution of India provide detailed provisions for the rights of the citizens and also lays down the Directive Principles of State Policy which set an aim to which the activities of the state are to be guided.
- 1.2. These Directive Principles provide
  - a) for securing the health and strength of employees, men and women;
  - b) that the tender age of children are not abused;
  - c) that citizens are not forced by economic necessity to enter avocations unsuited to their age or
  - d) strength;
  - e) just and humane conditions of work and maternity relief are provided;
  - f) that the Government shall take steps, by suitable legislation or in any other way, to secure the participation of employee in the management of undertakings, establishments or other organisations engaged in any industry.
- 1.3. On the basis of these Directive Principles as well as international instruments, Government is committed to regulate all economic activities for management of safety and health risks at workplaces and to provide measures so as to ensure safe and healthy working conditions for every working man and woman in the nation. Government recognizes that safety and health of workers has a positive impact on productivity and economic and social development. Prevention is an integral part of economic activities as high safety and health standard at work is as important as good business performance for new as well as existing industries.
- 1.4. The formulation of policy, priorities and strategies in occupational safety, health and environment at work places, is undertaken by

national authorities in consultation with social partners for fulfilling such objectives. A critical role is played by the Government and the social partners, professional safety and health organizations in ensuring prevention and in also providing treatment, support and rehabilitation services.

- 1.5. Government of India firmly believes that without safe, clean environment as well as healthy working conditions, social justice and economic growth cannot be achieved and that safe and healthy working environment is recognized as a fundamental human right. Education, training, consultation and exchange of information and good practices are essential for prevention and promotion of such measures.
- 1.6. The changing job patterns and working relationships, the rise in self employment, greater sub-contracting, outsourcing of work, homework and the increasing number of employees working away from their establishment, pose problems to management of occupational safety and health risks at workplaces. New safety hazards and health risks will be appearing along with the transfer and adoption of new technologies. In addition, many of the well known conventional hazards will continue to be present at the workplace till the risks arising from exposure to these hazards are brought under adequate control. While advancements in technology have minimized or eliminated some hazards at workplace, new risks can emerge in their place which needs to be addressed.
- 1.7. Particular attention needs to be paid to the hazardous operations and of employees in risk prone conditions such as migrant employees and various vulnerable groups of employees arising out of greater mobility in the workforce with more people working for a number of employers, either consecutively or simultaneously.
- 1.8. The increasing use of chemicals, exposure to physical, chemical and biological agents with hazard potential unknown to people; the indiscriminate use of agro-chemicals including pesticides, agricultural machineries and equipment; industries with major accident risks; effects of computer controlled technologies and alarming influence of stress at work in many modern jobs pose serious safety, health and environmental risks.
- 1.9. The fundamental purpose of this National Policy on Safety, Health and Environment at workplace, is not only to eliminate the incidence of work related injuries, diseases, fatalities, disaster and loss of national assets and ensuring achievement of a high level of occupational safety, health and environment performance through proactive approaches but also to enhance the well-being of the employee and society, at large. The necessary changes in this area will be based on a co-ordinated national effort focused on clear national goals and objectives.
- 1.10. Every Ministry or Department may work out their detailed policy relevant to their working environment as per the guidelines on the National Policy.

## **2.0. GOALS**

The Government firmly believes that building and maintaining national preventive safety and health culture is the need of the hour. With a view to

develop such a culture and to improve the safety, health and environment at work place, it is essential to meet the following requirements:

- 2.1. Providing a statutory framework on Occupational Safety and Health in respect of all sectors of industrial activities including the construction sector, designing suitable control systems of compliance, enforcement and incentives for better compliance.
- 2.2. Providing administrative and technical support services.
- 2.3. Providing a system of incentives to employers and employees to achieve higher health and safety standards.
- 2.4. Providing for a system of non-financial incentives for improvement in safety and health.
- 2.5. Establishing and developing the research and development capability in emerging areas of risk and providing for effective control measures.
- 2.6. Focusing on prevention strategies and monitoring performance through improved data collection system on work related injuries and diseases.
- 2.7. Developing and providing required technical manpower and knowledge in the areas of safety, health and environment at workplaces in different sectors.
- 2.8. Promoting inclusion of safety, health and environment, improvement at workplaces as an important component in other relevant national policy documents.
- 2.9. Including safety and occupational health as an integral part of every operation.

### **3.0. OBJECTIVES**

The policy seeks to bring the national objectives into focus as a step towards improvement in safety, health and environment at workplace. The objectives are to achieve:

- a. Continuous reduction in the incidence of work related injuries, fatalities, diseases, disasters and loss of national assets.
- b. Improved coverage of work related injuries, fatalities and diseases and provide for a more comprehensive data base for facilitating better performance and monitoring.
- c. Continuous enhancement of community awareness regarding safety, health and environment at workplace related areas.
- d. Continually increasing community expectation of workplace health and safety standards.
- e. Improving safety, health and environment at workplace by creation of “green jobs” contributing to sustainable enterprise development.

### **4.0. ACTION PROGRAMME**

For the purpose of achieving the goals and objectives mentioned in paragraphs 2 and 3 above, the following action programme is drawn up and where necessary time bound action programme would be initiated, namely,

#### 4.1. Enforcement

- a. By providing effective enforcement machinery as well as suitable provisions for compensation and rehabilitation of affected persons;
- b. By effectively enforcing all applicable laws and regulations concerning safety, health and environment at workplaces in all economic activities through an adequate and effective labour inspection system;
- c. By establishing suitable schemes for subsidy and provision of loans to enable effective implementation of the policy;
- d. By ensuring that employers, employees and others have separate but complementary responsibilities and rights with respect to achieving safe and healthy working conditions;
- e. By amending expeditiously existing laws relating to safety, health and environment and bring them in line with the relevant international instruments;
- f. By monitoring the adoption of national standards through regulatory authorities;
- g. By facilitating the sharing of best practices and experiences between national and international regulatory authorities;
- h. By developing new and innovative enforcement methods including financial incentives that encourage and ensure improved workplace performance;
- i. By making an enabling legislation on Safety, Health and Environment at Workplaces;
- j. By setting up safety and health committees wherever deemed appropriate;

#### 4.2. National Standards

- a. By developing appropriate standards, codes of practices and manuals on safety, health and environment for uniformity at the national level in all economic activities consistent with international standards and implementation by the stake holders in true spirit;
- b. By ensuring stakeholders awareness of and accessibility to applicable policy, documents, codes, regulations and standards;

#### 4.3. Compliance

- a. By encouraging the appropriate Government to assume the fullest responsibility for the administration and enforcement of occupational safety, health and environment at workplace, provide assistance in identifying their needs and responsibilities in the area of safety, health and environment at workplace, to develop plans and programmes in accordance with the provisions of the applicable Acts and to conduct experimental and demonstration projects in connection therewith;
- b. By calling upon the co-operation of social partners in the supervision of application of legislations and regulations relating to safety, health and environment at work place;
- c. By continuous improvement of Occupational Safety and Health by systems approach to the management of Occupational Safety and Health including developing guidance on Occupational Safety and Health management systems, strengthening voluntary actions, including mechanisms for self-regulatory concept and establishing

auditing mechanisms which can test and authenticate occupational Safety and Health management systems;

- d. By providing specific measures to prevent catastrophes, and to co-ordinate and specify the actions to be taken at different levels, particularly in the industrial zones with high potential risks;
- e. By recognising the best safety and health practices and providing facilitation for their adoption.
- f. By providing adequate penal provisions as deterrent for violation of laws for the time being in force;
- g. By encouraging all concerned to adopt and commit to “Responsible Care” and / or “Corporate Social Responsibility” to improve safety, health and environment at workplace performance;
- h. By ensuring a suitable accreditation machinery to recognise institutions, professionals and services relating to safety, health and environment at workplace for uniformity and greater coverage as also authenticating safe management system;
- i. By encouraging employers to ensure occupational safety and health management systems, establish them in efficient manner to improve workplace safety and health;
- j. By specifically focusing on such occupational diseases like pneumoconiosis and silicosis; developing a framework for its prevention and control as well as develop technical standards and guidelines for the same;
- k. By promoting safe and clean technology and progressively replacing materials hazardous to human health and environment;

#### 4.4. Awareness

- a. By increasing awareness on safety, health and environment at workplace through appropriate means;
- b. By providing forums for consultations with employers’ representatives, employees representatives and community on matters of national concern relating to safety, health and environment at work place with the overall objective of creating awareness and enhancing national productivity;
- c. By encouraging joint labour-management efforts to preserve, protect and promote national assets and to eliminate injuries and diseases arising out of employment;
- d. By raising community awareness through structured, audience specific approach;
- e. By continuously evaluating the impact of such awareness and information approach;
- f. By maximizing gains from the substantial investment in awareness campaigns by sharing experience and learning;
- g. By suitably incorporating teaching inputs on safety, health and environment at work place in schools, technical, medical, professional and vocational courses and distance education programme;
- h. By securing good liaison arrangements with the International organisations;
- i. By providing medical criteria wherever necessary which will assure in so far as practicable that no employee will suffer diminished health,

functional capacity, or life expectancy as a result of his work place activities and that in the event of such occupational diseases having been contracted, is suitably compensated;

- j. By providing practical guidance and encouraging employers and employees in their efforts to reduce the incidence of occupational safety and health risks at their places of employment and to impress upon employers and employees to institute new programmes and to improve existing programmes for providing safe and healthful working conditions, requiring employers to ensure that workers and their representatives are consulted, trained, informed and involved in all measures related to their safety and health at work;

#### 4.5. Research and Development

- a. By providing for research in the field of safety, health and environment at workplace, including the social and psychological factors involved, and by developing innovative methods, techniques including computer aided Risk Assessment Tools, and approaches for dealing with safety, health and environment at workplace problems which will help in establishing standards; By exploring ways to discover latent diseases, establishing causal connections between diseases and work environmental conditions, updating list of occupational diseases and conducting other research relating to safety, health and environmental problems at workplace;
- b. By establishing research priorities as per national requirements; exploring partnerships and improving communications with various national and international research bodies;
- c. By ensuring a coordinated research approach and an optimal allocation of resources in Occupational Safety and Health sector for such purposes;

#### 4.6. Occupational safety and health skills development

- a. By building upon advances already made through employer and employee initiative for providing safe and healthy working conditions;
- b. By providing for training programmes to increase the number and competence of personnel engaged in the field of occupational safety, health and environment at workplace;
- c. By providing information and advice, in an appropriate manner, to employers and employees organisations, with a view to eliminating hazards or reducing them as far as practicable;
- d. By establishing occupational health services aimed at protection and promotion of health of employee and improvement of working conditions and by providing employee access to these services in different sectors of economic activities;
- e. By integrating health and safety into vocational, professional and labour related training programmes as also management training including small business practices;
- f. By adopting Occupational Safety and Health training curricula in workplace



#### 4.7. Data collection

- a. By compiling statistics relating to safety, health and environment at work places, prioritising key issues for action, conducting national studies or surveys or projects through governmental and non-governmental organisations;
- b. By reinforcing and sharing of information and data on national occupational safety, health and environment at work place information amongst different stake holders through a national network system on Occupational Safety and Health;
- c. By extending data coverage relevant to work-related injury and disease, including measures of exposure, and occupational groups that are currently excluded, such as self-employed people;
- d. By extending data systems to allow timely reporting and provision of information;
- e. By developing the means for improved access to information;

#### 4.8. Review

- a. An initial review and analysis shall be carried out to ascertain the current status of safety, health and environment at workplace and building a national Occupational Safety and Health profile.
- b. National Policy and the action programme shall be reviewed at least once in five years or earlier if felt necessary to assess relevance of the national goals and objectives.

#### 4.9. Conclusion

- a. There is a need to develop close involvement of social partners to meet the challenges ahead in the assessment and control of workplace risks by mobilising local resources and extending protection to such working population and vulnerable groups where social protection is not adequate.
- b. Government stands committed to review the National Policy on Safety, Health and Environment at Workplace and legislations through tripartite consultation, improve enforcement, compilation and analysis of statistics; develop special programmes for hazardous operations and other focus sectors, set up training mechanisms, create nation-wide awareness, arrange for the mobilisation of available resources and expertise.
- c. The National Policy and programme envisages total commitment and demonstration by all concerned stake holders such as Government and social partners. Our goals and objectives will be that through dedicated and concerted efforts consistent with the requirements of safety, health and environment at work place and thereby improving the quality of work and working life.

### III. SAFETY FEATURES

#### 1.0. Poly Chlorinated Biphenyls: Methodological approach to the Occupational health and safety

##### a. Awareness about the chemical

Poly Chlorinated Biphenyl is a persistent organic pollutant. You are hereby alerted that this material is toxic and can cause bioaccumulation and can have long lasting problems in the biological systems. On entrance and movement in the premises you are hereby advised to avoid physical contact and be attentive of its contaminations in your personal accessories like clothes shoes etc.,

##### b. Awareness about the process of treatment

Poly Chlorinated Biphenyl is a persistent organic pollutant. You are hereby alerted that this material is toxic and can cause bioaccumulation and can have long lasting problems in the biological systems. This premises has been a dechlorination site and you are hereby advised to stay away from the active points and avoid contacts and extensive inhalation of vapours. You are hereby alert the authorities if any abnormal spillage and gas generation is observed.

##### c. Awareness about the safe storage

Poly Chlorinated Biphenyl is a persistent organic pollutant. You are hereby alerted that this material is toxic and can cause bioaccumulation and can have long lasting problems in the biological systems. This premises has been storage point of this chemical and you are hereby advised to stay away from the active points and avoid contacts and extensive inhalation of vapours. You are hereby alert the authorities if any abnormal situations like spillage and gas generation and any other dynamic situations.

##### d. Awareness about the accidental spillage

Poly Chlorinated Biphenyl is a persistent organic pollutant. You are hereby alerted that this material is toxic and can cause bioaccumulation and can have long lasting problems in the biological systems. This premises has been storage point and or dechlorination point. This chemical process and storage are the hot spots of physical contact and spillage. You are hereby advised to stay away from the active points and avoid contacts and extensive inhalation of vapours. You are hereby alert the authorities if any abnormal situations like spillage and gas generation and any other dynamic situations.

##### e. Awareness about the crisis management

Poly Chlorinated Biphenyl is a persistent organic pollutant. You are hereby alerted that this material is toxic and can cause bioaccumulation and can have long lasting problems in the biological systems. This premises has been storage point and or dechlorination point. This chemical process and storage are the hot spots of physical contact and spillage. In case of spillage you are hereby alert SOS situation so that the

hazardous mitigation task force will reach the spot and contain the spillage and have counter active actions to avoid contaminations.

f. Emergency Task Force

A team of members not less than 5 members will be formed who are equipped with tooling, vehicle, suction pump, containers and other accessories who can reach the spot on receiving SOS alarm and will isolate the hotspot and take measures to mitigate emergency.

1.1. About Poly Chlorinated Biphenyls: Methodological approach to the Occupational health and safety

It may be noted that national policy in place it would be easier to follow the policy in its full description and then have guidelines to ensure the occupational and safety in case of Poly Chlorinated Biphenyls.

Guidelines on occupational health and safety are based on the hazards observed in the historical use PCB's, systematic and comprehensive analysis of hazards existing in a given occupation be it the equipment owner, maintainer, monitoring agency or de-chlorination and final disposal agency. Each nature of work has to have a descriptive guideline so that the worker in each of these area and general public so that overall it would be ensured that health, safety, control of pollution and safe disposal are achieved.

It would be ideal to look in to the chemistry of the material, physical properties, combustion products, observed toxic effects, possible diseases preliminary measures and long term measures, guidelines to minimise the contact, minimise the chances of material getting in to the environment, minimise the chances of spillage, minimise the chances of accidents involving these materials, disaster management in case of severe pollution and contamination possibilities. Full set of guidelines for different type of workmen inclusive of safety devices and infrastructure made available for the workers involved will be discussed.

Persistent Organic Pollutants(POP) and Stockholm Convention: Global attention

Chemicals that have very stable structure and have toxic effect on living beings have been perceived to be having potential threat for the survival of life itself on the planet. International awareness on this subject lead to Stockholm Convention. This convention is a global treaty to protect human health and environment from Persistent Organic Pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel.

In implementing the Stockholm Convention, All the signatory countries and their Governments need to take measures to eliminate or reduce the release of POPs into the environment. Specifically, under Article 7 of the Convention, each Party is to develop and endeavour to carry out an implementation plan for its obligations under the Convention, to transmit this plan to the Conference of the Parties within two years of the date of which the

Convention enters into force and to review and update the plan, as appropriate, on a periodic basis.

### 1.2. Persistency and toxicity

Chemicals that have very stable structure and have toxic effect on living beings have been perceived to be having potential threat for the survival of life itself on the planet. International awareness on this subject led to Stockholm Convention. This convention is a global treaty to protect human health and environment from Persistent Organic Pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel.

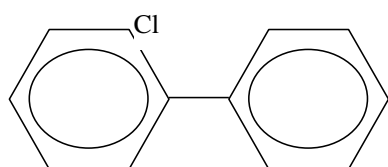
In implementing the Stockholm Convention, All the signatory countries and their Governments need to take measures to eliminate or reduce the release of POPs into the environment. Specifically, under Article 7 of the Convention, each Party is to develop and endeavour to carry out an implementation plan for its obligations under the Convention, to transmit this plan to the Conference of the Parties within two years of the date of which the Convention enters into force and to review and update the plan, as appropriate, on a periodic basis.

### 1.3. Poly Chlorinated Biphenyls (PCB's) and their Chemistry

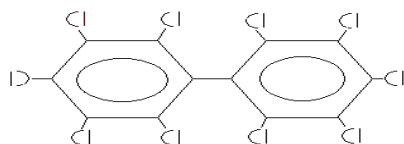
These are chemicals which were man made chemicals, found to have very good dielectric properties and fire resistance properties. These were manufactured between 1930 to 1980 in large quantities for use in power equipments, hydraulic oils and other applications. In India PCB's were never manufactured but were imported in the form of electrical and other equipment containing this liquid.

Exact quantities of this liquid, contamination of electrical equipment containing mineral insulating oil and exact levels of contamination, location of this equipment under use, stockpile of unserviceable equipment containing this liquid and its contaminations have not been estimated till date in this country.

Poly Chlorinated Biphenyls are the organic molecules having two benzene rings connected at one end and chlorination at one or more or all the ten corners of phenyl rings. In view of many type of possible molecular structural combinations around 209 congener molecules are possible. These range from Mono Chlorinated Biphenyl



## Deca Chlorinated Biphenyl



PCB's are usually having their brand names such as Arochlor, Phenochlor and Pyralene. These are also named with numbers along with their brand names such as Arochlor 1242, 1254 & 1260 etc. In these names first two numbers i.e. 12 refer to the presence of 12 Carbon atoms in the structure. Next two numbers refer to the percentage of chlorine in the molecule.

These molecules are very stable, non biodegradable and have very long periods of accumulations in the bodies of living organisms. Found to accumulate in fatty tissues. It is also observed they are highly toxic to the living organisms.

Toxicity of these chemicals is due to planar structure and conversion of molecule to dioxin like structures which are potential carcinogenic chemicals.

Increase in toxicity is proportional to the increasing % of Chlorine in their structure.

### Bibliography

- NTP Chemical Repository, MSDS Arochlor 1254. 10/97.
- SaifuddinAneesa and NorazahTaib, Chemical Characteristics of PCBs, Rensselaer Polytechnic Institute.

### 1.4. Poly Chlorinated Biphenyls (PCB's) and their Toxicity

PCB' were found to highly stable and refuse to be degraded in soil, water, algae, fungi bacteria and other oxidative mechanisms operating in environment in a natural manner.

Toxicity of PCB's increase with the increase in Chlorine % in their molecule. These molecules have been observed to be getting accumulated in fatty tissues in the living bodies and will stay for life time and will also be transferred to their offsprings.

PCBs can be released into the environment from hazardous waste sites that contain PCBs, dumping of PCB wastes, and leaks from electrical transformers containing PCBs. PCBs may be carried long distances in the air and a small amount of the PCBs may remain dissolved, but most sticks to organic particles and sediments. PCBs in water build up in fish and marine mammals and can reach levels thousands of times higher than the levels in water.

Animal experiments have shown that PCB mixtures produce adverse effects that include liver damage, skin irritations, reproductive and developmental effects, and cancer. People exposed to PCBs in the air for a long time have experienced irritation of the nose and lungs, and skin

irritations, such as acne and rashes. It is not known whether PCBs may cause birth defects or reproductive problems in people. Some studies have shown that babies born to women who consumed PCB-contaminated fish had problems with their nervous systems at birth. However, it is not known whether these problems were definitely due to PCBs or other chemicals. There are tests to find out if PCBs are present in human blood, body fat, and breast milk. Blood tests are probably the easiest, safest, and best method for detecting recent exposures to large amounts of PCBs. However, since all people in the industrial countries have some PCBs in their bodies, these tests can only show if one has been exposed to higher than- normal levels of PCBs. However, these measurements cannot determine the exact amount or type of PCBs one has been exposed to or how long exposition was. In addition, they cannot predict whether any harmful health effects will be experienced. Some the definitions used in Toxicity calculations are as under

Toxicity Equivalency Factor (TEF):

= Concentration of single compound X imposed Limit of concentration  
(Euro limit 0.1 TE ng / N m<sup>3</sup>)

Toxicity Equivalency Quotient (TEQ)

= Sum of products of all the components Poly Chlorinated Dibenzo Dioxins (PCDD), Poy Chlorinated Dibenzo furans and Biphenyls

TEQ concentrations in samples containing PCDDs, PCDFs and PCBs are calculated using the following equation:

$$\text{TEQ} = (\sum [\text{PCDD}_i \times \text{TEF}_i]_n) + (\sum [\text{PCDF}_i \times \text{TEF}_i]_n) + (\sum [\text{PCB}_i \times \text{TEF}_i]_n)$$

These values are valid for estimating human risk due to exposure for toxic pollutants. These equations are used for the compounds subjected to following conditions.

Compounds must:

- a. show a structural relationship to the PCDDs and PCDFs
- b. bind to the Ah receptor
- c. elicit dioxin-specific biochemical and toxic responses
- d. be persistent and accumulate in the food chain.

Overall it has been felt that Poly Chlorinated Biphenyls and group of chemicals derived from these have been found to show following toxicities

- a. Carcinogenic effect ; Liver, kidney and other organs
- b. Found to have neuro toxic effect on human beings and assumed to be responsible for alzmir's and other nerve disorder problems
- c. Found to have genotoxicity : PCB's have been observed to reduce sperm counts and also have toxic effects on estrogen levels found in women.
- d. Found to increase diabetic conditions

- e. PCB's are also assumed to have caused many other problems in living organisms.
- f. Threat of PCB's due to their persistancy and causing several type of toxicities in living organisms is viewed as a serious threat to life.

1.5. Poly Chlorinated Biphenyls (PCB's): their detection and evaluation of their contamination.

Poly Chlorinated Biphenyls are highly soluble in mineral oils which were conventionally used as liquid dielectrics and bulk of PCB's manufactured are used as liquid dielectrics. Hence, these are to be analysed from this matrix. Pure PCB's differ in their specific gravity (1.9) as compared to (0.83-0.89) of mineral oils. Only when we have known information about the type of oil this test can be used for confirming the PCB usage.

In reality there is a possibility that this is most probably contaminated mineral oil and it has to be evaluated for all ranges of contamination. Gas Chromatographic techniques are very good techniques to evaluate chemicals and Electron Capture Detector can be very sensitive chlorinated aromatic systems. Hence, internationally gas chromatography with electron capture detector is popularly used for detection of PCB contamination levels. Gas chromatography with Mass Spectroscopic detector (MSD) can be used. Further, GC with MS MS techniques have also been used for very low and confirmative evaluations of PCB's. PCB's are generally used in mixture of their congeners. Depending upon their chlorine % they are named as arochlors. Typically for liquid dielectric applications Arochlors 1242, 1258 & 1260 are representative mixtures of power transformer dielectric applications. Typically IEC 61619, ASTM 4059 and other standard test methods are used for evaluating PCB's from mineral oil matrix.

Typical Gas Chromatograph



## 2.0. Poly Chlorinated Biphenyls (PCB's) and their destruction

PCB's were found to highly stable and refuse to be degraded in soil, water, algae, fungi bacteria and other oxidative mechanisms operating in environment in a natural manner. Different countries have used various methods to avoid pollution and to destroy these compounds.

**Combustion:** This method of destruction is the most widely used but not considered as environmentally sound technique. PCB's get pyrolysed to water, Carbon dioxide and Hydrochloride (HCl) when burnt at temperatures 1400-1600°C. This method has potential danger of producing highly dangerous chemical species which are highly dangerous and toxic and can cause serious implications on living organisms. This is more likely when the temperature of combustion is lower than 1200°C.

**Encapsulation / burial:** Though this method is not a destruction method but can effectively seal the material and avoid the pollution of this compound for long periods. Concrete capsules can be made and used to bury the PCB's and seal them off by concrete. Once this is done and when the concrete loses its capacity and without allowing leakage of PCB material and finally reach out and contaminate the water resources.

**Chemical treatment of PCB's with Sodium Hydroxide:** The method has been tried for destruction of PCB's. In this method sodium hydroxide is made to react with PCB's to generate sodium chloride and biphenyl and phenolic mixtures are being generated as side products. Though the technique appears to be more simple, the method has not acquired popularity as the side products of the reaction are phenols and have higher solubility with water and has easy mode of spreading the toxic material by travelling in aqueous systems for long distances. This situation can be very threatening as it can cause much higher damage immediately as compared to PCB's themselves.

**Super Critical Water oxidation of PCB's:** Super critical conditions can be achieved for any material in which liquid and vapour states co-exist and are not distinguishable. Water achieves this condition when its temperature is above 374°C & pressure at 221 bar. PCB's, PAH's (Poly Aromatic Hydrocarbons), Waste plastics and other materials can be converted into simple hydrocarbons and can be reused and recycled. The technology is not yet perfected and needs a lot of technological developments to meet the requirements of PCB destruction.

**Sodium metal based conversion of PCB's:** In this process Sodium metal reacts with the chlorinated systems to dechlorinate the molecules at much lower temperatures than combustion. Our country has all the options available for mitigation of this hazardous chemical in an environmentally sound manner. Among these options non combustion technologies are considered as best and efficient. Whereas combustion seems to be the alternative for much faster



and cheaper method. Keeping in view of the geographical conditions we may have to use combination of technologies to get rid of this problem.

#### 2.1. Physical tools to be used

- Hand gloves
- Shoes
- Jackets
- Implementation of physical tools by the workers
- Implementation of basic instructions on arrival
- Minimum certificate course on PCB awareness to all the workers in the premises

#### 2.2. Monitoring systems

- Physical inspection
- Inspection of health authorities
- Inspection of the maintenance engineers
- Soil testing
- Water testing
- Air testing
- Documentation

#### 2.3. Reporting

- Reporting formats : Compliance reports of physical tools of safety
- Reporting formats: Compliance reports of awareness brochures
- Reporting formats: Inspection reports

#### 2.4. Reporting formats should include the following threat perceptions and their probabilities

##### 2.4.1 Threats to the equipment owners: working staff and others

- Possible leakages in the given equipment, maintenance of gaskets, valves, storage containers, filtration systems and other accessories
- All the threats should be foreseen and preventive measures are to be taken
- The inaction of the concerned engineer is liable to be prosecuted if the lapses are found in his/ her performance of duties.

##### 2.4.2. Threat of pollution by spillage

- Leakages of valves, taps, gaskets and all other possible components are to addressed on top priority. Management will ensure all the necessary funds will be given for such maintenance activity.
- Engineers will be authorised take actions at short notice if an emergency arises

#### 2.4.3. Threat of pollution by contamination

- Engineers would fully educate the working staff that the contaminated oil should not be mixed with any other oil and further contamination will be avoided.
- The accessories which come in to contact with the contaminated equipment will be cleaned and washings are also stored as contaminated and would be taken up for cleanup procedures
- All the cleaning consumables like waste cloth, cotton, tissues and any other consumables should be collected and would be taken up for clean up procedures.

#### 2.4.4. Threat of pollution by combustion

- All the possible causes of fire near the contaminated equipment should be pre meditated and precautionary measures are to be in place
- In case of fire necessary instructions
- Instructions for the people to wear masks
- Instructions for the people to move away and opposite to the direction of wind
- Instructions for the fire extinguishers with special instructions about the PCB materials
- Instructions for the subsequent health care and damage control measures.

#### 2.4.5. Threat of pollution by oil vapors

- Prevent the high operating temperatures in the transformers having PCB or its contamination by taking measures like reduction of load and other associated activities
- Keep external cooling accessories in the place to prevent higher temperatures
- Keep people protected using necessary masks
- Keep the rooms ventillated and vapours getting pumped to get the vapours getting adsorbed in to air filter columns

#### 2.4.6. Threat of pollution by oil spillage during transportation

- Keep the driver and his assistant informed of the material
- Keep the driver and his assistant informed of the precautionary measures like not to move with high speed, keep instructions to other vehicles that this vehicle is transporting hazardous material and keep distance.
- Avoid any accidents during steep bends and slopes
- Avoid any other possible obstacles like trees and other blocks
- Keep the security agencies informed of the movement of the material
- Keep the health authorities informed of the movement of the material
- Keep the emergency task force informed of the movement of the material

- Keep the control room informed of the movement track and updates on the present locations
  - Keep the emergency instruction kit
  - Keep emergency announcements
  - Keep crisis management plan document in the vehicle
- 2.4.7. Threat of pollution by accidental explosions or mishaps during dechlorination process
- Keep the chemical processing process well below the safety levels
  - Keep the monitoring frequency strictly followed
  - Keep the status and monthly reports regularly submitted to the Safety officer
  - Keep necessary updates during the maintenance schedules and attend to all the replacement necessities such as valves, taps, temperature controllers and pressure controllers
  - Keep all the monitoring and inspection documents submitted to safety officer
- 2.4.8. Any other threats not listed above
- Any other information made available can be submitted to the safety officer
- 2.4.9. Responsibilities of Engineers towards prevention of pollution of water, soil, air, food and bio system
- As engineer working in the country, we have the responsibility towards preserving environment, preventing pollution, avoid possible spillages by taking pre planned maintenance and avoid any catastrophic failures.
  - It is our responsibility to inform and convince all the authorities concerned about the grave possibilities and measures to be taken to prevent such dangerous situation.
  - We as a citizen of the country and living being on the plant we have the responsibility to prevent pollution of water, soil, water, air, food and bio system. We are responsible in taking action to prevent pollution of any form and get ourself educated in taking such action.
- 3.0. Documentation to be made available for the necessary information at easily accessible points for reference and use of all the concerned
- Guidelines for the general public
  - Guidelines for the working engineers
  - Guidelines for the working lab analysts
  - Guidelines for the water boards and other authorities
  - Guidelines for the agricultural authorities
  - Guidelines for the de-chlorination working engineers

