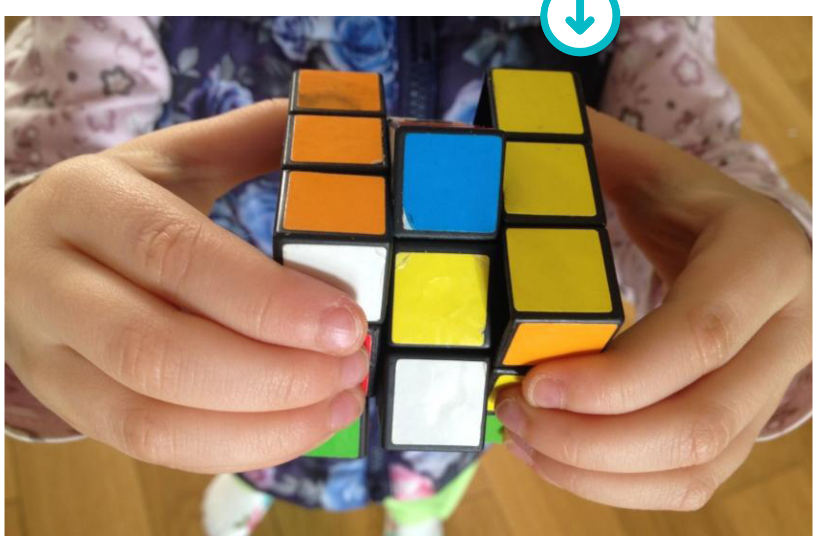
# Understanding Low POPs Content in waste



Toxics Link
for a toxics-free world

## ABOUT TOXICS LINK:

Toxics Link is an Indian environmental research and advocacy organization set up in 1996, engaged in disseminating information to help strengthen the campaign against toxics pollution, provide cleaner alternatives and bring together groups and people affected by this problem. Toxics Link's Mission Statement - "Working together for environmental justice and freedom from toxics. We have taken upon ourselves to collect and share both information about the sources and the dangers of poisons in our environment and bodies, and information about clean and sustainable alternatives for India and the rest of the world." Toxics Link has unique expertise in areas of hazardous, medical and municipal wastes, international waste trade, and the emerging issues of pesticides, Persistent Organic Pollutants (POPs), hazardous heavy metal contamination etc. from the environment and public health point of view. We have successfully implemented various best practices and have brought in policy changes in the aforementioned areas apart from creating awareness among several stakeholder groups.

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## ACKNOWLEDGMENT

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# About Persistent Organic Pollutants (POPs)

Persistent Organic Pollutants (POPs) are chemical substances that persist in the environment, bio-accumulate, bio-magnify and pose a risk of causing adverse effects to human health and the environment. These chemicals persist in the environment for decades and can be highly toxic even when released in small concentrations. Hence, considering the emerging chemical safety, in 2004 the Stockholm Convention on POPs was adopted to restrict and eventually eliminate the production, use, trade, release and storage of POPs.

As of now thirty one chemicals have been accepted as POPs. The Stockholm Convention has set measures which need to be taken by each country on the production, import, export, disposal and use of POPs and has put obligations on the parties to the convention to take necessary steps in these directions.

This group of priority pollutants consists of pesticides (such as Endosulfan, Dicofol, and DDT), industrial chemicals (such as polychlorinated biphenyls, Octa-BDEs) and unintentional by-products of industrial processes (such as dioxins and furans).

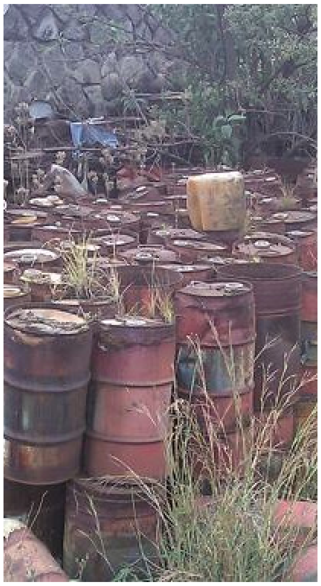
The Stockholm Convention addresses the control of POPs under three Annexes which can be summarised as follows:

**Annex A** Parties must take measures to eliminate the production and use of the chemicals listed under this Annex.

**Annex B** Parties must take measures to restrict the production and use of the chemicals listed under Annex B in light of any applicable acceptable purposes and/or specific exemptions listed in the Annex.

**Annex C** Parties must take measures to reduce the unintentional releases of chemicals listed under Annex C with the goal of continuing minimization and, where feasible, ultimate elimination.

Article 6, paragraph 2 of the Stockholm Convention mandates its Parties to cooperate closely with the appropriate bodies of the Basel Convention on common issues of relevance.[1]

1 http://www.basel.int/Implementation/POPsWastes/Overview/tabid/3908/Default.aspx

# About POPs waste

Wastes with POPs presented above a certain concentrations limits are considered POPs waste. This type of waste cannot be landfilled, reused, or recycled to prevent leaching of POPs into the environmental matrices. They have to be treated in a way that the POPs are either destroyed or irreversibly transformed. If the treatment does not reliably destroy the POPs, any waste that results from the treatment, and still contains these POPs, is also considered as POPs waste. POPs wastes are listed as wastes in Annexes I and VIII of the Basel Convention text.[2]

# What are Low POPs Content Level (LPCL)?

Article 6 of the Stockholm Convention directs countries to eliminate and reduce POP releases, this includes POP-contaminated wastes as well. Low POPs Content Levels or LPCLs were thus introduced as a tool to define whether certain wastes should be categorized as hazardous POP waste or not, based on their content of certain POPs as listed in Stockholm Convention.

It is also crucial for determining appropriate methods and option for POPs waste destruction or transformation might be the only global regulatory tool that could be used to prevent the import and export of contaminated wastes especially in case of chemicals like dioxins (PBDD/Fs) in after-incineration fly ash  or brominated flame retardants (PBDEs) in e-wastes.

**Table 1:** Provisional definitions of low POP content

| POP | Low POP content |
|---|---|
| Aldrin | 50 mg/kg |
| Alpha-HCH, beta-HCH and lindane | 50 mg/kg as a sum[3] |
| Chlordane | 50 mg/kg |
| Chlordecone | 50 mg/kg |
| DDT | 50 mg/kg |
| Dicofol | 50 mg/kg |
| Dieldrin | 50 mg/kg |
| Endrin | 50 mg/kg |
| HBB | 50 mg/kg |
| HBCD | 100 mg/kg  [or 500 mg/kg] or 1000 mg/kg |
| HCB | 50 mg/kg |
| HCBD | 100 mg/kg |
| Heptachlor | 50 mg/kg |
| Hexabromodiphenyl ether and heptabromodiphenyl ether and tetrabromodiphenyl ether and pentabromodiphenyl ether | 50 mg/kg or 1000 mg/kg as a sum[4] |

2 https://ipen.org/sites/default/files/documents/lpcl-fact-sheet-v1_3q-en.pdf
3 The limit value has been set for the sum of lindane and its by-products alpha- and beta-HCH, because they may be contained together in pesticides and production wastes.
4 The limit value has been set for the sum of tetra-, penta-, hexa-, and hepta-BDE, because commercial mixtures have varying congener composition (see section I.B.1 of the POP-BDE guidelines), and for analytical efficiencies.

| POP | Low POP content |
|---|---|
| [Hexabromodiphenyl ether and heptabromodiphenyl ether and tetrabromodiphenyl ether and pentabromodiphenyl ether and decabromodiphenyl ether (BDE-209) present in commercial decabromodiphenyl ether] | [[50 mg/kg] [500 mg/kg] [1000 mg/kg] as a sum[5]] |
| Mirex | 50 mg/kg |
| PCBs | 50 mg/kg |
| PCDDs and PCDFs[6] | 1 µg TEQ/kg or 15 µg TEQ/kg<br>[1 µg TEQ/kg or 5 µg TEQ/kg] |
| PCNs | 10 mg/kg |
| PCP and its salts and esters | 100 mg/kg |
| PeCB | 50 mg/kg |
| PFOA, its salts and PFOA-related compounds | [50 mg/kg]<br>[in Waste Aqueous Film Forming Foams (AFFF)<br>0.025 mg/kg for PFOA and its salts, and<br>1 mg/kg for related compounds] |
| PFOS, its salts and PFOSF | 50 mg/kg |
| SCCPs | [100 mg/kg][1 500 mg/kg] [10 000 mg/kg] |
| Technical endosulfan and its related isomers | 50 mg/kg |
| Toxaphene | 50 mg/kg |

**Table 1:** Wastes Covered Under LPCL

| POPs | Wastes |
|---|---|
| **PCBs, PCTs and PCNs** | 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 |
| | 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 |

5 [The limit value has been set for the sum of tetra-, penta-, hexa-, hepta-, and decaBDE, because commercial mixtures have varying congener composition (see section I.B.1 of the POP-BDE guidelines), and for analytical efficiencies.]

6 TEQ as referred to in Annex C, part IV, paragraph 2, to the Stockholm Convention [, [but only]for PCDDs [, and]PCDFs [ and dioxin-like PCBs].

| | |
|---|---|
| **Pesticide POPs, including aldrin, chlordane, DDT, dieldrin, endrin, HCB, heptachlor, mirex and toxaphene** | Wastes from the production, formulation and use of biocides and phytopharmaceuticals, including waste pesticides and herbicides, which are off-specification, outdated[6], or unfit for their originally intended use |
| **PCDDs and PCDFs** | Wastes that contain, consist of or are contaminated with any of the following:<br>• Any congener of polychlorinated dibenzofuran<br>• Any congener of polychlorinated dibenzodioxin |

# What are weak limits of POPs? What are its impacts?

Despite the existence of a 'provisional' limits (see Table 1), there are times when the set limits are not enough to reign in the excessive POP release. Some of these limits are not safe and do not meet health and environment protection requirements. Passing high LPCLs will only allow the expansion and acceleration of the transboundary movement of POPs-contaminated materials. This will allow materials like construction wastes, plastic wastes, and other wastes contaminated with POPs to remain within the system by the industries.[7] Which in turn will increase our exposure to contaminated products like building material and toys, thus harming children and adults unanimously.

A 2019 study reported alarming levels of brominated dioxins and brominated flame retardants in consumer products such as toys and hair clips made of recycled plastics sold in Argentina, Brazil, Cambodia, Canada, the EU, India, Japan and Nigeria. The data showed the significant levels of PBDD/Fs ranging from 5,600 – 386,000 pg/g and 56 – 3,800 pg WHO-TEQ/g. Researchers had revealed that these flame retardants and related chemicals, were originated largely from discarded electronics equipment and were contaminating the recycling stream and new consumer goods made from recycled plastics.[8]

Similarly, the much greater releases of POPs through the municipal solid waste incineration residues have largely been ignored. Incinerator fly ash are used to make roads and sidewalks, Construction products Cover layer at municipal landfills Embankments. Research studies have revealed the global scale of the problem of POPs-contaminated incinerator ash, which is generated at a rate of millions of tons every year. A 2022 study have reported PCDD/Fs concentration in fly ash in the range of 0.002–0.051 ngI-TEQ/g, with an average of 0.027 ngI-TEQ/g.[9] It was found that contamination of soil with dioxins and furans levels 0.05 μg TEQ/kg – or even less – in soil can lead to serious pollution of the food chain, to simply unacceptable levels of dioxins in food, such as poultry meat and eggs or sea food (fish, crabs). Similarly, a 2018 study has revealed several cases where processed waste contained PCDD/Fs levels between 20 and 12,000 pg TEQ/g (0.02 and 12 ppb)[10].

Likewise, the current provisional level of LPCL for PCBs is defined using only their intentionally produced congeners. Levels don't reflect unintentional POPs products as they nearly always accompany PCDD/Fs and are found together in measurements of wastes and other matrices.

7 https://ipen.org/sites/default/files/documents/weak-pop-limits-v1_5.pdf
8 https://ipen.org/sites/default/files/documents/toxic_flood_web2.pdf
9 Pan, S.; Yao, Q.; Cai, W.; Peng, Y.; Luo, Y.; Wang, Z.; Jiang, C.; Li, X.; Lu, S. Characterization of Dioxins and Heavy Metals in Chelated Fly Ash. Energies 2022, 15, 4868.
10 https://ipen.org/sites/default/files/documents/petrlik_2018-popswaste-dioxin2018-english.pdf

Considering these impacts, there is a demand for strong limits for POPs (LPCL) to stop the flow of POPs into recycling chain. Establishing strong limit values for POPs in waste will significantly promote innovation in recycling, increase the pressure on industries to remove POPs from products, and ensure that the circular economy is not poisoned in its nascent stage.

# Example of weak limit proposals by the European Commission

The methodology to determine POPs limits suggests a range of values from strong limits that protect human health down to weak limits that are based on 'economic considerations' of the plastic, recycling, and waste incineration industries. Unfortunately, the 'recycle at all costs' approach neglects the serious harm for human health and related socioeconomic costs that can arise from recycling wastes that contain POPs, which translates into the current suggestion for middle ground limit values. Using the PBDE example, Figure 1 shows a comparison between the recommended range of levels presented to the European Commission (EC) by its expert consultants, the levels proposed by the EC, and finally, the strong, scientifically and technically justifiable limits proposed by IPEN and civil society organizations.

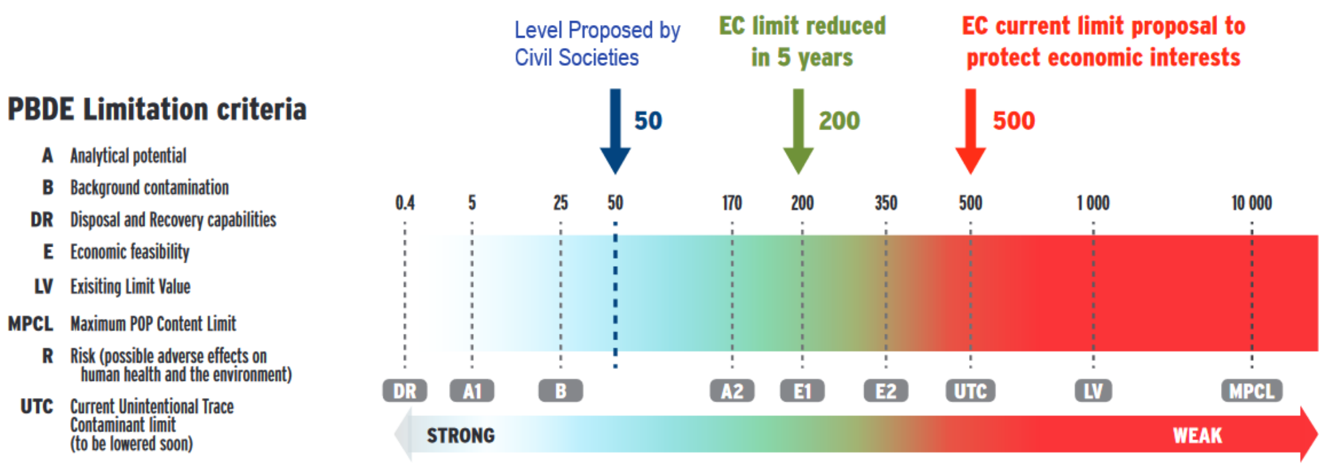



**Figure 1:** Limitation levels for PBDE (EC = European Commission)

# What are the technical guidelines for environmentally sound management of POPs wastes?

General Technical Guidelines are the document that defines the mentioned limits values for POPs waste (Low POPs Content Levels, LPCL), above which POPs waste should be treated in such a way that the POPs are either destroyed or irreversibly transformed.

General Technical Guidelines also describe methods for POPs waste destruction. The preferable are the non-combustion technologies, because they do not produce any further POPs (see the examples in the Figure 2 below).

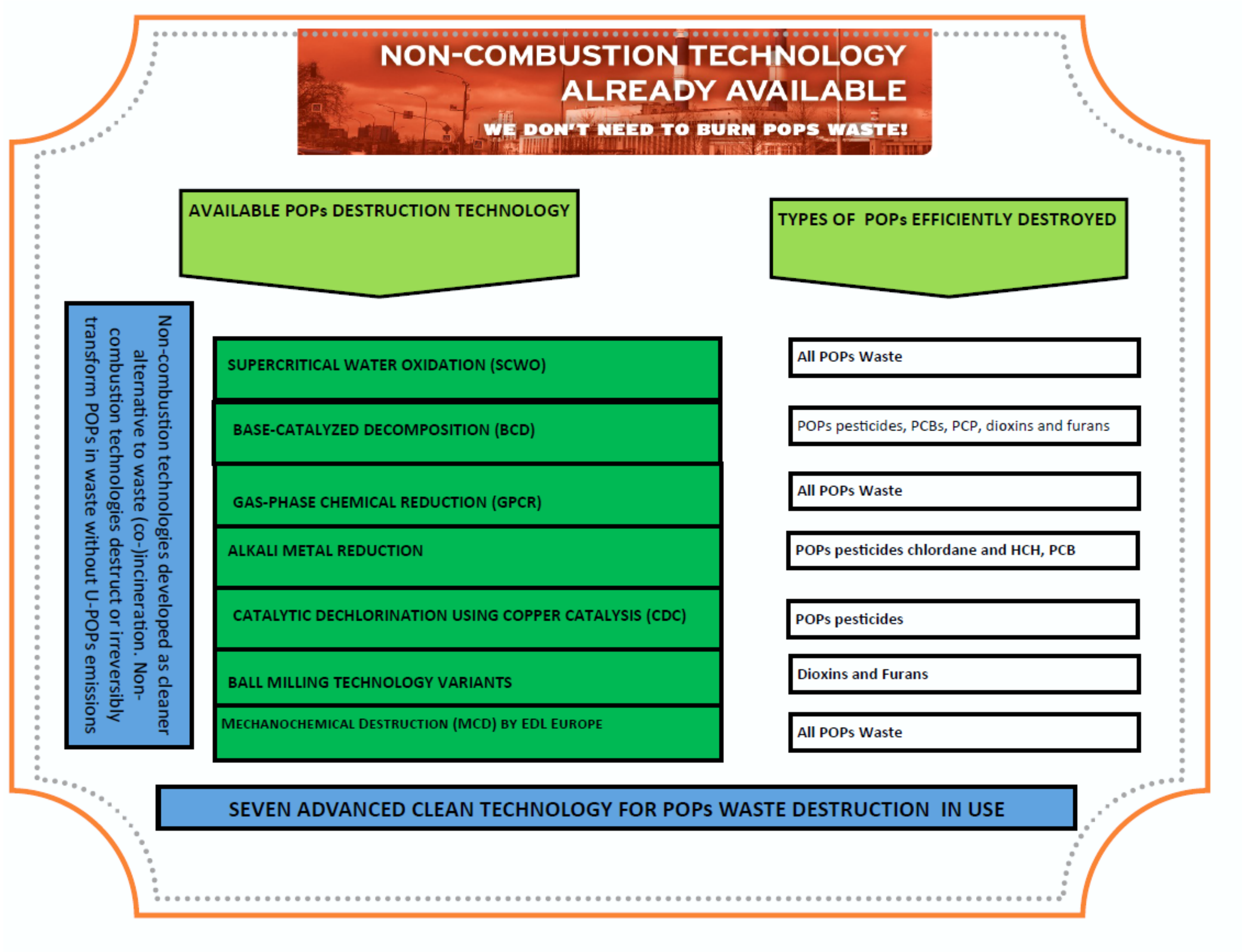



**Figure 2:** Non-combustion technologies already available

# Issue of LPCL in India

India is a party to Basel Convention as well. In fact, it was one of the first countries of the global south in the early 1990s to call for a ban on exports to developing countries. India notified the hazardous waste rules in 1989 even before the Basel Convention came into force in 1992, and became a party to the Basel Convention in 1992. With time several amendments have been made in hazardous waste rules and "The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016".have been promulgated.

Similarly, India ratified the Stockholm Convention on 13th January 2006 and came in to force on 13th April 2006 and has promulgated the POPs Management Rules -2018.

Although the country has commitment towards the Stockholm and Basel conventions, however there is no framework in place to manage with the POPs waste. Therefore there is a possibility that many of the banned POPs can keep on circulating in the product chain and will defeat the purpose of the convention resulting impact on the environment and human health.

A research study has reported high brominated flame retardants in recycled plastic toys and corroborated the fact that POPs can infiltrate into the products. In that study twenty five children plastic toys were collected from markets in India in 2015 – 2016. The products were screened for chemical markers of brominated flame retardants, out of which found six products that contained the markers, suggesting the plastic included BFRs. 10 ppm is the EU safety limit for BFRs in virgin plastic products.

- Four out of six samples contained the BFR Deca-BDE at concentrations ranging from 5.7 ppm to 516 ppm.
- All six samples contained the BFR PentaBDE at concentrations ranging from 0.04 ppm to 2.1 ppm.
- All six samples contained the BFR OctaBDE at concentrations ranging from 0.01 ppm to 336 ppm.
- Two out of six samples contained the BFR HBCD at concentrations 1.8 and 78 ppm respectively.
- Across all six samples there were six novel BFRs found at concentrations ranging from 2.7 ppm to 452 ppm.
- One sample of Rubik's like cube was tested for brominated dioxins and was found to contain of 690 pg TEQ/g respectively, level observed for example in waste incineration ashes and/or other hazardous wastes, confirming that these highly toxic dioxins are in recycled plastic in consumer products.

# Conclusion

POP wastes are a consequence of our indiscriminate use of POP-based products. These wastes are toxic, persistent and difficult to manage by basic waste management techniques. It is becoming clearer that the people most affected by this issue are the countries from Global South where management or mitigation of such threats is difficult, due to the lack of technical expertise, limited technological capacity and sparse financial resources.

Considering the current state of legislation in our country, here are the recommendations that can be taken into consideration:

- Ratifying Basel Ban Amendment.
- Ratifying all the chemicals enlisted under Stockholm Convention.
- Implementing the following stricter limits on LPCLs rather than relying on provisional limits:

| POPs | Toxics Link-IPEN proposal |
| --- | --- |
| HBCD | 100 mg/kg |
| Hexa-, hepta-, tetra-, penta-, and decabromodiphenyl ether (PBDEs) | 50 mg/kg as a sum |
| PCDDs, PCDFs, and dioxin-like PCBs | 1µg TEQ/kg |
| SCCPs | 100 mg/kg |
| PFOS, PFOA, and $PFH_xS$ and related compounds | 0.025 mg/kg for PFOS, PFOA or $PFH_xS$ and their salts individually;<br>10 mg/kg for sum of PFOS, PFOA, $PFH_xS$ and related compounds |

- Capacity building for non-combustion technologies for POPs destruction. Programs should not only include skill training but should also provide support for the proliferation of POP treatment plants, throughout the country, regardless of the size of the municipality.
- Inventorization of POPs waste. India lacks country-specific data for POPs, hence impairing policy-making and process implementation. Therefore, mapping our present situation in the form of data should be of the utmost importance

# Annex-I: POPs enlisted under Stockholm Convention

**Table 3:** Year-wise Chemicals Listed in the Stockholm Convention

| Annex A (Elimination) | Annex B (Restriction) | Annex C (Unintentional Production) |
|---|---|---|
| 2004 | 2004 | 2004 |
| Aldrin<br>Chlordane<br>Dieldrin<br>Endrin<br>Heptachlor<br>Hexachlorobenzene (HCB)<br>Mirex<br>Toxaphene<br>Polychlorinated biphenyls (PCB) | DDT | Hexachlorobenzene (HCB)<br>Polychlorinated biphenyls (PCB)<br>Polychlorinated dibenzo-p-dioxins (PCDD)<br>Polychlorinated dibenzofurans (PCDF) |
| 2009 | 2009 | 2009 |
| Alpha- hexachlorocyclohexane<br>Beta- hexachlorocyclohexane<br>Chlordecone<br>Hexabromobiphenyl<br>Hexabromodiphenyl ether & heptabromodiphenyl ether<br>Lindane<br>Pentachlorobenzene (PeCB)<br>Tetrabromodiphenyl ether and pentabromodiphenyl ether | Perfluorooctane Sulfonic acid its salts and Perfluorooctane Sulfonyl fluoride | Pentachlorobenzene (PeCB) |
| 2011 | 2011 | 2011 |
| Technical Endosulfan and its related isomers | | |
| 2013 | 2013 | 2013 |
| Hexabromocyclododecane (HBCDD) | | |
| 2015 | 2015 | 2015 |
| Polychlorinated naphthalenes<br>Pentachlorophenol and its salts and esters | | Polychlorinated naphthalenes<br>Hexachlorobutadiene (HCBD) |
| 2017 | 2017 | 2017 |
| Decabromodiphenyl ether (commercial mixture, c-decaBDE)<br>Short-chain chlorinated paraffins (SCCPs)<br>Hexachlorobutadiene | | |

| Annex A (Elimination) | Annex B (Restriction) | Annex C (Unintentional Production) |
|---|---|---|
| 2019 | 2019 | 2019 |
| Dicofol | Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds | |
| 2022 | **2022** | **2022** |
| Perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds | | |

# ANNEX -II: POPs containing wastes categorized in the Basal Convention

**List A of Annex VIII of Basel Convention includes a number of wastes or waste categories that have the potential to contain or be contaminated with POPs, including:**

- A1090 Ashes from the incineration of insulated copper wire
- A1100 Dusts and residues from gas cleaning systems of copper smelters
- A2040 Waste gypsum arising from chemical industry processes, when containing Annex I constituents to the extent that it exhibits an Annex III hazardous characteristic (note the related entry on list B B2080)
- A2060 Coal-fired power plant fly ash containing Annex I substances in concentrations sufficient to exhibit Annex III characteristics (note the related entry on list B B2050)
- A3020 Waste mineral oils unfit for their originally intended use
- A3040 Waste thermal (heat transfer) fluids
- A3050 Wastes from production, formulation and use of resins, latex, plasticizers, glue/adhesives excluding such wastes specified on list B (note the related entry on list B B4020)
- A3070 Waste phenols; phenol compounds including chlorophenol in the form of liquids or sludges
- A 3090 Waste leather dust, ash, sludges and flours when containing hexavalent chromium compounds or biocides (note the related entry on list B B3100)
- A3100 Waste paring and other waste of leather or of composition leather not suitable for the manufacture of leather articles containing hexavalent chromium compounds or biocides (note the related entry on list B B3090)
- A3110 Fellmongery wastes containing hexavalent chromium compounds or biocides or infectious substances (note the related entry on list B B3110)
- A3120 Fluff – light fraction from shredding
- A3150 Waste halogenated organic solvents
- A3160 Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations
- A4010 Wastes from the production, preparation and use of pharmaceutical products but excluding such wastes specified on list B

- A4020 Clinical and related wastes; that is wastes arising from medical, nursing, dental, veterinary, or similar practices, and wastes generated in hospitals or other facilities during the investigation or treatment of patients, or research projects
- A4040 Wastes from the manufacture formulation and use of wood preserving chemicals7
- A4070 Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish excluding any such waste specified on list B (note the related entry on list B B4010)
- A4100 Wastes from industrial pollution control devices for cleaning of industrial off-gases but excluding such wastes specified on list B
- A4130 Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics
- A4140 Wastes consisting of or containing off specification or outdated chemicals corresponding to
- A4150 Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on human health and/or the environment are not known
- A4160 Spent activated carbon not included on list B (note the related entry on list B B2060)

# ANNEX III: Research Studies

| Year | Name of author | Institutions | Title | Results and Findings |
|---|---|---|---|---|
| 2008 | Kashyap R. et. al. | National Institute of Occupational Health | Residues of Dioxin in Egg Samples Collected from West Zone of India | Chicken grown in sites close to Municipal Corporation incinerator showed presence of PCDDs/Fs/<br>TEQ of dioxin and furan were 7.10pg/g and 0.39 pg/g respectively |
| 2014 | Chaemfa C. et al. | Guangzhau Institute of Geochemistry, China; SRM Research Institute, India; Quaid-i-Azam University, Pakistan; Yontai Institute of Coastal Zone Research, China; Lancaster University, UK | Screening of Atmospheric Short- and Medium-Chain Chlorinated Paraffins in India and Pakistan using Polyurethane Foam Based Passive Air Sampler | Indian concentrations showed higher average levels of both SCCPs and MCCPs. India (10.2 ng $m^{-3}$ and 3.62 ng $m^{-3}$ than the samples from Pakistan. |
| 2016 | Van der Berg et. al. | Institute for Risk Assessment Sciences (IRAS), Netherlands; Dept. of Food and Safety and Zoonoses, WHO, Geneva, CH; Stockholm Convention Secretariat, UNEP, CH; UNEP, Geneva, CH<br>State Institute for Chemical and Veterinary Analysis of Food, DE | WHO/UNEP global surveys of PCDDs, PCDFs, PCBs and DDTs in human milk and benefit-risk evaluation of breastfeeding. | Levels of PCDDs and PCDFs were highest in India and some European and African countries. PCB levels were highest in East and West Europe.<br>The highest levels of ΣDDTs were found in less industrialized countries.<br>A temporal downward trend for PCDDs, PCDFs and PCBs is indicated.<br>A risk–benefit assessment indicates that human milk levels of PCDDs, PCDFs and PCBs are still signifi- cantly above those considered toxicologically safe, while ΣDDTs are below or around those considered safe. |

| Year | Name of author | Institutions | Title | Results and Findings |
|---|---|---|---|---|
| 2016 | Hafeez S. et al. | Quaid-i-Azam University, Pakistan; COMSATS Institute of Information Technology Pakistan, Guangzhou Institute of Geochemistry, China | Waste dumping sites as a potential source of POPs and associated health risks in perspective of current waste management practices in Lahore city, Pakistan | The study presented baseline data on PBDEs, DP and PCBs in environmental matrices (soil, dust, water and air) emitted from waste dumping site in Lahore, Pakistan. Levels of PCBs were considerably higher than PBDEs and DPs in all matrices. In air, concentrations of PCBs, PBDEs and DPs were higher followed by water> dust>soil. |
| 2019 | Kumari K., Kumar S., Rajagopal V., Khare A. & Kumar R. | CSIR – National Environmental Engineering Research Institute, Nagpur & National Institute of Technology - Karnataka | Emission from open burning of municipal solid waste in India | The study reported very high dioxins and furans emissions, as high as 82599 µg TEQ/day. This is due to open burning of municipal solid waste across the country |
| 2021 | S.V. Ajay et al. | CSIR – National Institute for Interdisciplinary Science and Technology, India; Academy of Scientific and Innovation Research (AcSIR) India | An experimental simulation study of conventional waste burning practices in India for the assessment and inventorisation of PCDD/F/dl-PCB emissions | The PCDD/F's $EF_{air}$ ranged from 3 to 675 µg toxicity equivalence (TEQ)/ton of waste with a geometric mean ($GM_{air}$) of 67.0 µgTEQ/ton and $EF_{land}$ ranged from 10 to 2531 µgTEQ/ton waste ($GM_{land}$ - 100.0 µgTEQ/ton). The $EF_{air}$ and $EF_{land}$ of dl-PCBs ranged from 0.5 to 46 µgTEQ/ton ($GM_{air}$ 7.0 µgTEQ/ton) and 0.5 to 96 µgTEQ/ton of waste ($GM_{land}$ 6.0 µgTEQ/ton) respectively. A detailed assessment of correlations between emission and MSW composition/combustion practices were conducted along with a comparative evaluation of $EF_{present}$ vis-à-vis EFs reported elsewhere. |