INFORMATION ON IMPLEMENTATION OF THE STOCKHOLM CONVENTION BY THE KYRGYZ REPUBLIC IN CONNECTION WITH POLYCHLORINATED BIPHENYLS

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Introduction

This survey of implementation of the Stockholm Convention by the Kyrgyz Republic in connection with polychlorinated biphenyls (PCBs) was developed by the Independent Environmental Expertise NGO, jointly with Eco-Accord Centre, with support from IPEN (the International Pollutants Elimination Network).

In the past 40 years, major and growing attention has been paid globally to analysis of the group of persistent organic pollutants (POPs) that affect the environment at extremely low levels[1]. Many of them were known for a long time and were widely used in industry and agriculture in the majority of countries. The compounds have a number of specific features:

- bioconcentration (or bioaccumulation) - due to low solubility in water[2] and high solubility in fats and lipids;
- global presence due to ability for long-range migration;
- extreme resistance to physical, chemical and biological changes;
- ability to generate toxic effects for living organisms in extremely low doses.

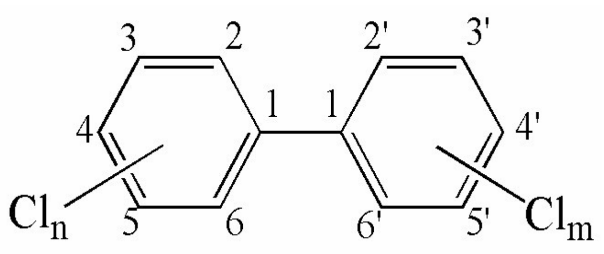
In the group of POPs, polychlorinated biphenyls (PCBs) belong to the class of synthetic organic chemicals that, due to their chemical resistance, were widely used since 1929 for various industrial purposes. From that time and by the end of their industrial production in 1986, about 2 million tons of PCBs were produced worldwide. Initially, PCBs were not considered as hazardous substances. Many decades passed before evidence was obtained on the long-term negative impacts of PCBs on human health and the environment. Since then, the process of gradual introduction of bans and restrictions on their use started. However, even now, PCBs management remains one of the most pressing problems of chemical security, as most of the polychlorinated biphenyls produced are still used or stored at various industrial sites.

All the physical and chemical properties that have made PCBs useful in industry have also made them one of the most dangerous environmental pollutants. With their thermal and chemical stability, PCBs have been proven to be extremely resistant to biotic and abiotic factors. When released into the environment, PCBs are distributed among all its components - air, water, soil, etc. They are able to incorporate into global circulation processes and move with water and air flows over long distances. In particular, PCBs are found in areas located at considerable distances from places of their production and use. Hazards of PCBs are associated with their ability to migrate in food chains (bioconcentration) and to accumulate in fat-containing components (bioaccumulation). Accumulation rates of PCBs in some biological objects were found to reach millions of times background levels. Therefore, even low concentrations of PCBs in components of the natural environment pose a threat of accumulation in the human body (as the highest link in food chains). Currently, PCBs have been proven to generate profound embryotoxic and potential carcinogenic effects. However, their most dangerous effects are associated with mutagenic action. PCBs are recognised as priority pollutants of a global scale and they are called “superecotoxicants of the 21st century,” along with substances such as dioxins and mercury.

[1] http://www.dioxin.ru/history/pcb.htm
[2] With the exception of PFOS/PFOA

Electric equipment, which is considered as the main source of PCBs in the Kyrgyz Republic, was manufactured in the Russian Federation, Kazakhstan, Armenia, and Uzbekistan, from the period of approximately 1958 to 1993. Typically, such equipment items are characterised by specific application and well-defined specifications that can be identified by manufacturers' labelling. PCBs are also likely to be found in other products, such as paints, special purpose lubricants, and in some polymers. However, in general, there is no accurate information on the amounts of PCBs or PCBs-containing equipment items imported into the country.

PCBs belong to the class of aromatic compounds consisting of two benzene rings connected by a C – C bond and substituted by from one to ten chlorine atoms in ortho, meta or para positions (Fig. 1). There are 209 individual PCB congeners differing in the number and positions of chlorine atoms in the molecule (I), having the general empiric formula: $C_{12}H_{10-n}Cl_n$, (n=1-10).



n,m=0-5 (I)

Fig. 1. Molecular structure of polychlorinated biphenyls.

PCBs have a number of unique physical and chemical properties: exceptional thermal and electrical insulation characteristics, heat resistance, inertness to acids and alkalis, fire resistance, good solubility in fats, oils and organic solvents, high compatibility with resins, and excellent adhesion[3]. These properties caused their widest use as dielectrics in transformers and capacitors, hydraulic fluids, heating medium and coolants, lubricating oils, components of paints, varnishes and adhesives, plasticisers and fillers in plastics and elastomers, fire retardants, and solvents[4].

Industrial production of PCBs is based on sunstitution chlorination of diphenyl in presence of an electrophilic substitution catalyst (usually Fe)[5].

The degree of chlorination depends on the reaction time, which ranges from 12 to 36 hours. The reaction of electrophilic substitution is not of a specific nature; as a result the reaction product contains a mixture of a large number of individual PCBs - from 30 to 100 compounds. Most of them contain from 3 to 8 chlorine atoms, although there are small amounts of both more and less chlorinated PCBs. These mixtures are known under various brand names - Arochlor (USA), Kanehlor (Japan), Chlorphen (Germany), Delors (Slovakia), Fenochlor (France), Fenkhlor (Italy) Sovol and Sovtol (USSR, Russia). A far from complete list of trade names is provided in Annex 1.

Nature and dynamics of PCBs distribution in the environment are largely determined by their physical properties, such as chemical inertness, high vapour density, and ability to sorb onto

[3] Zanaveskin L.N., Averianov V.A. // Uspekhi Khimii, 1998, 67 (8), pp. 788-800. (Rus.)
[4] Yufit S.S. Poisons around Us. A series of lectures. Moscow: James, 2001 (Rus.)
[5] Klyuev N.A., Brodskiy E.S. Determination of Polychlorinated Biphenyls in the Environment and Biota. Polychlorinated Biphenyls. Supertoxicants of XXI Century. Inf. bulletin # 5 VINITI, Moscow, 2000, pp. 31-63. (Rus.)

particles. Despite the gradual reduction of PCBs application in economic activities, they continue to pollute the environment, and now these toxic products have spread around the globe[6]. As PCBs are incorporated into biological food chains, progressive loss of low-chlorinated components occurs due to their selective biotransformation. Therefore, the most dangerous - highly chlorinated PCBs - accumulate in humans and animals.[7]

According to the World Health Organisation[8] the main routes of PCBs releases into the environment include the following ones:

- evaporation from plasticisers;
- emissions from burning of household and industrial wastes, as well as from fires at transformers, capacitors and other industrial equipment items that contain PCBs;
- leaks with other industrial waste; disposal of PCBs to landfills and disposal fields;
- other uncontrolled paths.

The Stockholm Convention sets the objective of complete phase out of PCBs. PCBs must be removed from circulation and disposed of in an environmentally sound manner. Waste batches containing these compounds should be minimised by isolating the waste and separating it at their sources to prevent their mixing with other types of waste and contamination of waste flows. For example, large quantities of construction debris (in the course of demolition works) may be contaminated with PCBs contained in electrical equipment items, paint coatings, synthetic resin-based floor coverings, sealants, and glass packs on sealants if they were not removed from buildings before the demolition. Mixing wastes containing PCBs in amounts exceeding the established level of low POPs content with other materials solely for the purpose of obtaining a mixture with a concentration of POPs below this level is not an environmentally sound option. However, mixing materials prior to waste treatment may be required for optimum processing efficiency.

According to the Stockholm Convention, each Party shall:

a) With regard to the elimination of the use of polychlorinated biphenyls in equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) by 2025, subject to review by the Conference of the Parties, take action in accordance with the following priorities:

i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres;

ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres;

iii) Endeavour to identify and remove from use equipment containing greater than 0.005 percent polychlorinated biphenyls and volumes greater than 0.05 litres;

b) Consistent with the priorities in subparagraph (a), promote the following measures to reduce exposures and risk to control the use of polychlorinated biphenyls:

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[6] Boyle R.H., Hignland J.H. // Environment, 1979, 21(5), p. 6-8.
[7] Klyuev N.A., Brodskiy E.S. Determination of Polychorinated Biphenyls in the Environment and Biota. Polychlorinated Biphenyls. Supertoxicants of XXI Century. Inf. bulletin # 5 VINITI, Moscow, 2000, pp. 31-63. (Rus.).
[8] Hygiene Criteria of the State of Environment. Protocol #2. Polychlorinated Biphenyls and Triphenyls Joint publication of UN Chemicals and the World Health Organisation, Geneva, 1980.

i) Use only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimised and quickly remedied;

ii) Not use in equipment in areas associated with the production or processing of food or feed;

iii) When used in populated areas, including schools and hospitals, all reasonable measures to protect from electrical failure which could result in a fire, and regular inspection of equipment for leaks;

c) Notwithstanding paragraph 2 of Article 3, ensure that equipment containing polychlorinated biphenyls, as described in subparagraph (a), shall not be exported or imported except for the purpose of environmentally sound waste management;

d) Except for maintenance and servicing operations, not allow recovery for the purpose of reuse in other equipment of liquids with polychlorinated biphenyls content above 0.005 per cent;

e) Make determined efforts designed to lead to environmentally sound waste management of liquids containing polychlorinated biphenyls and equipment contaminated with polychlorinated biphenyls having a polychlorinated biphenyls content above 0.005 per cent, in accordance with paragraph 1 of Article 6, as soon as possible but no later than 2028, subject to review by the Conference of the Parties;

f) In lieu of note (ii) in Part I of this Annex, endeavour to identify other articles containing more than 0.005 per cent polychlorinated biphenyls (e.g. cable-sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 1 of Article 6;

g) Provide a report every five years on progress in eliminating polychlorinated biphenyls and submit it to the Conference of the Parties pursuant to Article 15"

IMPLEMENTATION OF COMMITMENTS UNDER OF THE STOCKHOLM CONVENTION BY THE KYRGYZ REPUBLIC IN CONNECTION WITH POLYCHLORINATED BIPHENYLS

para (a) of Part II of Annex A of the Stockholm Convention:
Every Party shall: a) With regard to the elimination of the use of polychlorinated biphenyls in equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) by 2025, subject to review by the Conference of the Parties, take action in accordance with the following priorities:
i) Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres;
ii) Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres;
iii) Endeavour to identify and remove from use equipment containing greater than 0.005 percent polychlorinated biphenyls and volumes greater than 0.05 litres;

The Kyrgyz Republic ratified the Stockholm Convention on Persistent Organic Pollutants in 2006. [9] At the same time, Decree # 371-p of the Government of the Kyrgyz Republic of July 3, 2006 approved the National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants by the Kyrgyz Republic. In the framework of development of the National Action Plan, the GEF/UNEP project “Assistance to the Kyrgyz Republic in Development of the National Implementation Plan of the Stockholm Convention on Persistent Organic Pollutants” conducted a preliminary inventory of PCBs-containing equipment and waste.

Main sources of PCBs releases into the environment may be sub-divided by 4 groups:

1) production of PCBs and PCBs-containing products (equipment);
2) use of products with PCBs;
3) waste and materials, contaminated by PCBs;
4) emissions from contaminated soil, water and bottom deposits.

In the Kyrgyz Republic, PCBs have been never manufactured and were always imported, primarily as a dielectric fluid for large electrical equipment items. These substances could also enter the territory of the country as parts of electrical equipment items, transformer oils, paints and varnishes, and various lubricants. No exact data is available on import or export in terms of numbers and types of electric equipment, volumes and brands of transformer oils, paints and other materials.

The second group of PCBs sources is rather broad, since polychlorinated biphenyls have had and, partly, still have very diverse uses - as dielectric liquids in capacitors and transformers, in hydraulic and cooling equipment, cables, as plasticisers in manufacture of paints, varnishes, glues, carbon paper etc.

The third group of sources covers various PCBs-containing waste, first of all, waste equipment items and materials, that are ultimately recycled (e.g. transformer casings and sometimes oil), or end up at landfills. With the acceleration of decommissioning of PCBs-containing equipment,

[9] KR Law # 114 of July 19, 2006 on Ratification of the Stockholm Convention on Persistent Organic Pollutants of May 22, 2001, signed by the Kyrgyz Republic on May 16, 2002 (Rus.)

this source category is becoming increasingly important in releases of PCBs into the environment.

The next **group of sources** includes polluted soils, bottom sediments and water that become secondary sources of PCB emissions.

In addition to the main pollution sources, other processes may also make a certain contribution to PCBs emissions - in such processes PCBs are synthesised in a mechanism similar to dioxins (from predecessors - polyaromatic compounds, or from carbon in the presence of chlorine), or released due to incomplete combustion of PCBs impurities contained in fuel (raw materials).

For example, in the European inventory of PCBs emissions, the following sources were mentioned: burning of lignite and coal, open-hearth steel production, converter steel production, sintering, waste incineration, electric equipment (capacitors and transformers), ingot casting, electric arc furnaces, rolled steel production and transportation[10].

In the course of the First Preliminary Inventory, efforts mainly focused on the second group of PCBs sources, namely: presence of these substances in electric equipment and transformer oils. Due to the fact that there is no accurate data on volumes of electrical equipment items accumulated in the country, transformer oils and other PCBs-containing materials, potential PCBs-containing equipment items were identified by equipment types and brands, as well as by brands of oils.

According to results of the preliminary inventory[11] in the Kyrgyz Republic, the total registered (inventoried) numbers of equipment items and volumes of oils reached:
- 19230 transformers; 14285.435 tons of transformer oils-; 139.662 tons of transformer oils in stocks;
- 2373 capacitors; 24.407 tons of dielectric oils.

Electric equipment and oils are used in the energy sector, coal, metallurgical industries and in engineering and production of construction materials, while the major share of electric equipment and oils are concentrated in the energy sector. In the first inventory (selectively based on equipment types and brands), the following items were found:
- two TNZ 1000/10 type transformers in the city of Tokmok at "Interglass" JSC with a PCBs content of 2.2 tons;
- 789 KS-2, KS-2A, KSK type capacitors with 18.8 tons of PCBs-containing materials. Most of them have a service life of more than 25-30 years.

Chromatography-mass spectrometry analysis of transformer oil samples from these two transformers showed that only one of them is filled by a PCBs-containing oil. Presence or absence of PCBs in the remaining transformers, transformer oils and dielectric liquids, reserve stocks and waste could not be reliably determined based on types/brands of the equipment or oils. No information is available on methods used for environmentally sound disposal of

[10] Materials of GEF/UNEP project - Assistance to the Kyrgyz Republic in Development of the National Implementation Plan of the Stockholm Convention on Persistent Organic Pollutants: "Assessment of capacity of the national infrastructure and organisations for PCBs assessment, preparing the initial PCBs inventory" Novitskiy N.I. 2006 (Rus.)

[11] The data was incorporated into the National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants by the Kyrgyz Republic, approved by the KR Government Decree # 371-r of July 3. 2006.

decommissioned equipment and oils, nor on methods to eliminate effects of oil leaks on the ground. There is a high probability that oils used in transformers, as well as oils in stocks, may be contaminated by PCBs due to improper handling, for example, due to cross-contamination in the course of repairs or recharge of oils.

Maintenance workers were not aware of health hazards associated with work with PCBs-contaminated or PCBs-containing transformers, capacitors and oils.

The second inventory was conducted in a more detailed manner and in two stages: the first stage was implemented in 2008-2009, as a part of the GEF grant for development of the UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan"; while stage 2 was implemented in the framework of the project itself.

At the first stage, the State Energy and Gas Inspectorate, which was responsible for operational and technical control of electric equipment and power supply providers, compiled an inventory list of PCBs-containing electric equipment items. The summary of the work results is provided below:

- twenty-two (22), operational TNZ type transformers, located at various enterprises across the country, according to inventory registers they contain 96 tons of materials that require decontamination and/or utilisation in the future, including approximately 32 tons of PCBs oils; (Annexes 4, 5)
- eight (8) transformers from the above 22 items, being nominally in working condition, are not actually used. [12] Two (2) transformers are installed in a vulnerable (dangerous) location;
- two (2) TNZ type transformers were refilled with mineral oil and put into operation. Information on discharge and disposal of used oil is not available. Two (2) more TNZ type transformers were previously identified as decommissioned items in storage. The information was not confirmed;
- fifty-four (54) sites used for repairs and maintenance of electric equipment were identified, allowing to consider them as areas potentially contaminated with PCBs;
- 141,458 operational power capacitors were identified. According to inventory registers, these equipment items contain 83 tons of materials, including approximately 34.5 tons of PCBs oils, that need to be utilised in the future. No arrangements for storage of decommissioned capacitors were found, suggesting a lack of control over circulation of PCBs-containing equipment; (Annexes 2, 3)
- lack of stocks of PCBs-contaminated equipment in storage is usually explained by its sale or scrapping. According to unofficial information gathered in the framework of the Project, an active trade in used electric equipment exists, including trade in PCBs-containing equipment. The situation is associated with lack of awareness of the problem and lack of any national regulation and control in the sphere of trade in such equipment, despite the ban under the Stockholm and Basel Conventions.

At the second stage, from 2010 to 2015, the UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan", where the role of the executive partner of the project was assigned to the Ministry of Energy and Industry of the Kyrgyz Republic, identified 250 potential owners of electric equipment; 52 transformers that potentially contained PCBs (confirmed by laboratory

[12] Large units, with their actual share of 70% of the operational equipment, are located at the chemical and metallurgy plant in foreign ownership.

analysis with PCB concentrations under 50 ppm); as well as 579 capacitors containing 34 tons of PCBs located at "NESK" sites (the National Electric Network of Kyrgyzstan).

Results of the inventory (Annex 6) were included into the draft of the Updated National Implementation Plan of the Stockholm Convention by Kyrgyzstan. According to the final inventory results, 579 PCBs-containing capacitors with a total weight of 344,047 kg were identified. 348 capacitors are located in the subsidiary of the National Electric Network of Kyrgyzstan (Issyk-Kulskaya oblast, Cholpon-Ata, Akimalieva St.), and 231 capacitors are located in the subsidiary of the National Electrical Network of Kyrgyzstan in Oshskaya oblast (Kara-Suu village, Lenina St.)[13]

The information below was taken from the draft National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants (updated)- at the time of the survey the draft plan underwent the process of review and approval by governmental ministries and agencies:
“The National Electric Networks of Kyrgyzstan (NESK) is the largest owner of PCB waste in Kyrgyzstan. PCBs are located in capacitors that are connected to the grid, they are labelled and their status reports are submitted every six months to the Ministry of Energy and Industry. Capacitors rejected as unfit in operation are not dismounted by the owner, but are disconnected from grids and remain staying idle on racks in places of their installation. The number of PCB-contaminated capacitors reaches 579 units, including capacitors of KS-2-1,05-60-1U1 type (348 units weighing 60 kg) and capacitors of KS-2A-0.66-40-1U1 type (231 units weighing 57 kg). The total weight of PCB-contaminated capacitors reaches 34047 kg. At the average content of PCBs in capacitors of these types of 23 kg per item, the overall contents of PCBs in them reaches 13731 kg."

The inventory also revealed presence of 52 PCBs-containing transformers of TMN, TDTN, TMG, TN3 and GB types Specialists selected 52 samples from transformer oils from these equipment items. Cross-comparison inter-laboratory studies of samples to determine accuracy of test results were conducted in an accredited laboratory in Kazakhstan (Almaty).

The test results demonstrated PCB contents in samples below 50 ppm (mg/kg), allowing to categorise them as conditionally clean from PCBs contamination.
The inventory revealed:
- lack of stockpiles of stored equipment items contaminated with PCBs;
- out of 250 enterprises, 23 companies maintain relevant technical documentation for their electric equipment items, and based on review of the documentation, 11 companies reported that they have equipment and materials potentially contaminated with PCBs;
- the largest number of PCBs-containing equipment is concentrated in large enterprises and companies, such as NESK and Interglass;
- fifty-four (54) sites were identified where electric equipment was repaired and maintained, these sites could potentially serve PCBs-containing equipment, and three (3) of them, in the past, mostly met demands of the energy and industrial sectors.”

The PCBs inventory results are available on http://tailing.in.kg/.

[13] Response letter # 09/612 of the State Environmental and Technical Inspectorate under the KR Government of 20.02.2019.

In the course of preparations for this study, experts identified inconsistencies in the mid-term evaluation of the UNDP/GEF project “PCBs Management and Disposal in Kyrgyzstan” and in the final assessment, which was included into the draft updated National Implementation Plan of the Stockholm Convention by Kyrgyzstan (Annex 6). Due to these inconsistencies, the experts prepared a letter to the Prosecutor’s Office of the Kyrgyz Republic requesting information on availability and safety of operational and dismantled PCBs-containing electric equipment. In response to requests of the Prosecutor General's Office of the Kyrgyz Republic, the Interregional Office for Tokmaksk, Keminskiy and Chuiskiy Districts of the State Environmental and Technical Safety Inspectorate under the Government of the Kyrgyz Republic, in its response letter # 32-4/50 of March 5, 2019, reported the following information: “at the territory under control of the Interregional Office, PCBs-containing electric equipment is available at two enterprises: Tokmoksky Interglass flat glass plant (1000kVA, type TNZ-1000/10kVA, year of manufacture 1975, filled by 1855 kg of Sovtol oil) and Bystrovsky KHMZ in Orlovka village (8 TNZ 16000 / 10-75UZ type transformers). In addition, the Issyk-Kul Plant of high-voltage power stations responded that they have 445 capacitors with PCB oils in their registration records.” The information received makes the final inventory results of the UNDP/GEF project “PCBs Management and Disposal in Kyrgyzstan” questionable, in that it suggests that there are no transformers with PCBs-containing oils in Kyrgyzstan, and 348 PCBs-containing capacitors are located in the Issyk-Kul subsidiary of the National Electric Network of Kyrgyzstan. PCBs in TNZ type transformers with PCB concentrations under 50 ppm may suggest either inadequate sampling, or undetected sources of contamination in oil discharges points, or cross-contamination with significant dilution of oil concentrations. The latter option, considering the volumes of oils required to reduce concentrations of PCBs to levels under 50 ppm, seems to be unlikely from technical and economic points of view.

It is worth noting that a part of private enterprises - owners of equipment - could not be covered by the inventory due to objective reasons. Access to private sites and, accordingly, to their accounting documents, is limited. In other words, in reality, the amount of PCBs-contaminated equipment items may be much larger than that listed in the inventory.

No inventory of sources of the third and the fourth groups of PCBs releases into the environment has been made in the Kyrgyz Republic.

para (b) of Part II of Annex A of the Stockholm Convention:
b) Consistent with the priorities in subparagraph (a), promote the following measures to reduce exposures and risk to control the use of polychlorinated biphenyls:
i) Use only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimised and quickly remedied;
ii) Not use in equipment in areas associated with the production or processing of food or feed;
iii) When used in populated areas, including schools and hospitals, all reasonable measures to protect from electrical failure which could result in a fire, and regular inspection of equipment for leaks

1. The national legislation does not provide for separate rules for regulation of PCBs. According to the Decree of the Government of the Kyrgyz Republic on Actions to Protect the Environment

and Human Health from Adverse Impacts of Certain Hazardous Chemicals and Pesticides[14], polychlorinated biphenyls are categorised as substances under strictly restricted use and special control requirements.

In this connection, and according to Law of the Kyrgyz Republic on Procedure for Conducting Inspections of Business Actors[15] and Checklists for Inspections of Business Actors on Environmental Safety[16], the list of issues for inspections on management of PCBs includes the following:

- inventory of waste and waste disposal facilities;
- setting limits on waste disposal and their types;
- compliance with rules of storage, transportation and use of hazardous waste;
- determination of the hazard class and toxicity of the waste;
- compliance with technical regulations, rules and standards in waste processing, on-site waste storage at enterprises, for each type of waste;
- availability of safety data sheets for hazardous waste;
- identification of chemicals in product mixes;
- hazard information on chemical products. Marking in compliance with hazard labels (pictogram) with interstate standards GOST 31340-2007 "Warning labelling of chemical products. General requirements";
- compliance with rules of storage, use, transportation and destruction of hazardous chemicals;
- adequacy of available amounts of chemicals and amounts specified in permits;
- status of registration record keeping on hazardous chemicals (supply and consumption).

However, due to the fact that the majority of owners of PCBs-containing equipment are neither aware of PCBs-related hazards, nor about PCBs contents in equipment items and oils, no special actions are stipulated for dealing with PCBs-containing equipment, nor for disposal of PCBs wastes at enterprises. In addition, workers are not aware of PCBs and their health impacts[17].

2. The Coordination Commission for Promotion of Safe Chemicals Management (including those containing polychlorinated biphenyls (PCBs)), was established by Decree # 335-r of the KR Government of July 22, 2001. The main objective of the Commission's activities is - to ensure safe chemicals management (including management of PCBs-containing ones), to attract donor assistance, to improve relevant legislation and coordination, to interact efficiently with all stakeholders, to promote prompt decision-making and to develop concerted actions. In this period, the Coordination Commission in its full composition met only once.

3. In 2013, as a part of the GEF/UNDP project "PCBs Management and Disposal in Kyrgyzstan", central laboratories of SES Department and the Environmental Protection Agency were equipped with Shimadzy gas chromatographs for determination of polychlorinated biphenyls (PCBs) in transformer oils. Due to the project, specialists of these laboratories have mastered

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[14] KR Government Decree # 376 of July 27, 2001 on Actions to Protect the Environment and Human Health from Adverse Impacts of Certain Hazardous Chemicals and Pesticides.

[15] Law # 72 of the Kyrgyz Republic on Procedure for Conducting Inspections of Business Actors of May 25, 2007.

[16] Order # 169 of the KR Ministry of Economy of June 22, 2016 and Order # 239 of the State Environmental and Technical Safety Inspectorate under the Government of the Kyrgyz Republic of May 31, 2016 on Approval of Checklist Forms of the State Environmental and Technical Safety Inspectorate under the Government of the Kyrgyz Republic.

[17] According to results of research study on Stakeholders' Awareness of Safety of PCBs Management under UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan"

and implemented methodologies for determination of PCBs in food products, drinking water and transformer oils. Additionally, 10 specialists were trained to use the test kits, and 250 screening test kits (reagents) and 10 express analysers were purchased for 2 inspectorates, customs authorities, sanitary education departments and NESK.

4. In the course of implementation of the ADB project “Rehabilitation of the Electric Power Sector, Phase 1”, in 2014, 2017 and 2018, samples of cable and transformer oils were analysed for presence of PCBs in disassembled oil-filled equipment. Oil samples were analysed with the application of a L2000DX analyser in the chemical laboratory of the Toktogul Cascade of HPPs. Concentrations of PCBs in all samples were below 50 ppm (mg/kg). Thus, these oils can be considered as clear from PCBs and special measures for their treatment or disposal were not required.[18]

5. In the course of compiling the inventory list of PCBs-containing electric equipment, the State Energy and Gas Inspectorate revealed that almost all facilities do not keep records on their operational PCBs-containing equipment, nor records on decommissioned equipment items containing PCBs oils; equipment contaminated by PCBs; PCBs stockpiles and contaminated sites; or on PCBs in products. Generally, technical guidance documents (manuals) were non-existent or were not available. Actually, such oils were not tested and sampled in practice.

Furthermore, the UNDP/GEF project “PCBs Management and Disposal in Kyrgyzstan” revealed that the facilities where the transformers are located are not operational for the most part. Only site owners are present, while equipment maintenance workers are not available, except in the case of "Interglass" flat glass plant in Tokmak and KHMZ Plant in Kemin township. Therefore, one should not expect any production facility level control over the safety of such equipment.

Lack of stockpiles of stored PCBs-contaminated equipment is usually associated with sale or scrapping such equipment items. However, unofficial information on practices of repairs and maintenance of transformers suggests that replacement of PCBs-containing oil by mineral oil is practiced. As a result, in addition to waste PCB oils and contaminated transformers, some cross contamination may be possible due to use of common equipment for handling transformer oils.

6. Control of PCBs levels in environmental media was not conducted due to the lack of an appropriate instrumental base. MAC limits for PCBs levels in water, soil, air, and food products are not developed in the regulatory framework. There are no programs to control PCBs in the environment and, accordingly, there is no assessment of their adverse effects for human health and the environment.

7. One of reasons for inadequate control over PCBs management is associated with low awareness of decision makers, regulatory authorities and owners of PCBs-containing equipment, as well as representatives of local authorities and the general public about PCBs. Control and inventory problems also include restrictions for access of regulators to private facilities and their associated registration records.

[18] Semi-annual Environmental Monitoring Report. Project code number: 44198 – KGZ, ADB grant/loan code: L2869/G0294-KGZ, Reporting period: January 2018 - June 2018. The Kyrgyz Republic: project “Rehabilitation of the Electric Power Sector, Phase 1”

8. The situation concerning supervision over management of PCBs-containing equipment and waste is worsening due to the fact that the Government introduced a moratorium on inspections of business actors from January 1, 2019 for a period of 2 years[19].

para (c) of Part II of Annex A of the Stockholm Convention:
c) Notwithstanding paragraph 2 of Article 3, ensure that equipment containing polychlorinated biphenyls, as described in subparagraph (a), shall not be exported or imported except for the purpose of environmentally sound waste management

Unofficial information gathered in the course of the UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan" suggests that there is an active trade in used electric equipment, including PCBs-containing equipment items, as well as import/export of used equipment items from/to neighbouring countries. For example, according to information from the website http://tailing.in.kg/, the following facts were found:

- transformers registered as belonging to the Kara Altyn industrial enterprise and Besh-Burkhankomur Mine JSC were dismantled and transported to Uzbekistan;
- TNZP type transformer registered as belonging to cotton plant "Satvaldy" JSC (Karasuiskiy district, Machak village), was purchased but it was not installed. The transformer was sold due to its failure to meet the specifications of technical documents issued by "Oshelectro" JSC. When the organisation that bought this transformer was checked, it reported that the transformer failed, was sold as ferrous metal scrap and taken away in an unknown direction. (Annex 5).

para (d) of Part II of Annex A of the Stockholm Convention:
d) Except for maintenance and servicing operations, not allow recovery for the purpose of reuse in other equipment of liquids with polychlorinated biphenyls content above 0.005 per cent;

No information is available on reuse of PCBs in other equipment.

para (e) of Part II of Annex A of the Stockholm Convention:
e) Make determined efforts designed to lead to environmentally sound waste management of liquids containing polychlorinated biphenyls and equipment contaminated with polychlorinated biphenyls having a polychlorinated biphenyls content above 0.005 per cent, in accordance with paragraph 1 of Article 6, as soon as possible but no later than 2028, subject to review by the Conference of the Parties;

According to the National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants[20], the following actions on PCBs are planned - preparation of storage sites for PCBs-containing equipment and oils, as well as collection and transportation of PCBs-containing equipment items and oils to these storage sites. In the period from 2006 to 2018, these actions were not implemented due to economic, social and environmental problems.

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[19] Decree # 586 of the KR Government of December 17, 2018 on Introduction of Temporary Ban (Moratorium) on Inspection of Business Actors.

[20] The National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants by the Kyrgyz Republic (approved by the KR Government Decree # 371-r of July 3. 2006.)

In 2016, the draft "National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants (Updated)" was posted on the website of the KR Government for public discussion. This document is still at the stage of review and discussion. The following actions are provided for safe operation and storage of PCBs-containing equipment:

- marking the equipment. Control of operation of PCBs-containing equipment. Inclusion into checklists for inspectors (by 2025);
- full identifications of economic actors that are not covered by the inventory and have PCBs-containing equipment, materials, contaminated sites. Conclusion of contracts with all owners of PCBs-containing equipment;
- allocation of special storage space for contaminated equipment and materials. Collection and transportation of contaminated equipment and materials to the storage site (by 2025);
- rehabilitation of PCB-contaminated sites.

Despite the fact that actions for collection and transportation of PCBs waste to the storage site were stipulated as early as 2006, in the current National Action Plan of Implementation of the Stockholm Convention, the land area for the site of hazardous waste has not yet been defined and agreed upon between governmental agencies.

Currently there are no legal or economic possibilities to destroy or dispose of PCBs waste in the country.

In 2011, the UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan" attempted to remove PCBs wastes from the country for disposal; however, due to the fact that PCBs are in the Basel Convention list, the transit countries did not give permission to move these wastes through their own territories.

Methods of elimination of PCBs-containing waste

Now, two main options for elimination of PCBs-containing waste are considered for use in the world: incineration at high temperatures and application of non-incineration technologies.

As a preliminary assessment of economic costs of utilisation of PCB-containing oils, the UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan" estimated costs of a mobile unit with a capacity of 80 tons per year and costs of a fixed installation with capacity of 1000 tons per year with application of the incineration technology in flow of hot gases. Estimated cost of the mobile unit reached $180-200 thousand, while estimated costs of processing 1 ton of PCBs reached $280-320. Estimated costs of the fixed installation reached more than $10 million, while estimated costs of processing reached $1000 per 1 ton of PCBs. In order to increase processing load of the fixed installation, it may be also used to destroy accumulated stockpiles of obsolete pesticides, as well as other organic waste. However, incineration-based technologies themselves are potential sources of unintentional releases of POPs. In order to ensure a high level of environmental safety of the PCBs incineration method, modernised incineration units (furnaces) are used - they are expensive and difficult to operate in practice.[21]

[21] Analytical Survey of the Situation in Management of PCBs-containing Equipment and Waste in the Kyrgyz Republic - Bishkek, 2013 (Rus.)

Common sense and requirements of the Stockholm Convention force us to give preference to alternative non-incineration technologies[22] for neutralisation/destruction of persistent organic pollutants (POPs). This approach to the problem is fully supported by the Stockholm Convention on POPs.

In addition to preventing formation and unintentional releases of POPs, the alternative technologies also provide lower capital and operating costs in comparison to use of incinerators equipped with state-of-the-art control and monitoring devices.[23]

In general terms, the abovementioned technologies use physical and chemical means of converting POPs and POPs-containing wastes into less hazardous substances. Such agencies such as FAO[24], the Australian Department of Environment[25], the US Department of State Security[26] and the Department of Energy[27] have evaluated and prepared relevant reports for both indicators - Destruction Efficiency (DE) and Destructive and Removal Efficiency (DRE) [28] for the technologies used to neutralise and destroy POPs.

There are non-incineration industrial technologies for destruction of POPs, as well as operating facilities licensed to destroy accumulated waste stockpiles with high concentrations of POPs. In particular, it is worth noting the technologies of gas phase chemical reduction (GPCR), base catalytic decomposition (BCD), reduction by sodium (SR) and oxidation in supercritical water (SCWO)[29]. A brief description and discussion of these non-incineration industrial technologies are provided in Annex 7.

para (f) of Part II of Annex A of the Stockholm Convention:
f) In lieu of note (ii) in Part I of this Annex, endeavour to identify other articles containing more than 0.005 per cent polychlorinated biphenyls (e.g. cable-sheaths, cured caulk and painted objects) and manage them in accordance with paragraph 1 of Article 6

Due to the fact that all implemented projects on inventory of PCBs in the country were focused on identification of PCBs contents in transformers and capacitors only, no information is available on amounts of equipment items and volumes of PCBs in other equipment and goods

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[22] Non-incineration technologies mean processes in oxygen-free atmosphere or in atmosphere with normal oxygen levels.
[23] Petrlik, J., "Global NGOs Community and Chemical Conventions with a Special Reference on Stockholm Convention", Arnika Association, Czech Republic, 2004.
[24] "Disposal of Bulk Quantities of Obsolete Pesticides in Developing Countries", United Nations Food and Agriculture Organization, 1996.
[25] "Appropriate Technologies for the Treatment of Scheduled Wastes", Review Report Number 4, Environment Canada, 1997.
[26] "U.S. Army Chemical Demilitarization and Remediation Activity", Delivery Order Number 136, Combined 3rd & 4th Quarterly Report, U.S. Army, 1996.
[27] Schwinkendort, W., McFee, J., et.al., "Alternatives to Incineration", U.S. Department of Energy, Office of Technology Department, 1995.
[28] Destruction Efficiency (DE) is defined as presence of undestroyed chemicals in all gaseous, liquid or solid processing residues. Destructive and Removal Efficiency (DRE) is defined for gaseous residues only.
[29] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

(hydraulic and cooling equipment, in cables, as plasticisers, in production of paints, varnishes, glues, carbon paper, etc.). No inventory of such products was conducted.

para (g) of Part II of Annex A of the Stockholm Convention:
g) Provide a report every five years on progress in eliminating polychlorinated biphenyls and submit it to the Conference of the Parties pursuant to Article 15

After ratification of the Stockholm Convention in 2006[30], and up to 2017, the Kyrgyz Republic did not submit reports on the implementation of provisions of the Stockholm Convention. As part of the GEF/UNEP project "Review and Update of the National Implementation Plan of the Stockholm Convention on Persistent Organic Pollutants in the Kyrgyz Republic", and after repeated appeals of non-governmental organisations to the Government of the Kyrgyz Republic, in January 2018, the State Agency for Environment and Forestry under the Government of the Kyrgyz Republic submitted its third (for 2014) online report of the Stockholm Convention and in November 2018, the report for the fourth reporting cycle of 2018 was developed.

Conclusions:

Paragraph (a): According to information from inventories completed in the country, electric equipment (transformers and capacitors) containing PCB oils, as well as wastes contaminated by PCBs are present in the Kyrgyz Republic. The inventories were of a preliminary nature, as presence of PCBs-containing oils in equipment items was mainly determined by visual inspection (based on types and characteristics of electric equipment items). Only 52 transformer oil samples were analysed for the presence of PCBs. The test results suggested PCBs contents in samples under 50 ppm (mg/kg), allowing to categorise the equipment as conditionally clean from PCBs. The data obtained as a result of the inventories conducted are fragmentary and non-systemic, and the data obtained do not coincide with each other, which casts doubt on the final results. Due to the lack of registration record keeping at enterprises, there is no information on movements of equipment: from purchase and operation to dismantling and storage of PCBs waste.

Paragraph (b): Notwithstanding that according to regulations of the Kyrgyz Republic, PCBs are categorised as substances of strictly restricted use and subject to special control, the state control over management of PCBs-containing equipment and waste is at a low level. At the level of production facilities, PCBs are almost never controlled and registered. As some part of the equipment is located at idle facilities, and most owners of PCBs-containing equipment are not aware of hazards of PCBs, PCBs contents in equipment items and oils, no special facility level precautions are applied for dealing with PCBs-containing equipment and disposal of PCBs waste. Employees of facilities are also poorly informed about PCBs and their health impacts. Maintenance workers are not aware of health risks associated with handling PCBs-containing transformers, capacitors and oils.

Paragraph (c): Unofficial information suggests that there is an active trade in used electrical equipment, including PCBs-containing equipment items. This is due to a lack of awareness of the problem and absence of any national regulation and control in the sphere of trade in such equipment, despite the ban under the Stockholm and Basel Conventions.

[30] KR Law # 114 of July 19, 2006 on Ratification of the Stockholm Convention on Persistent Organic Pollutants of May 22, 2001, signed by the Kyrgyz Republic on May 16, 2002 (Rus.)

Paragraph (d): Due to lack of registration and maintenance of records on PCBs as hazardous chemicals, there is no information on reuse of PCBs in other equipment.

Paragraph (e): According to materials from the UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan", the Government currently cannot provide funding for purchase of technologies for neutralisation/destruction of PCBs in the country. There is no possibility of exporting PCBs for disposal, because Belarus, Russia and Kazakhstan do not permit transit of PCBs-containing waste through their territories. Allocation of a central warehouse for temporary storage of hazardous waste has not been made yet (despite the fact that it was provided for in action plans of the Government of the Kyrgyz Republic since 2006). All PCBs-containing equipment items and waste are still kept by their owners. At the same time, some facilities where the transformers are installed now stay idle, suggesting that PCBs-containing wastes are almost abandoned.

Paragraph (f): No inventory of other pollution sources was conducted.

Paragraph (g): In 2018, the country fulfilled its obligations to submit a national report to the Convention Secretariat.

Recommendations:

- to re-check and legitimise results of inventories conducted in the framework of past projects by international organisations.
- to continue inventories of all sources of PCBs contamination. To develop a database of PCBs-containing equipment, waste and sites potentially contaminated by PCBs.
- to develop a plan for phasing out PCBs-containing equipment from operation and for its collection on temporary storage sites.
- to develop and implement standards for PCBs levels in environmental media.
- to tighten state control over facilities with registered PCBs-containing equipment and/or wastes.
- to tighten control over sale and transboundary movements of PCBs-containing equipment and waste.
- to train inspectors of the state supervisory authority for identification pf PCBs-containing equipment, reserves and wastes of PCB oils, for identification places of possible soil contamination due to leaks and spills.
- the specially authorised body in the sphere of chemical safety needs to strengthen its search for environmentally sound non-incineration technologies for destruction of PCBs and search for funding for these activities.
- to build capacity, raise awareness and enhance responsibility of entities in charge of management of PCB-containing equipment and wastes.
- to raise public awareness of PCBs-related hazards and impacts of PCBs.
- to implement a lobbying and information campaign on alternative non-incineration technologies for neutralisation/destruction of persistent organic pollutants (POPs).
- to hold public hearings, regional meetings and other public events for discussion of initiatives to meet requirements of the Stockholm Convention.

Information sources:

1. Materials of ADB project "Rehabilitation of the Electric Power Sector, Phase 1";

2. Materials of GEF/UNEP project “Review and Update of the National Implementation Plan of the Stockholm Convention on Persistent Organic Pollutants in the Kyrgyz Republic”;
3. Materials of GEF/UNEP project “Assistance to the Kyrgyz Republic in Development of the National Implementation Plan of the Stockholm Convention on Persistent Organic Pollutants”;
4. Materials of UNDP/GEF project “PCBs Management and Disposal in Kyrgyzstan”;
5. The National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants by the Kyrgyz Republic (approved by the KR Government Decree # 371-r of July 3. 2006.)
6. Online reports on implementation of the Stockholm Convention by the Kyrgyz Republic in the third and fourth reporting cycles;
7. The draft National Action Plan of Implementation of the Stockholm Convention on Persistent Organic Pollutants (updated).

Annex 1

Synonyms and brand names of PCBs, PCTs and PBBs

Chemicals	Synonyms and brand names[31]
PCBs	Abestol, Aceclor, Adkarel, ALC, Apirolio (Italy), Apirorlio, Areclor, Arochlor, Arochlors, Aroclor/Arochlor(s) (US), Arubren, Asbestol (US), Ask/Askarel/Askael, Auxol, Bakola, Biclor, Blacol (Germany), Biphenyl, Clophen (Germany), Cloresil, Chlophen, Chloretol, Chlorextol (US), Chlorfin, Chlorinal/Chlorinol, Chlorinated biphenyl, Chlorinated diphenyl, Chlorobiphenyl, Chlorodiphenyl, Chlorophen (Poland), Chlorphen, Chorextol, Chorinol, Clophen/Clophenharz (Germany), Cloresil, Clorinal, Clorphen, Crophene (Germany), Decachlorodiphenyl, Delofet O-2, Delor (Slovakia), Delor/Del (Slovakia), Delorene, Delorit, Delotherm DK/DH (Slovakia), Diaclor (US), Diarol, Dicolor, Diconal, Disconon, DK (Italy), Ducanol, Duconal, Duconol, Dykanol (US), Dyknol, Educarel, EEC-18, Elaol (Germany), Electrophenyl, Elemex (US), Elinol, Eucarel, Euracel, Fenchlor (Italy), Fenclor (Italy), Fenocloro, Gilotherm, Hexol, Hivar, Hydelor, Hydol, Hydrol, Hyrol, Hyvol (US), Inclor, Inerteen (US), Inertenn, Kanechlor (Japan), Kaneclor, Kennechlor (Japan), Kenneclor, Leromoll, Magvar, MCS 1489, Montar, Monter, Nepoli, Nepolin, Niren, NoFlamol, No-Flamol (US), Non-Flamol, Olex-sf-d, Orophene, Pheaoclor, Pheneclor, Phenochlor, Phenoclor (Framce), Plastivar, Polychlorinated diphenyl, Polychlorinated diphenyls, Polychlorobiphenyl, Polychlorodiphenyl, Prodelec, Pydraul, Pyraclor, Pyralene (France), Pyranol (US), Pyroclor (US), Pyrochlor, Pyronol, Safe-T-Kuhl, Saft-Kuhl, Saf-T-Kohl, Saf-T-Kuhl (US), Santosol, Santotherm (Japan), Santothern, Santovac, Sat-T-America, Siclonyl, Solvol, Tarnol (Poland), Sorol, Soval, Sovol, (USSR), Sovtol, Terphenychlore, Therminal, Therminol, Turbinol
PCTs	Aroclor (US), Clophen Harz (W), Cloresil (A,B,100), Electrophenyl T-50 and T60, Kanechlor KC-C (Japan), Leromoll, Phenoclor, Pydraul
PBBs	Adine 0102, BB-9, Berkflam B_{10}, Bromkal 80, Firemaster BP-6, Firemaster FF-1, Flammex B-10, hbb, hexabromobiphenyl, HFO 101, obb, BB-8

Annex 2

Map of sites with PCBs-containing capacitors (UNDP/GEF project “PCBs Management and Disposal in Kyrgyzstan” http://tailing.in.kg/.)

Data on capacitors with PCBs – Shapar V.

Annex 3

Information on capacitor units. (UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan")

#	Substations	Control units	Capacitors types	Capacity kVA (nominal)	Year of manuf.	Year of commiss	Number of elements	Total mass kg	Locations
	BSK		**TOTAL:**	**173 595.7**			2154		
1.	"Kara-Suu"	BSK-1	KS2A-0.66-40	5 040	1973	1974	121	6897	Kara-Suu
2.	"Kara-Suu"	BSK-2	KS2A-0.66-40	5 040	1973	1974	122	6954	Kara-Suu
3.	"Zhetigen"	BSK-1	BKE-1.05-252U1	5 000	1987	1988	96	2496	Kazarman v.
4.	"Zhetigen"	BSK-2	BKE-1.05-252U1	5 000	1987	1988	96	2496	Kazarman v.
5.	"Uzgen"	BSK	BKE-1.05-252U1	2 110	1984	1986	48	1248	Uzgen
6.	"Tyuleiken"	BSK	BKE-1.05-252U1	2 410	1988	1988	96	2496	Osh
7.	"Pamirskaya"	BSK	BKE-1.05-252U1	2 110	1988	1990	84	2184	Osh
8.	"Karatai"	BSK	BKE-1.05-252U1	2 110	1988	1990	84	2184	Karatai v.
9.	"Przevalskaya"	BSK-1	KEK-1-1.05-63-1U1	5 975.1	1991	1994	96	2496	Karakol
10.	"Przevalskaya"	BSK-2	KEK-1-1.05-63-1U1	6 066.6	1991	1994	96	2106	Karakol
11.	"Naryn-1"	BSK	BKE-1.05-252U1	3 000	1986	1994	96	2496	Naryn
12.	"Vostochnaya"	BSK-1	KEK-1-1.05-63-1U1	5 292	1991	1995	84	2184	Karakol
13.	"Vostochnaya"	BSK-2	KEK-1-1.05-63-1U1	5 292	1991	1995	84	2158	Karakol
14.	"Tyup"	BSK-1	KEK-1-1.05-63-1U1	5 292	1991	1995	86	2236	Tyup v.
15.	"Tyup"	BSK-2	KEK-1-1.05-63-1U1	5 292	1991	1995	82	2132	Tyup v.
16.	"Cholpon-Ata"	BSK-1	KS-2-1.05-60-1U1	10 440	1996	1996	168	4368	Cholpon-Ata
17.	"Cholpon-Ata"	BSK-2	KS-2-1.05-60-1U1	10 440	1996	1996	180	4680	Cholpon-Ata
18.	"Boz-Teri"	BSK-1	KEK-1-1.05-63-1U1	4 368	1996	1996	84	2184	Boz-Teri v.

19.	"Boz-Teri"	BSK-2	KEK-1-1.05-63-1U1	4 368	1996	1996	84	2184	Boz-Teri v.
20.	"Talasskaya"	BSK	KEK-1-1.05-63-1U1	5 300	1991	1995	63	1638	Talas
21.	"Taklasskayaя"	BSK	KEK-1-1.05-63-1U1	5 300	1991	1995	84	2184	Talas
22.	"Pokrovka"	BSK-1	MERLIN-GERIN RECNIPNASE P40PINA4	8 750	1998	1998	15		Kyzyl-Suu
23.	"Pristan"	BSK-1	MERLIN-GERIN RECNIPNASE P40PINA4	9 800	1998	1998	15		Karakol
24.	"Pristan"	BSK-2	MERLIN-GERIN RECNIPNASE P40PINA4	9 800	1998	1998	15		Karakol
25.	"Tamga"	BSK-1	MERLIN-GERIN RECNIPNASE P40PINA4	8 000	1996	1996	15		Tamga v.
26.	"Tamga"	BSK-2	MERLIN-GERIN RECNIPNASE P40PINA4	8 000	1996	1996	15		Tamga v.
27.	"Tamga"	BSK-3	MERLIN-GERIN RECNIPNASE P40PINA4	8 000	1996	1996	15		Tamga v.
28.	"Tamga"	BSK-4	MERLIN-GERIN RECNIPNASE P40PINA4	8 000	1996	1996	15		Tamga v.
29	"Tamga"	BSK-5	MERLIN-GERIN	8 000	1996	1996	15		Tamga v.

Notes:
Product datasheet mass of 1 unit of KS2-0.66-40.0 = 57 kg.
Product datasheet mass of 1 unit of KS-2-1.05-60-1U1= 26 kg.
Product datasheet mass of 1 unit of KEK-1-1.05-63-1U1= 26 kg.
Product datasheet mass of 1 unit of BKE-1.05-252U1= 26 kg.
Special labels, required by p.5.6.10. of Operation Manual for KS2-0.66-40.0 (none)
In the case of KS2-0.66-40.0 total land area under the installation - 336 m2

Annex 4

Map of sites with PCB-containing transformers (UNDP/GEF project “PCBs Management and Disposal in Kyrgyzstan” http://tailing.in.kg/.)

Data on transformers with PCBs - Tavasharov E.

Annex 5

Information on transformers (UNDP/GEF project "PCBs Management and Disposal in Kyrgyzstan")

Organisation	**Location**	**Last inventory date**	**Transformers numbers/ capacity**	**Oil mass kg**	**Notes**
"Kara Altyn" production facility, coal mining	Sulyukta	01.05.2011-15.05.2011	1/40	205	The transformer was transported to Uzbekistan
"Besh-Burkhankomur Mine" JSC	Nookatskiy district	01.05.2011-15.05.2011	1/40	205	The transformer was dismounted and transported to Uzbekistan
Cotton plant of "Osh Pamuk" JSC	Aravan v., 94 Osh-3000 let, Oshskaya oblast	01.05.2011-15.05.2011	1/630	1100	The transformer was disassembled into spare parts
Cotton plant of "Ak Niet" JSC	Aravan v., 33 Lenina St.	01.05.2011-15.05.2011	2/800	5100	A TNZ type transformer was installed in 1989. in 1990, it was dismounted and disassembled into spare parts
Cotton plant of "Makhdiy" JSC	Karasuiskiy district, Kyzyl Shark v.	01.05.2011-15.05.2011	1/40	205	A TNZ type transformer was installed in 1981, now it is idle
Cotton plant of "Ak Teks" JSC	Osh, 87 Tursunbayeva St.	01.05.2011-15.05.2011	1/1000	2500	A TNPU type transformer was installed in 1982. It was dismounted and oil was removed, its fate is unknown
Warehouse of "Vzryvprom Company" JSC	Osh, Nookatskoye higway-6 km.	01.05.2011-15.05.2011	1/25	160	The transformer stays idle
Cotton plant of "Satvaldy" JSC	Karasuiskiy district, Machak v.	01.05.2011-15.05.2011	1/630	1350	A TNZP type transformer was purchased, but it was not installed. The transformer was

					sold due to its failure to meet specifications of technical documents issued by "Oshelectro" JSC. When the purchasing organisation, that bought this transformer, was checked, it reported that the transformer failed, was sold as ferrous metal scrap and taken away to unknown destination.
"Mata" (non-woven materials factory)	Dzalal-Abad, Kokart residential district	15.05.2011-31.05.2011	1/25	160	In the course of the inventory, the transformer was dismounted and sent to repairs
"Ak-Altyn" JSC (cotton processing plant)	Dzalal-Abad, industrial zone	15.05.2011-31.05.2011	1/40	205	The transformer is unusable
"Doma-Ata" cotton processing plant	Suzaksjiy district, Askar-Ata township	15.05.2011-31.05.2011	1/25	160	
"Atlas Cotton Limited" JSC	Bazar-Korgon village	15.05.2011-31.05.2011	1/630	1100	The transformer stays idle
"Altyn-Bula" JSC	Bazar-Korgonskiy district, Kyzyl Ai v.	15.05.2011-31.05.2011	1/40	205	The transformer is dismounted
"Gulam-Ata" JSC	Bazar-Korgonskiy district, Abdraimova v.	15.05.2011-31.05.2011	1/630	1100	The transformer was dismounted and removed to a warehouse facility, oil was removed
Cotton processing plant	Nookenskiy district, Tashtak v.	15.05.2011-31.05.2011	1/40	205	The transformer is not operational, oil was removed
"Nur Pakhta" JSC (cotton processing plant)	Nookenskiy district, Aral v.	15.05.2011-31.05.2011	1/25	160	The transformer was modernised and refilled

"Intercottongroup" cotton processing plant	Nookenskiy district, Aral v.	15.05.2011-31.05.2011	1/630	1100	The transformer is inoperable
"Belhlopprom" JSC (cotton processing plant)	Nookenskiy district, Komintern v.	15.05.2011-31.05.2011	1/40	205	A TNZ type transformer was installed but it was refilled in 1993
"Gleizer Dunai Naryn" JSC (cotton processing plant)	Uch-Korgon v., Aksyiskiy district	15.05.2011-31.05.2011	1/40	205	The transformer was sold as spare parts, only some components are available
Kara Balta carpet plant	Kara-Balta, 1 Palmiro Toliatti St.	03.06.2011-10.06.2011	1/1600	2850	The transformer was dismounted and sold to an assembling organisation. Inspection revealed that the transformer was disassembled for spare parts
"BShZ" facility	Bishkek, 1 Mira ave.	01.07.2011-05.07.2011	2/1000	3600	The transformers were installed earlier, but in 1990 they were dismounted as solid as non-ferrous scrap.
"Interglass" Tokmok flat glass plant	Tokmok, industrial zone	03.06.2011-10.06.2011	1/1000	1855	Operational
Bystrovskiy KKhMZ	Orlovla township, 1A Lenina St.	03.06.2011-10.06.2011	8/1600	22800	
Oil terminal of "Gazpromneftazia" JSC	Balykhchi, Ozernaya St.	13.06.2011-19.06.2011	1/630	1100	The transformer was dismounted and taken away to an unknown destination

Annex 6

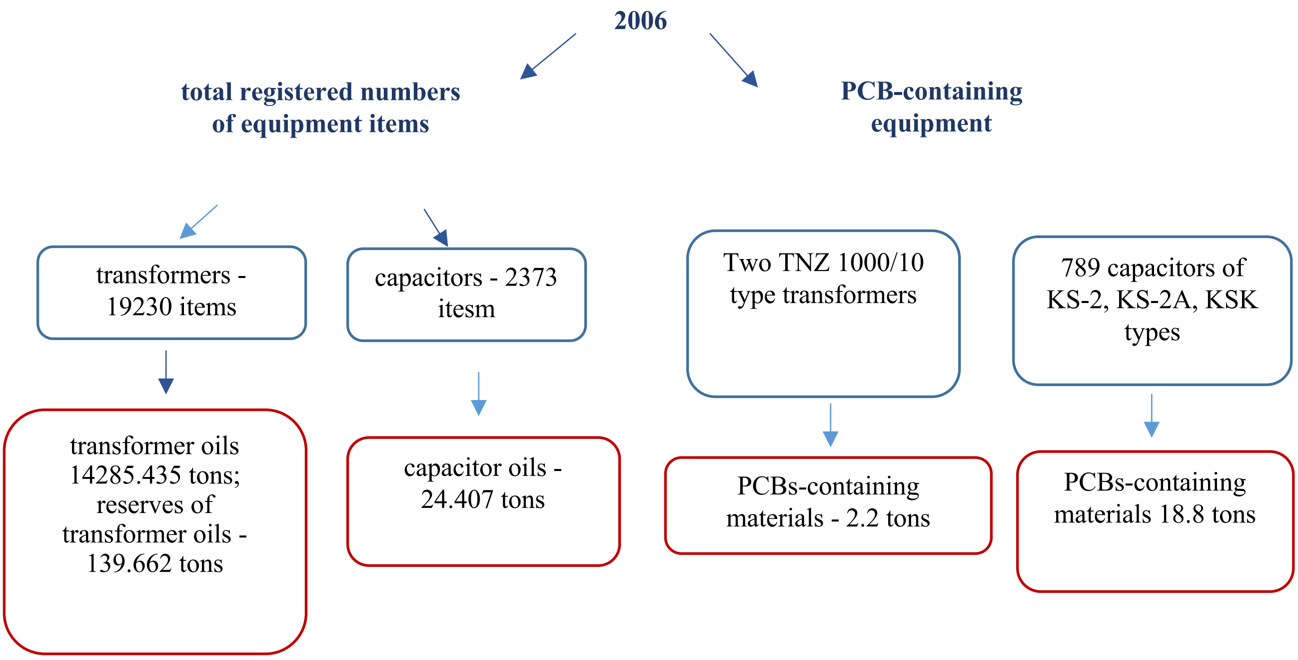
Survey of inventory results at different stages of project “PCBs Management and Disposal in Kyrgyzstan"[32]

	Initial inventory	**Project development stage of project “PCBs Management and Disposal in Kyrgyzstan"**	**Inventory status at the moment of medium terms assessment**	**Inventory status at the moment of the final assessment**
Transformers	1 (estimated oil contents - 2.2 tons)	22 *operational* TNZ type transformers (containing 32 tons of PCB oils, overall 96 tons of materials in need of decontamination and/or utilisation) These items include 3 transformer that were identified but their operational status was not ascertained as owners restricted access to them.	25 (36 tons of PCB oils) Idle: 3 (1000) - 6,000 kg 2 (800) - 5,100 kg 7 (630) - 7,055 kg 7 (40) - 1,435kg Total: 19 items Operational: 5 (1600) - 14,250 kg 1 (1000) - 1,855 kg Total: 6 items	52 oil samples were taken from 52 transformers at the second stage of inventory. Laboratory analysis of PCBs by State SES suggested that all samples of PCB oils contain less than 50 mg/kg of PCBs .
Capacitors (operational)	789 (estimated PCB oils contents - 18.8 tons)	1458 electric capacitors (containing 34.5 tons of PCB oils, overall 83 tons of materials in need of burial in the future)	2045 (containing 46.5 tons of PCB oils)	597 PCB-containing capacitors (operational at two NESK substations) with overall contents of 34 tons

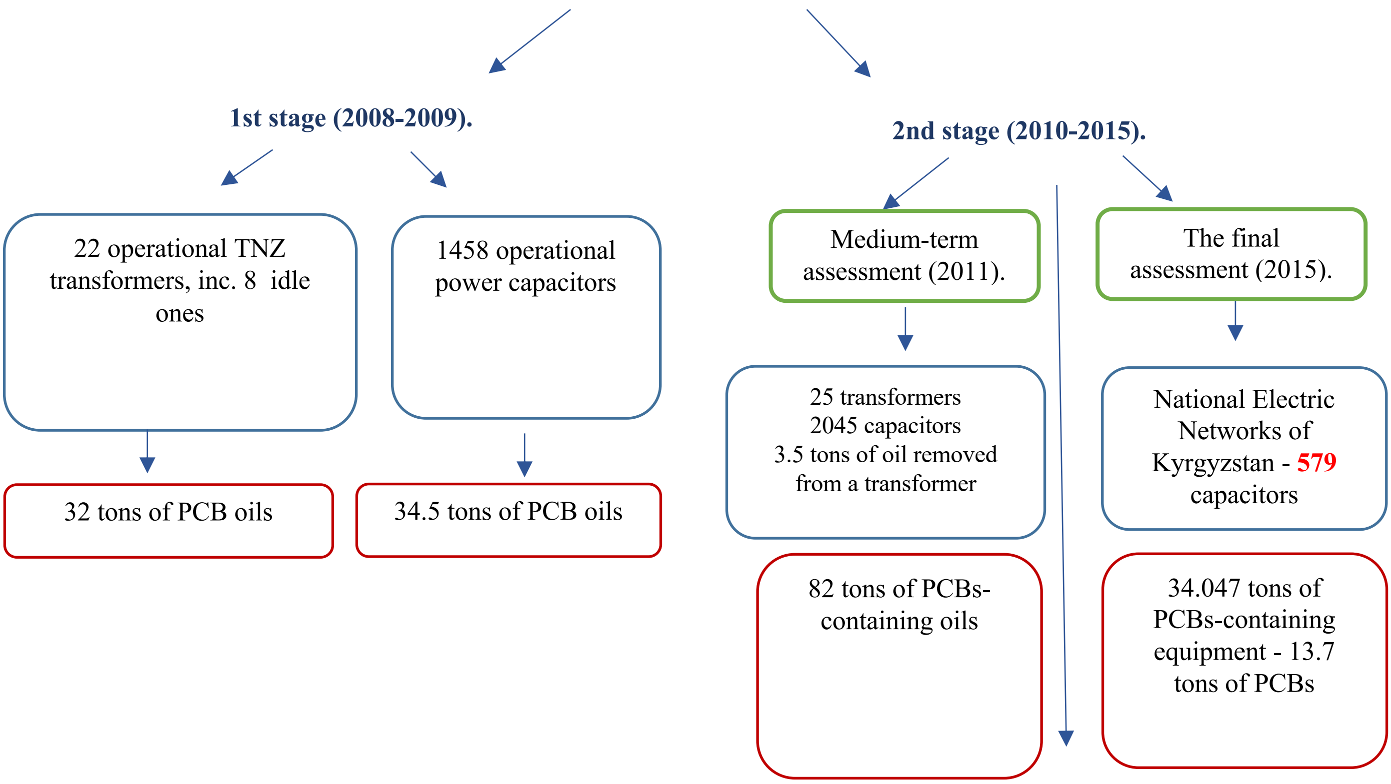
[32] The Final Report of project “PCBs Management and Disposal in Kyrgyzstan" . February 2016

Waste oils		1.8 tons of PCB oil (removed from a transformer)	~ 3.5 tons (a laboratory analysis is needed to estimate precise amounts of spent oils)	Checked in the course of the inventory (<50 ppm)
Electric equipment repair and maintenance sites (numbers).		54	54	
TOTAL	**■ 1 transformer (2.2 tons of oils)** **■ 789 capacitors (18.8 tons of oils)**	**■ 22 transformers (32 tons of oils)** **■ 1,458 capacitors (34.5 tons of oils)** **■ 1.8 tons of oil removed from a transformer**	**■ 25 transformers (32 tons of oils)** **■ 2,045 capacitors (46.5 tons of oils)** **■ 3.5 tons of oil removed from a transformer**	**■ 597 PCB-containing capacitors (operational at two NESK substations) with overall contents of 34 tons**
TOTAL (tons of PCB-containing oils)	**21**	**68,3**	**82**	**34**

THE FIRST INVENTORY



THE SECOND INVENMTORY



Annex 7

Alternative to incineration technologies for neutralisation/destruction of persistent organic pollutants (POPs)

1. Gas Phase Chemical Reduction (GPCR)

This technology provides the best results among all non-incineration technologies for destruction (neutralisation) of POPs, it was used for destruction of POPs-containing waste over the past eight years[33]. In the GPCR process, decomposition of POPs takes place in a low pressure gaseous media in absence of oxygen, that prevents formation of dioxins and promotes decomposition of dioxins initially present in wastes [34,35,9]. The process is based on a reaction of gas-phase thermochemical reduction, that includes interaction of hydrogen with organic and organochlorine compounds. At temperatures in the range from 800 to 900^{o}C and at a low pressure, hydrogen reacts with such compounds as polychlorinated biphenyls, DDT, hexachlobenzenes and mixtures of pesticides, decomposing these substances, mainly into methane and other hydrocarbons, including some light hydrocarbons. Liquid wastes can be injected into the reaction unit. Solid waste is processed directly without any pre-treatment shredding or size reduction of waste fractions.[36,37,38].

Depending on waste amounts and installation capacity, this technology allows to process up to 100 tons of waste per day. This destruction technology can be applied to all POPs, including

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[33] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[34] "Disposal of Bulk Quantities of Obsolete Pesticides in Developing Countries", United Nations Food and Agriculture Organization, 1996.

[35] "PCB Treatment Technologies Based on the Waste Disposal and Clean Up Law", (29 Profiles), September, 2003.

[36] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[37] Environment Australia 1997

[38] "Gas Phase Chemical Reduction (GPCR)", Non-Incineration Technology Fact Sheet # 4 Greenpeace.

wastes with high concentrations of POPs, PCB containing transformers, batteries and spent oils[39,40].

Technical parameters of the GPCR process: according to available information, this process demonstrates high destruction efficiency (DE) for HCB, PCB, waste containing dioxins and furans, as well as mixed organochlorine pesticides. In the case of testing industrial plants in Canada, DE values at the level of 99.999% were achieved for PCBs and HCB. Dioxins and furans, present as pollutants in polychlorinated biphenyl oils, were also decomposed by this process with DE value of 99.999%. Similar tests in Japan and estimates of levels of decomposition of dioxins and furans in wastes in the GPCR process also demonstrated high destruction efficiency reaching 99.9999%[41,42].

Environmental performance: In the GPCR process, all emissions and particulate matter can be captured for analysis and further processing, if necessary[43,44]. Residues of the process include the produced gas, water of a scrubber, sand and sludge from the processing (purification) of the produced gas. In the resulting gas in the GPCR process, dioxins and furans were not detected. According to data provided by Canada, no uncontrolled emissions were found from use of this process for destruction of PCB-containing materials[45].

39 "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

40 "Gas Phase Chemical Reduction (GPCR)", Non-Incineration Technology Fact Sheet # 4 Greenpeace.

41 "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

42 "Gas Phase Chemical Reduction (GPCR)", Non-Incineration Technology Fact Sheet # 4 Greenpeace.

43 "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

44 "Gas Phase Chemical Reduction (GPCR)", Non-Incineration Technology Fact Sheet # 4 Greenpeace.

45 ELI Eco Logic International, Inc. 1996.

This technology has passed industrial level tests, it is licensed and applied in Australia, Japan and Canada. In addition, a pilot project on destruction of POPs is planned in the Slovak Republic with application of the GPCR process[46].

Basic catalytic destruction (BCD)

This technology has been used to process large volumes of wastes with high levels of POPs, such as DDT, PCB, dioxins and furans. BCD technology is an improved version of the catalytic dechlorinating process developed earlier by the US Environmental Protection Agency to rehabilitate soils and sediments contaminated by organochlorine compounds[47].

In the BCD technology, solid or liquid wastes are processed by heating them up to 300-350°C under normal pressure and in presence of a mixture of high-boiling hydrocarbons, sodium hydroxide and a catalyst. In the process, highly reactive atomic hydrogen formed in the preheated mixture decomposes organochlorine and other wastes with formation of inorganic salts, inert residues and water. Then the catalyst used in the BCD process is separated from precipitates, recovered and reused[48,49,50].

The BCD technology allows to process up to 20 tons of contaminated solid waste per hour and up to 9000 liters of liquids at a time. One may design lower capacity installations based on the BCD process. Contaminated soils and sediments require some pre-treatment before using the BCD technology, that is mainly applied for neutralisation of liquid waste[51].

Technical parameters of the BCD process: Technical parameters of the BCD process: measurements of discharges and emissions from outdated plants with the BCD technology

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[46] “Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries”, The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[47] “Remediation Technologies Screening Matrix and Reference Guide”, 3rd Edition October, 1997.

[48] “Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries”, The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[49] “PCB Treatment Technologies Based on the Waste Disposal and Clean Up Law”, (29 Profiles), September, 2003.

[50] “Examples of Commercial Scale POPs Stockpile Destruction Technologies”, Non-Incineration Fact Sheet #3, Greenpeace.

[51] “Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries”, The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

revealed presence of organochlorine compounds and dioxins, but modern versions of the technology can achieve DREs> 99.99999% for 30% DDT and> 99.999999 for 90% PCB[16]. In the course of experimental tests, higher destruction efficiencies (DEs) were obtained for HCB, DDT, PCB, dioxins and furans[52].

Environmental performance: In the BCD process, all emissions and precipitates may be captured for analysis and re-treatment if necessary. In general, the BCD technology is considered as a low-risk technology[7]. The BCD technology was used to destroy 42,000 tons of PCB-contaminated soils [17]. Similarly, this technology has also been applied at the highly contaminated by dioxins site of Spolana Neratovic enterprise in the Czech Republic. Unfortunately, processed sludge and used oils were burned in an incinerator operated by SITA Bohemia in the Czech Republic[18].

This technology is licensed for industrial application in Australia, USA, Mexico, Spain, the Czech Republic and in neighbouring countries of the Central and Eastern Europe[53].

Supercritical water oxidation (SCWO)

The technology relies on unique properties of supercritical water (with temperatures > 374 ^{o}C and pressures > 22 MPa) for complete oxidation and decomposition of toxic organic substances and wastes. In early systems, problems of reliability and corrosion of equipment materials were regularly encountered. Currently, these problems have been successfully resolved by use of corrosion-resistant materials and special design of installations. Now, an industrial scale unit with the SCWO process is operating in Japan. After an effective pilot-scale demonstration and refinement, this process has been recently approved for full-scale application in the United States[54,55,56].

Supercritical water is known to have very high catalyst properties in oxidation/reduction reactions, by dissolving organic substances and oxygen[10]. The SCWO process is a high-temperature one at high pressures in completely isolated systems at temperatures of 400–500

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[52] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[53] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[54] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[55] Costner, P., Luscombe, D. and Simpson, M., "Technical Criteria for the Destruction of Stockpiled Persistent Organic Pollutants", Greenpeace 1998.

[56] BCD CZ, "Project Spolana - dioxiny" report for EIA process, BCD CZ, Prague 2004.

°C and pressures of about 25 MPa, promoting rapid completion of the oxidation process. The reduction products include carbon dioxide, inorganic acids and salts. Application of the system is limited to processing of liquids and solids with organic contents <20% and sizes of solid particles < 200 µm. Wastes with high PCBs contents produce acidic precipitates (low pH) in the process, and therefore, to avoid equipment corrosion, the material of reactors and attached pipes are treated with alkaline solutions for neutralisation[57,58].

The existing demonstration installation based on the SCWO process has processing capacity of about 400 kg/h. There are plans to increase its processing capacity up to 2700 kg/h. The SCWO process was used to destroy a wide range of materials, including POPs, industrial organic chemicals, agro-chemicals, explosives, as well as to treatment of a wide range of contaminated materials, such as industrial effluents, sludges, household wastewaters contaminated by PCBs, pesticides, aliphatic and aromatic halogenated substances[59,60].

Technical parameters of the SCWO process: Registered destructive and removal efficiency values (DREs) for the SCWO technology reach > 99.99994% for processing of dioxin-containing waste and > 99.999% for processing of various hazardous organic compounds (including chlorinated solvents, PCBs and pesticides)[12,20]. Experimental testing has demonstrated a significant potential for highly efficient destruction of PCBs with application of the technology[61].

Environmental performance: In the case of application of the SCWO process, all emissions and residues may be captured for further analysis and re-treatment, if necessary[62]. Gaseous emissions are minor with low carbon monoxide levels of <10 ppm, without particulate matter, nitrogen oxides, hydrogen chloride or sulphur oxides[63]. Some studies have demonstrated that formation of PCDDs/Fs may occur under certain conditions in the course of PCBs decomposition

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[57] Costner, P., Luscombe, D. and Simpson, M., "Technical Criteria for the Destruction of Stockpiled Persistent Organic Pollutants", Greenpeace 1998.

[58] BCD CZ, "Project Spolana - dioxiny" report for EIA process, BCD CZ, Prague 2004.

[59] Environment Australia 1997

[60] Costner, P., Luscombe, D. and Simpson, M., "Technical Criteria for the Destruction of Stockpiled Persistent Organic Pollutants", Greenpeace 1998.

[61] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[62] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[63] Thomson, T.B., Hong, G.T. et al., "The MODAR Supercritical Oxidation Process", published in Freeman, H.M. (Ed), "Innovative Hazardous Waste Treatment Technology Series", Volume 1, Technomic Publishing Inc. 1990.

by this technology,[64] therefore mandatory monitoring of CO emissions and due and complete control over operational equipment is needed.

Sodium reduction (SR)

This technology is considered as a well-developed one, it was used at the industrial scale for several years to process spent oils with low and high concentrations of PCBs. The technology allows a mobile option and it is widely used to destroy PCBs at production sites where operational transformers are located[65].

In the SR process, chlorine is completely removed from PCBs by alkali metal reduction with use of sodium dispersed in mineral oils. The dechlorinating process is conducted by mixing the reactive mixture in a dry nitrogen atmosphere at normal pressure. Sizes of metal sodium particles, its concentration, and optimal reaction temperatures vary depending on types of the SR process used. Pre-treatment is limited to removal of moisture from the reagents. At the end of the reaction, excess sodium is removed by adding water. The SR process generates minimum amounts of solid precipitates. Reaction by-products includes water, sodium chloride, sodium hydroxide, and biphenyls. After the treatment, processed oils may be reused.[66]

A mobile unit using the SR technology, with processing capacity up to 15,000 liters of oil per day, was used to process contaminated transformer oil containing PCBs[67]. Destruction efficiency (DE) exceeds 99.999%, and destructive and removal efficiency (DRE) of 99.9999% was found for chlorine and hexachlorobenzene. Emissions of nitrogen and hydrogen are possible, while no information is available on emissions of organic substances. Nevertheless, recycle of spent transformer oils by sodium reduction (SR) has successfully demonstrated compliance with the legislatively set criteria of the US, EU, Canada, Australia, Japan, and South Africa. The technology is widely used all over the world[68].

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[64] Weber, R., "Relevance of PCDD/PCDF Formation for the Evaluation of POPs Destruction Technologies – PCB Destruction by Super Critical Water Oxidation (SCWO)". Organohalogen Compounds – Volume 66 (2004), 1281-1288.

[65] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[66] "PCB Treatment Technologies Based on the Waste Disposal and Clean Up Law", (29 Profiles), September, 2003.

[67] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

[68] "Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries", The Scientific and Technical Advisory Panel of the GEF, UNEP 2003.

Other non-incineration technologies

Non-incineration technologies for destruction of POPs-containing waste represent an area with great opportunities for development and introduction of new technologies, but knowledge about them and implementation of such technologies are limited. Many technologies already exist at the industrial scale of development (for example, the continuous circuit CDP process used in Cyprus[69] for decontamination of PCB-contaminated transformers), as well as several promising technologies that can be used in the near future, for example, for decontamination of waste incinerators polluted with polychlorinated dibenzodioxins/furans (PCDD/F), flue ashes, and PCBs-containing wastes (based on different catalytic reactions[570,71]).

*** *** The Working Group on development of the Basel Guidelines on POPs Waste Management agreed to recommend that the technologies used should provide destruction efficiency (DE) of 99.9999% for processing POPs waste or POPs-containing waste in concentrations over 1%. Among other things, the Working Group also agreed to recommend the technologies described above (GPCR, BCD, SCWO and SR) as “Environmentally Sound and Affordable” technologies. Recent studies also recommend assessing available technologies for destruction of POPs in terms of all technological parameters - TEQ (including both its elements: PCDD/Fs and PCBs), that would include formation of both PCBs and PCDD/Fs.

[69] Tumiatti, V., Tumiatti, C., Tumiatti M., “Oil, PCBs & POPs: The inventory, management and decontamination in electrical networks” in UNEP Chemicals “Consultation Meeting on PCB Management and Disposal under the Stockholm Convention on Persistent Organic Pollutants. Geneva, Switzerland, 9 - 10 June 2004.

[70] Relevance of PCDD/PCDF Formation for the Evaluation of POPs Destruction Technologies - PCB destruction over a TiO2-Based V2O5-WO3 Catalyst”. Organohalogen Compounds – Volume 66 (2004), 1289-1295.

[71] Pekarek, V. “Technology of catalytic dehalogenation of POPs compounds” in International Workshop on Non-combustion Technologies for Destruction of POPs, ed. Arnika/IPEN Dioxin, PCBs and Waste WG, Prague 2003.