Eco-SPES NGO, Dzerzhinsk, Nizhegorodskaya Oblast

eco-dzerzhinsk@yandex.ru

PCBs Elimination Progress Report

2019

Polychlorinated biphenyls (PCBs) belong to the group of persistent organic pollutants (POPs), they have toxic properties, are persistent and bioaccumulative, capable of long-range transport in different environmental media.

PCBs are released into the environment in a variety of ways, both due to current industrial use of PCBs and due to their possible formation as by-products. PCBs may escape into the environment from technical items, transformers, capacitors, varnishes, paints, chemicals, construction materials, etc. Of the total amount of PCBs production, 35% are released into the environment. [17].

PCBs are extremely toxic to human health and the environment. PCBs are classified as belonging to the group of POPs under the Stockholm Convention on POPs.

Occurrence of foetal pathologies due to impacts of PCBs indicates their ability to cross the placenta barrier. Similarly to dioxins, some dioxin-like PCBs interact with AhR receptors, causing relevant alterations in cellular metabolism. [18].

Production of PCBs in Russia

Producers of PCBs in the former USSR, and then in Russia, included "Orgsteklo" Plant (in Dzerzhinsk, Nizhegorodskaya oblast) and "Orgsintez" Plant (in Novomoskovsk, Tulskaya oblast).

"Sovol" was produced in the period from 1939 to 1990, while "Sovtol-10" was produced from 1939 to 1987, and trichlorobiphenyl was produced from 1968 to 1990.

In the whole period of operation of the above plants (from 1939 to 1993) they produced about 180 thousand tons of various PCBs brands.

Trichlorobiphenyl (TCB), as well as pentachlorobiphenyl or mixtures of tetra- and pentachlorobiphenyl ("sovols") had diverse applications in different industrial sectors.

PCBs mixtures with electric grade 1,2,4-trichlorobenzene (in different ratios) were produced under "sovtol" brand name and were used as dielectric liquids to fill transformers. Mixtures of "sovol" with 1,2,4-trichlorobenzene were sold under brand name "Sovtol-10" since 1957.

PCBs-containing equipment at the territory of Russia

According to the inventory conducted by the RF Ministry of Natural Resources and the Environment and the RF Ministry of Industry and Science in the framework of AMAP project, in 1999, in the Russian Federation, at chemical and petrochemical plants, in metallurgy and engineering industry, in the forestry and timber complex, including pulp and paper facilities, the overall amount of PCBs on their production sites reached about 9900 tons, including: 9000 tons in 3342 transformers and 900 tons in 44,382 capacitors.

In 1999, facilities of the fuel and energy complex operated or kept in reserves 175,837 units of electric equipment filled by polychlorinated biphenyls, with the total volume of about 3,140 tons. The inventory revealed only 22 power transformers with dielectric liquids on the base of polychlorinated biphenyls in the fuel and energy complex.

In the course of the first PCBs inventory in Russia (1999), 7 constituents of the Russian Federation (out of 89) did not provide information whether they had PCBs in equipment.

The information provided by 82 constituents of the Russian Federation was not sufficiently complete, as it did not include data on some facilities. According to expert estimates, volumes of PCBs in equipment at these facilities could reach about 5,800 tons.

PCBs-containing equipment items are not used by railway transport. However, according to expert estimates, out of 12,000 railway stations, about a half of them (6000) could have PCBs-containing electric equipment items. According to expert estimates, electric equipment items at railway stations by the moment of the inventory could contain up to 1000 tons of PCBs.

Distribution of PCBs between different industries in regions of Russia at that time corresponded to distribution of industrial facilities in these regions. In particular, the largest number of chemical and engineering plants operated in the Volga region, and the inventory results demonstrated the largest amount of PCBs in that region. "KAMAZ" JSC (2053 tons) and "AVTOVAZ" in Samara (1940 tons) reported the main share of PCBs in PCBs-containing equipment in that region.

In the Urals region, the largest numbers of ferrous metallurgy plants were located in Sverdlovskaya and Chelyabinskaya oblasts and, correspondingly, large volumes of PCBs were found in their equipment - 1643 and 1246 tons, respectively.

Table # 1. PCBs in transformers and capacitors commissioned at the territory of the Russian Federation

Transformers			Capacitors		
Years	Items	PCBs for filling, tons	Years	Items	PCBs for filling, tons
1939-1949	1 000	1 800			
1950-1959	2 000	3 600			
1960-1969	2 600	4 800			
1970-1979	7 400	14 000	1968-1979	750 000	14 900
1980-1989	5 200	10 000	1980-1989	450 000	9 100
Total	18 200	34 200		1 200 000	24 000

More than a half of PCBs (61%) contained in decommissioned PCBs-containing electric equipment items (in 124 transformers and 5222 capacitors) of ferrous metallurgy plants. The largest numbers of capacitors in the ferrous metallurgy sector are accumulated in the Urals region, in Chelyabinsk Electrometallurgical Plant JSC (1901 items) and "Verkhnyaya Salda" Metallurgic Association JSC (1,690 items), as well as in the Volga region, including Samara Metallurgic Plant JSC (500 items).

According to data of 1999, 91 facilities of the fuel and energy complex of Russia operated 19,657 capacitors and 3,872 transformers filled by PCBs.

According to the inventory data, the total number of capacitors used by facilities of the Russian Federation reached 193179 capacitors, that contained 3439 tons of trichlorobiphenyl (TCB).

The quantity of PCBs identified in PCBs-containing equipment at the territory of Russia reached 27,000 tons, and - taking into account PCBs in waste - the total amount of PCBs identified at the territory of Russia as a result of the inventory of 1999 reached 33,600 tons [1].

Table # 2. Quantity of PCBs at the territory of the Russian Federation in 1999, by industries

#	Industries	Transformers	Capacitors	Total PCBs

		Items	Amount of PCBs (tons)	Items	Amount of PCBs (tons)	in equipment (tons)
1.	Chemical and petrochemical industry, metallurgy, non-ferrous metallurgy, timber and chemical, pulp and paper industry, engineering industry	3543	9028	48515	879	9907
2.	Fuel and energy complex	22	40	175815	3139	3179
3.	Data of territorial environmental bodies	3599	4175	133170	2745	6920
	Total	7164	13243	357500	6763	20006

Interregional Distribution Grid Company of Siberia JSC reported on decommissioning and disposal of PCBs-containing equipment by 2015, with the overall amount of 28 tons. in May 2009, IDGC of Siberia was granted a single license for collection, use, neutralisation, transportation and disposal of hazardous waste.

IDGC of Siberia JSC incorporates the following subsidiaries: "Altayenergo", "Buryatenergo", Gorno-Altaiskie Electric Networks, "Krasnoyarskenergo", "Kuzbassenergo-RES", "Omskenergo, Khakasenergo", "Chitaenergo", Tomsk Distribution Company JSC, "Ulan-Ude Energo" JSC, "Tyvaenergo" JSC [3].

In particular, En + company reported that it conducts replacement of high-voltage capacitors containing trichlorobiphenyl in its subsidiaries . As Mr Boris Karataev, the Director General of Irkutsk Grid Company said to BG, "... by now, more than 1,000 capacitors out of 6720 have been replaced. The replacement plan for 2017 covers 1800 items. Dismantled trichlorobiphenyl-containing capacitors were completely utilised under a contract with specialised organisations. In the period from 2015 to 2016, 59.77 tons were utilised" [4].

It is worth to note that a significant share of Russian companies conceal information on availability of PCBs-containing electric equipment and/or PCBs waste on their production sites, failing to provide it to UNIDO, or even to governmental authorities, nothing to say about environmental NGOs.

Companies do not want to disclose information on processes of disposal of their contaminated oils. Representatives of companies often told experts that their companies have already checked oils in their equipment for presence of PCBs in them and have not detected any hazardous substances. However, none of the companies disclosed information on specific oils used to fill their capacitors, specific additives used and their compositions.

As a UNIDO expert, Ms Ekaterina Ivanova said, "So, we applied, for example, to KAMAZ JSC, and we were told that studies had already been completed, PCBs were identified and destroyed. But the company did not answer the question on quantity of the equipment inspected, how exactly did they dispose of hazardous substances". KAMAZ JSC also did not respond to information request of "Kommersant" [8].

According to AMAP inventory data of 1999, 76 facilities of the fuel and energy complex operated electric installations with PCBs-filled electric equipment. PCBs-containing equipment items were distributed as follows:

- power industry - 173378 capacitors and 1144 transformers of different capacity at 53 power industry facilities;

- oil industry - 2036 capacitors and 20 transformers of different capacity at 14 oil industry facilities;

- coal industry - 401 capacitors and 2 transformers of different capacity at 8 coal industry facilities.

In 2009, according to expert estimates of the Ministry of Natural Resources of Russia, 188740 units of PCBs-containing electric equipment, including 960 transformers and 187780 capacitors, were installed in 84 organisations of the fuel and energy complex. The total amount of PCBs-containing oils was estimated at the level of 4298.45 tons.

Processed results suggest that 8114 organisations have accumulated 7147 tons of synthetic PCBs-containing transformer oils. These organisations owned 152254 PCBs-containing electric equipment items, including 1311 transformers and 150943 capacitors.

Currently, more than 80% of PCBs-containing capacitors and 92% of transformers are operational. Such equipment items mostly have usable service life of 25-30 years or more.

PCBs-containing transformers are concentrated in 5 organisations (Enel Russia JSC, Evraz Holding JSC, "Rosatom" SC, "Severstal" JSC, Gazprom JSC). About 80% of PCBs-containing capacitors are owned by 3 organisations ("FSK EES JSC, Russian Networks JSC, "Kurganenergo" JSC).

Almost the entire volume of PCBs-containing oils (96%) is concentrated in 3 organisations of the fuel and energy complex: Enel Russia JSC, Machine-building Plant JSC of "Rosatom" SC and Evraz Holding JSC. Enel Russia JSC leads in terms of volumes of synthetic PCBs-containing transformer oils (4.73 thousand tons) - the company is one of the leading Russian wholesale producers of electric and thermal energy. The main volume of PCBs is concentrated at 2 district power plants (Reftinskaya and Sredneuralskaya power plants in the Urals region).

A half of all PCBs-containing transformers in the power industry sector are concentrated in facilities of the Urals Federal District, while capacitors are mainly accumulated in the Urals Federal District and the Central Federal District. More than a half of all PCB-containing oils are concentrated in facilities of the Urals Federal District. Almost a third of them are located in facilities of the Central Federal District, plus an insignificant share in facilities of the North-Western and the Volga Federal Districts [5].

In 2015, in the framework of UNIDO and the Russian Energy Agency project, with support of the Ministry of Energy of Russia, a pilot inventory of PCBs-containing equipment in the fuel and energy sector organisations was implemented. The inventory data revealed that 7914 organizations have accumulated 7147 tons of synthetic PCBs-containing transformer oils. There were 152254 units of PCBs-containing electric equipment, including 1311 transformers and 150943 capacitors owned by the organisations [6].

More than 80% of PCBs-containing capacitors and 92% of transformers are currently in operation. These equipment items mainly have a service life of 25-30 years or more.

PCBs-containing transformers are concentrated in 5 organisations (Enel Russia JSC, Evraz Holding JSC, "Rosatom" SC, "Severstal" JSC, Gazprom JSC). About 80% of PCBs-containing capacitors are owned by 3 organisations ("FSK EES JSC, Russian Networks JSC, "Kurganenergo" JSC).

Almost the entire volume of PCBs-containing oils (96%) is concentrated in 3 organisations of the fuel and energy complex: Enel Russia JSC, Machine-building Plant JSC of "Rosatom" SC and Evraz Holding JSC. Enel Russia JSC leads in volumes of synthetic PCBs-containing transformer oils (4.73 thousand tons) - the company is one of the leading Russian wholesale producers of electric and thermal energy. The main volume of PCBs is concentrated at 2 district power plants (Reftinskaya and Sredneuralskaya PPs in the Urals region).

A half of all PCBs-containing transformers in the power industry sector are concentrated in facilities of the Urals Federal District, while capacitors are mainly accumulated in facilities of the Urals Federal District and the Central Federal District. More than a half of all PCB-containing oils are concentrated in facilities of the Urals Federal District. Almost a third of them are located in facilities of the Central Federal District, while the rest of the oils are located in facilities of the North-Western and the Volga Federal Districts [7].

The Ministry of Ecology and Natural Resources (the Ministry of Natural Resources of Russia) has been appointed the authorised governmental body of the Russian Federation in charge of implementation of provisions of the Stockholm Convention. By RF Government Decree # 651 of June 29, 2015, the Federal Supervisory Natural Resources Management Service (Rosprirodnadzor) was incorporated into the list of responsible authorities as pertains to the Stockholm Convention on POPs.

However, as practice shows, officials of the Service (Rosprirodnadzor) either do not have complete information on PCBs reserves and PCBs-containing wastes, or do not wish to provide such information to environmental NGOs.

In particular, by its letter No. 11-57/1412 of March 14, 2019, senior managers of Rosprirodnadzor Office in the Far Eastern Federal District reported that the Office had no information on volumes of PCBs-containing electric equipment.

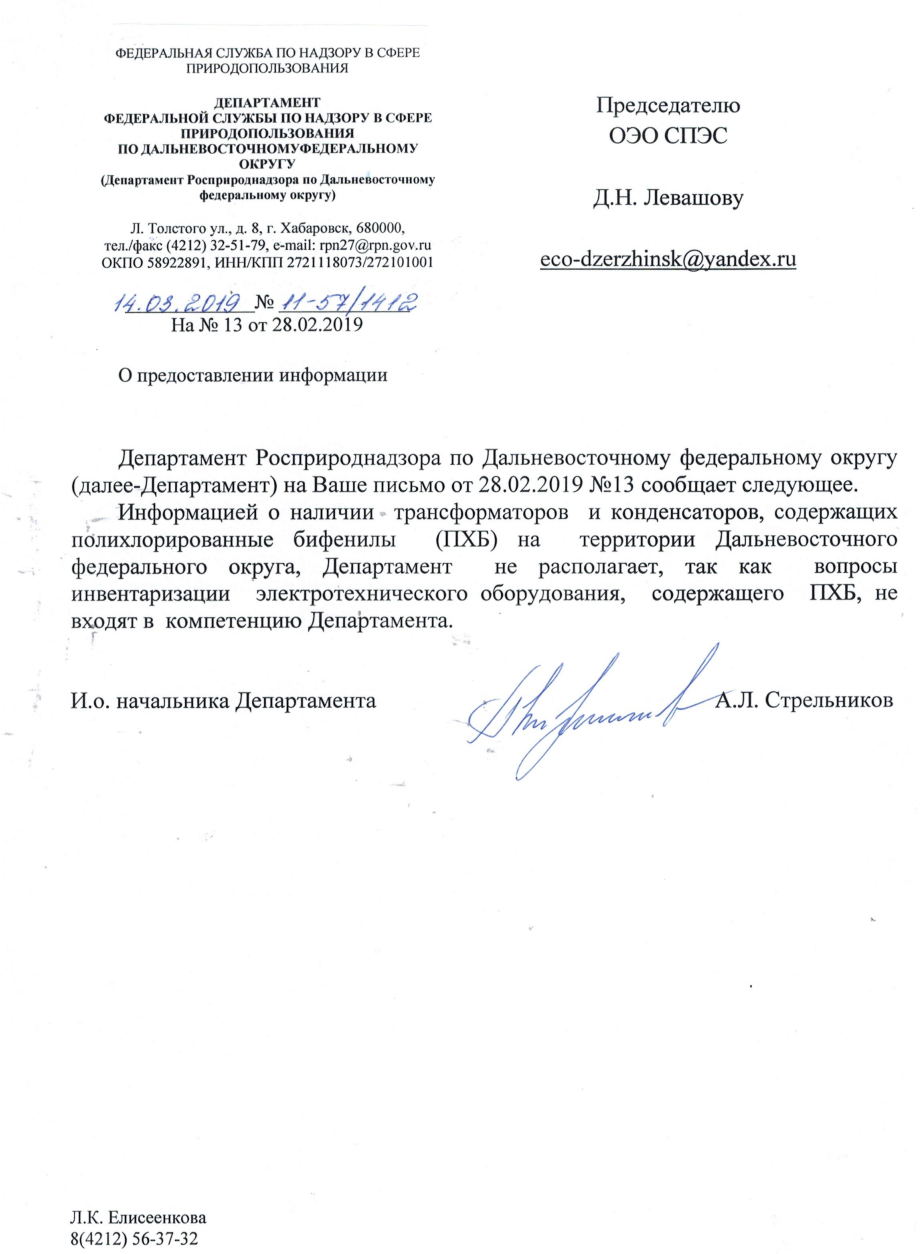
Similar responses on lack of information were provided by Rosprirodnadzor offices in the Southern, Central and Urals Federal Districts.

The Interregional Office of Rosprirodnadzor in Krasnoyarskiy Krai and the Tyva Republic reported that currently (by April 2019), "Tyvaenergo" JSC had 302 equipment items, containing 17.516 tons of PCBs. The equipment decommissioning was planned for the period from 2020 to 2022. It is worth to note that no information on the Republic of Tyva was available in the course of inventory of 1999.

Krasnoyarsk Railways (subsidiary of the Russian Railways JSC), "Krasmash" JSC, "IDGC of Siberia" - "Krasnoyarskenergo", the Mining Chemical Plant FSUE, "Krasnoyarskenergosbyt" JSC confirmed that they do not have PCBs-containing equipment.

It can be assumed that the largest companies of Krasnoyarskiy Krai: "KraMZ" JSC, "Rusal Krasnoyarsk" JSC, "Rusal Achinsk" JSC, "Krastsvetmet" JSC, Krasnoyarsk subsidiary of "SGK" JSC and "GMK Norilsk Nickel" JSC continue to keep PCBs-containing equipment, as earlier. Rosprirodnadzor Office in the Krasnoyarsk Krai did not have information on availability of PCBs-containing equipment and PCBs wastes (by April 2019) in these companies.

According to information provided by the territorial Rosprirodnadzor Office in Krasnoyarsk Krai, there are no licensed facilities operating in the sphere of collection, transportation, processing, utilisation, neutralisation and disposal of PCBs at the territory of Krasnoyarsk Krai.



ФЕДЕРАЛЬНАЯ СЛУЖБА ПО НАДЗОРУ В СФЕРЕ ПРИРОДОПОЛЬЗОВАНИЯ

ДЕПАРТАМЕНТ ФЕДЕРАЛЬНОЙ СЛУЖБЫ ПО НАДЗОРУ В СФЕРЕ ПРИРОДОПОЛЬЗОВАНИЯ ПО ДАЛЬНЕВОСТОЧНОМУФЕДЕРАЛЬНОМУ ОКРУГУ
(Департамент Росприроднадзора по Дальневосточному федеральному округу)

Л. Толстого ул., д. 8, г. Хабаровск, 680000,
тел./факс (4212) 32-51-79, e-mail: rpn27@rpn.gov.ru
ОКПО 58922891, ИНН/КПП 2721118073/272101001

14.03.2019 № 11-57/1412
На № 13 от 28.02.2019

Председателю
ОЭО СПЭС

Д.Н. Левашову

eco-dzerzhinsk@yandex.ru

О предоставлении информации

Департамент Росприроднадзора по Дальневосточному федеральному округу (далее-Департамент) на Ваше письмо от 28.02.2019 №13 сообщает следующее.

Информацией о наличии трансформаторов и конденсаторов, содержащих полихлорированные бифенилы (ПХБ) на территории Дальневосточного федерального округа, Департамент не располагает, так как вопросы инвентаризации электротехнического оборудования, содержащего ПХБ, не входят в компетенцию Департамента.

И.о. начальника Департамента А.Л. Стрельников

Л.К. Елисеенкова
8(4212) 56-37-32

Figure 1. Response letter of Rosprirodnadzor Office in the Far Eastern Federal District.

In 1999, Omsk Refinery JSC (Omskaya oblast) had 2 decommissioned capacitors containing 0.008 tons of PCBs, as well as 10 transformers in operation. Currently, in 2019, 10 TNZ-40/10 type transformers continue to operate at the facility. There are no capacitors in operation, and the currently operational transformers are planned to be decommissioned up to 2025. Contents of PCB-oils in them are estimated to reach 205 kg of "Sovtol" in each (with total calculated volume of 2,050 tons).

In 1999, "KuibyshevAzot" JSC (Samarskaya oblast) had 21 decommissioned capacitors containing 0.21 tons of PCBs. According to the company's response, now there are 2 transformers and 177 PCBs-containing capacitors.

In 1999, Samara Metallurgic Plant JSC (Samarskaya oblast) had: 1 transformer and 500 decommissioned capacitors containing 12.71 tons of PCBs. According to the response letter of “Arkonik SMZ” JSC, currently (in 2019), no PCBs-containing equipment is available in the plant.

In 1999, Norilsk Nickel JSC (Krasnoyarskiy Krai) had 3 decommissioned transformers and 246 capacitors containing 10.76 tons of PCBs. In addition, 222 transformers were operational at that time. In 2019, no open information was available on presence (or lack of) PCBs-containing equipment and PCB waste at the plant. In 2019, the company did not respond to the request.

In 1999, Volzhsky Pipe Plant Production Association (Volgogradskaya oblast) had 12 decommissioned transformers and 99 capacitors, containing 24.2 tons of PCBs. In 2019, the company has 55 transformers, including 35 operational transformers, 9 transformers in reserve, 4 transformers decommissioned and 7 transformers utilised. The company has 1076 capacitors, including: 549 capacitors in operation, 98 in reserve, 60 decommissioned and 369 utilised.

In 1999, GAZ JSC (Gorkovskiy Automobile Plant) in Nizhny Novgorod had 149 transformers and 3368 capacitors with the highest amount of PCBs oils in Nizhegorodskaya oblast - 580.79 tons of PCBs, plus also 12.3 tons of PCBs in waste. In 2005, as a result of the SPES inventory, GAZ JSC (according to the company) had 154 equipment items containing PCBs oils. In 2019, the company did not provide a response to the request, that might mean continued use of PCBs-containing equipment.

In 2005, in the framework of the SPES inventory, Vyksa Steel Works JSC (Vyksa, Nizhegorodskaya oblast), reported availability of 22 transformers and 198 capacitors. Calculations suggest the overall amount of PCBs oils at the plant as 47.5 tons.

In 2005, "Lukoil-Nizhegorodnefteorgsintez" JSC had 4 transformers containing "Sovtol-10". In 2005, the company planned to decommission 2 transformers.

In 1999, "Plastik" JSC (Dzerzhinsk, Nizhegorodskaya oblast) had 35 transformers and 128 capacitors. In 2005 it had 27 TNZ type transformers, filled by "Sovtol-10". In 2019, the company did not respond to the information request.

PCBs-containing waste

According to data of 1999, the largest numbers of defective capacitors were stored in the Urals region (4857 units, filled by 65.7 tons of TCBs).

Overall emissions from all 8,687 transformers that were operational at the time of the inventory (in 2000) reached about 130 tons/year. Accounting for 25 years long service life of the transformers, emissions of PCBs into the environment from these transformers may be estimated as 3300 tons.

Some facilities of the energy complex provided information for that period (1999) on disposal of their defective PCBs and TCBs containing capacitors to municipal landfills.

In the Russian Federation, waste substances and products containing PCBs or contaminated with PCBs at levels of 50 mg/kg or higher (according to provisions of the Interstate GOST 30774-2001 "Resource Conservation. Waste Management. Waste Hazard Fact Sheet. Basic Requirements") are classified as 1st Hazard Class ones (extremely hazardous waste)

The due Federal Waste Classification Catalogue (FWCC) of the Russian Federation categorises transformer oils and other waste oils containing polychlorinated biphenyls as 1st Hazard Class substances for the natural environment (as extremely hazardous waste).

In 1999, the largest volumes of PCBs were located at the territory of the Krasnoyarskiy Krai (totally, about 990 tons in the region) and PCBs-containing equipment units are concentrated in the following cities:

- Krasnoyarsk - about 396 tons of PCBs in 197 transformers and 821 capacitors; Krasnoyarsk Pulp and Paper Plant is a major equipment owner (about 290 tons of PCBs in 151 transformers and 242 capacitors). "Krasnoyarskenergo" JSC also is a major owner of PCBs-containing capacitors with its 1,669 capacitors;

- Norilsk - about 461 tons of PCB in 223 transformers and 397 capacitors, with Norilsk Mining and Metallurgical Combined Plant as the sole owner.

In Yamalo-Nenetskiy Autonomous District, the largest quantities of PCBs (overall, about 235 tons in the district) and PCBs-containing equipment units are concentrated in the following cities:

- Novyi Urengoi with about 118 tons of PCBs in 67 transformers;

- Noyabrsk with 114 tons of PCBs in 75 transformers and 41 capacitors [2].

Cases of illegal transportation and illegal disposal of PCBs-containing waste at the territory of the Russian Federation

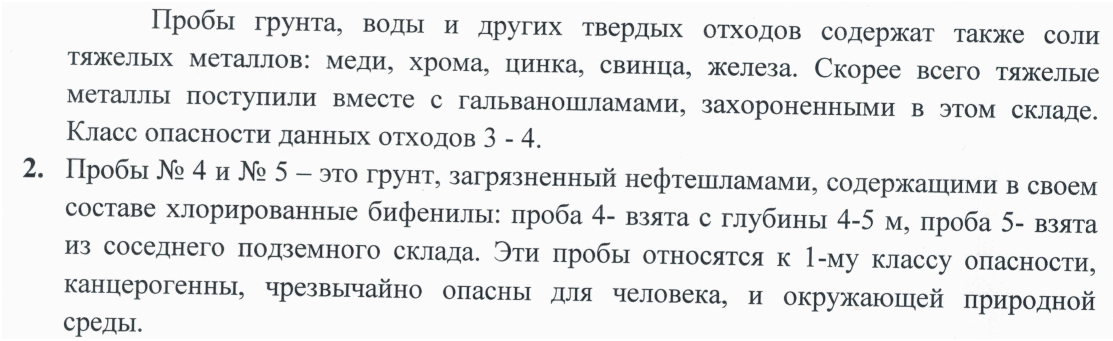
Case study 1. In 2008-2009, at the territory of the Vyksa urban district in Nizhegorodskaya oblast, about 700 tons of wastes were illegally disposed of, including PCBs-containing wastes (pentachlorobiphenyl, hexachlorobiphenyl, tetrachlorobiphenyl), in two hangars and basements at Doschatinsky Highway.

In the hangars at Doschatinsky Highway (buildings 50/1 and 50/2), at distances of 200 m from the collective gardening cooperative, and 500 m from residential areas, businessmen of "Nizhegorodbusinessecology" JSC arranged a dump of waste paint and varnish products, PCBs-containing wastes and oil sludges.

In 2014, according to results of analytical studies conducted by Chemical R&D Institute of N.I. Lobachevskyi Nizhny Novgorod State University, the following components were identified in these wastes: chromium, lead, zinc and copper compounds, as well as polychlorinated biphenyls, classified as 1st Hazard Class substances and subject to the Stockholm Convention on Persistent Organic Pollutants (POPs) ratified by the Russian Federation.

Figure 2. The hangar at Doschatinsky Highway in Vyksa.

In 2015, some part of the waste (20 tons of PCBs), was removed for utilisation to Omskaya oblast. However, the waste has not been utilised, as "Merk" company was not duly licensed for their utilisation, moreover the company actually buried the waste illegally.



Пробы грунта, воды и других твердых отходов содержат также соли тяжелых металлов: меди, хрома, цинка, свинца, железа. Скорее всего тяжелые металлы поступили вместе с гальваношламами, захороненными в этом складе. Класс опасности данных отходов 3 - 4.

2. Пробы № 4 и № 5 – это грунт, загрязненный нефтешламами, содержащими в своем составе хлорированные бифенилы: проба 4- взята с глубины 4-5 м, проба 5- взята из соседнего подземного склада. Эти пробы относятся к 1-му классу опасности, канцерогенны, чрезвычайно опасны для человека, и окружающей природной среды.

Figure 3. Expert conclusions of Chemical R&D Institute of N.I. Lobachevskyi Nizhny Novgorod State University (# 4205/17 of 18.10.2014)

Case study 2. Mr Dmitry Zolotarev, the Director of "Merk" JSC, in the city of Omsk, was granted a license for management of waste of I-V hazard classes by Omsk Office of Rostechnadzor. The same Mr D. Zolotarev, as the Director of "Merk" Environmental Enterprise, was granted an open-ended license by Omsk Office of Rosprirodnadzor. However, the both organisations had only demercurisation equipment for mercury removal. Then, the both companies started to conclude contracts for utilisation of transformers and capacitors from electrical substations throughout Russia.

According to investigation bodies, under 8 contracts, worth about ₽ 20 million, "Merk" enterprise received capacitors and transformers (weighing about 200 tons and containing toxic trichlorobiphenyl and pentachlorobiphenyl) from various divisions of the Federal Grid Company, IDGC of Siberia and a number of other companies. They were taken from Zabaykailsky Krai and Altaiskiy Krai, Sverdlovskaya, Ulyanovskaya, Irkutskaya, Penzenskaya and Lipetskaya oblasts, as well as from the Republic of Bashkiria. According to the contract, all wastes should have been delivered to Omskaya oblast. However, according to the investigation bodies, the waste items were transported "in an unspecified direction and buried in an unspecified place" [9].

In Tyumen, a criminal case is investigated involving poisoning of soils by hazardous chemicals. There, companies from Omsk discharged chemicals on ground instead of their utilisation.

According to investigators, the wastes was stored in Tyumen, and also in the neighbouring regions - in Omskaya and Novosibirskaya oblasts. In the course of court hearings, the businessman himself did not disclose places of disposal of hazardous chemicals.

According to the court ruling, Mr Dmitry Zolotarev, a resident of Omsk, used "Merk" JSC and "Merk" Environmental Enterprise for waste utilisation in the period from 2010 to 2015. Overall, the company received more than 489 tons of polychlorbiphenyls (sovtol, trichlorobiphenyl and pentachloribiphenyl) and was paid ₽ 41.8 million for their utilisation (while actually no utilisation has taken place).

The CEO of "Merk" JSC and "Merk" Environmental Enterprise disposed of capacitors and transformers with assistance of a Roma community. Heavy truck transported their loads to wasteland, then the Roma people found citizens of Tajikistan, who disassembled capacitors for scrap metal, and discharged polychlorinated biphenyls into the ground. Remaining metal parts were sold to scrap metal collection outlets.

Tyumen prosecutors conducted their own surveys and confirmed presence of pollution. Damages to soils amounted to more than ₽ 137 million.

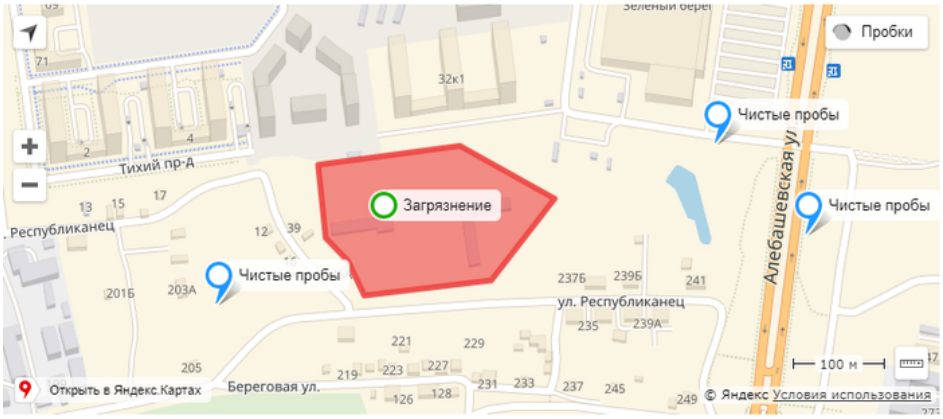


Figure 4. The contamination hot spot was fenced (Tyumenskaya oblast).

The prosecutor's office reported that more than 2.6 hectares of land were contaminated on the left bank of the Tura River, near Alebashevskaya Street. The Investigation Committee of the Russian Federation in Omskaya oblast reported that “European” residential block was partially built on poisoned land areas of two land plots with Cadastre numbers 72:23:0110002:9089 and 72:23:0110002: 9067.

The Environmental Prosecutor's Office specified the developer - "Zapsibinterstroy" financial and construction corporation, that owns one of the sites contaminated by hazardous waste - the developer has already been warned on inadmissibility of residential construction on that territory [10].

It is worth to note that 20 tons of PCBs-contaminated waste from Vyksa of Nizhegorodskaya oblast were delivered to Omskaya oblast, for transfer to "Merk" JSC and "Merk" Environmental Enterprise for eventual utilisation. In 2014, environmental NGOs warned the Ministry of Ecology of Nizhegorodskaya oblast on the need to control delivery of these PCBs-containing wastes. However, the environmental authority of Nizhegorodskaya oblast preferred to avoid due supervision over the waste utilisation, limiting its efforts to formal approval of the waste utilisation protocol from the company-carrier that transported PCBs from Nizhegorodskaya oblast to Omskaya oblast. It is worth to note that the position of the Deputy Minister in the Ministry of Ecology of Nizhegorodskaya oblast is still occupied by a representative of the company ("Nizhegorodbusinessecology" JSC), that organised a waste dump in 2 hangars at Doschatinsky Highway in Vyksa.

Case study 3. In early 2018, 80 tons of PCBs-containing waste “disappeared” in of Roshal of Moscow oblast. The contract for utilisation of hazardous substances was fulfilled by "Progress" company.

In December 2017, the Chief of Rosprirodnadzor Office in the Volga Federal District, Mr O.V. Kruchinin, reported that his office would monitor the PCBs utilisation process. As Mr Oleg Kruchinin said, “We set ourselves the task of monitoring this process from the beginning to the end.”

According to the Rosprirodnadzor Office in the Volga Federal District, more than 1,300 trichlorobiphenyl containing capacitors were identified by the Office in the course of an administrative investigation on the improper storage of 1st Hazard Class substances at the territory of "RUMO" in October of that year.

As the press service of the Office noted, “some of the capacitors were depressurized, some were in a horizontal or inclined positions, in violation of requirements for storage of solid industrial wastes of 1st Hazard Class".

Managers of “RUMO” plant concluded a contract for utilization of capacitors with "Progress" JSC The company had a license for operations of handling wastes of I-IV hazard classes (including transportation, processing, neutralisation and utilisation of 1st Hazard Class waste).

According to Rosprirodnadzor, “capacitors, with the total weight of about 80 tons, under the direct control of the Rosprirodnadzor Office in the Volga Federal District, were delivered by specialised

transport for neutralisation and utilisation to Roshal of Moscow oblast. Rosprirodnadzor specialists also accompany the cargo to the destination.” [12].

In the course of a journalistic investigation, real facts of the so-called “utilisation” of PCBs under “control” of Rosprirodnadzor in 2018 became known. Representatives of "Progress" company claimed that in Roshal of Moscow oblast, they have a SKGO-10-EET installation, that can be used for utilisation of PCBs. The contract was signed on December 4, 2017 ("Progress" company was responsible for all works, including transportation).

"Progress" company has its address in Roshal at 18 Kosyakov Street. In the Soviet times, A.A. Kosyakov Roshal Chemical Plant was located at this address. Currently, it is a large site, mostly overgrown by trees, with dozens of dilapidated administrative buildings and warehouses [11].

Back in 2005, eco-SPES environmental NGO (a member of the IPEN network), based on results of the inventory of PCBs in Nizhegorodskaya oblast, noted that "RUMO" plant refused to provide information on presence or absence of PCBs-containing electric equipment at its production sites.

It is worth to note that, according to AMAP, in 1999, just under 949 capacitors containing 9.860 kg of PCBs were present on the site of "RUMO" plant.

Figure 5. Territory of "Roshal Chemical Plant" in Roshal of Moscow oblast [14].

As the deputy city mayor, Mr Mikhail Karasev, replied to local journalists, - “at the territory of the city, no equipped buildings are available intended for this type of licensed activity, as well as equipped sites plots and landfills for utilisation of waste of a high hazard class. Besides that, no company applied to the city administration for approval of transportation of hazardous goods to Roshal territory for their further utilisation” [11].

When Rosprirodnadzor Office of the Volga Federal District posted information on its official Facebook page on delivery of 80 tons of PCBs from Nizhny Novgorod to Moscow oblast, eco-SPES NGO, made a proposal on the need of strict control over transportation and utilisation of PCBs instead of formal arrangements limited to approval of waste utilisation protocols. Costs of "utilisation" works (including transportation) as charged by "Progress" JSC under the contract amounted to ₽ 60,000 per 1 ton of PCBs waste.

Case study 4. At the same time, PCBs waste utilisation services (including transportation) provided by *bona fide* enterprises in Nizhegorodskaya oblast are charged at the level of about ₽ 120,000 per ton of PCBs. It is also worth to note that, at the territory of Nizhegorodskaya oblast, some enterprises, (e.g. "Evrokom" JSC in Dzerzhinsk - see Figure 5), charge only ₽ 35,000 per ton for "utilisation" of PCBs waste, categorising them as substances from 1st to 3rd hazard classes.

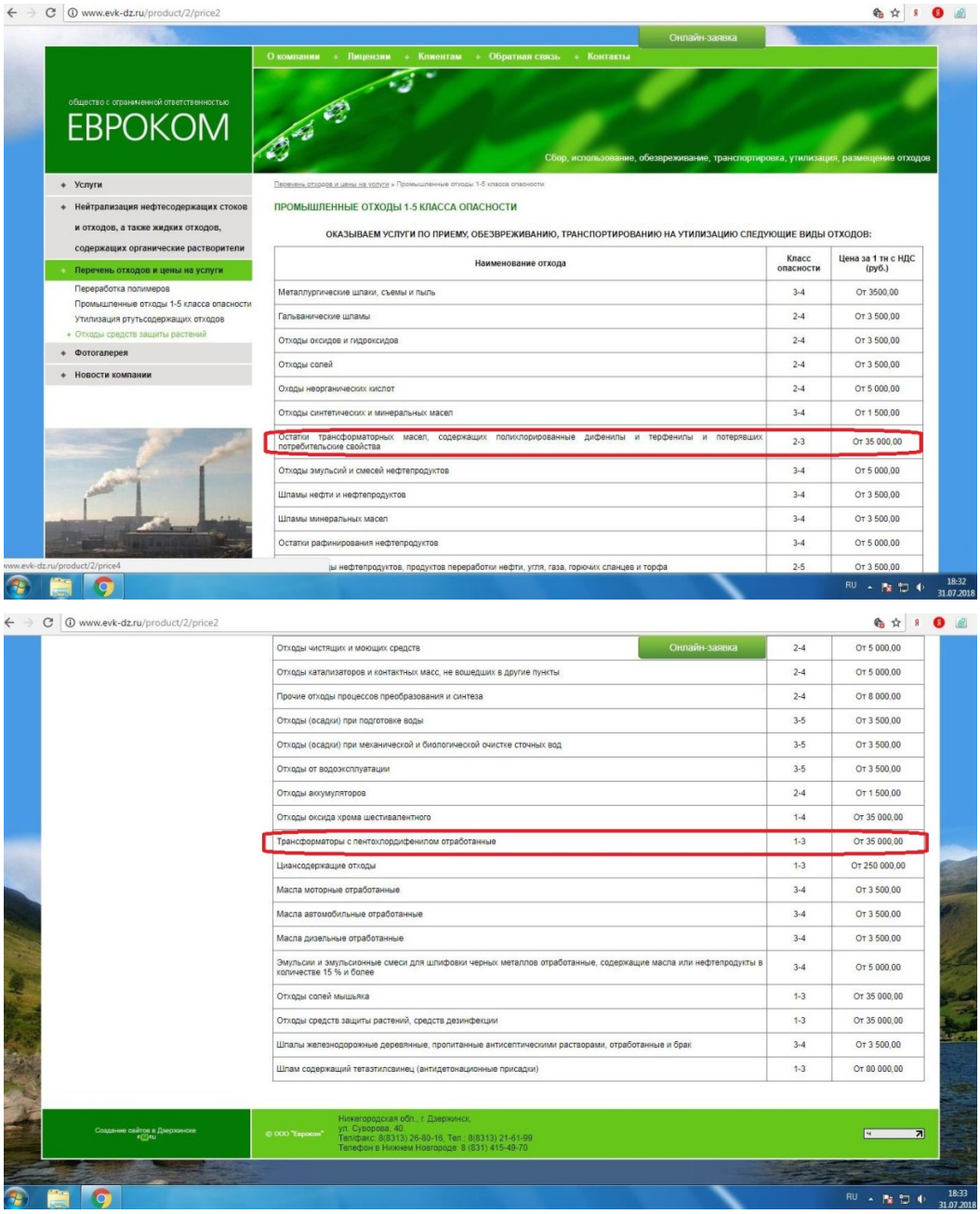


Figure 6. Web-page of "Evrokom" company [15].

In St. Petersburg, PCBs utilisation costs reach ₽100,000 per ton.

Therefore, legality of activities of "Evrokom" JSC in the sphere of utilisation of PCBs-containing wastes raises fairly reasonable suspicions.

Case study 5. In February 2019, under a municipal contract worth ₽ 10 million, works were launched to clean the hangars at Doschatinsky Highway, where PCBs-containing wastes were stored earlier.

Figure 7. February 2019. Removal of waste from hangars in Vyksa, Nizhegorodskaya oblast.

Waste removal works were carried out by a regional operator (CityLux52 JSC - a garbage collection company). The wastes were delivered to a municipal solid waste landfill, operated by "ORB-Nizhny" JSC.

It is worth to note that both the garbage collection company and the municipal waste landfill site are subjects to federal environmental supervision (by Rosprirodnadzor Office in the Volga Federal District).

In order to clarify information on amounts of PCBs-containing electric equipment, in the framework of the current project, we sent information requests to the largest Russian companies that previously had PCBs in their property.

Information requests were sent to companies that previously used the largest amounts of PCBs-containing equipment, including: "Kuybyshevazot" JSC (Tolyatti), Samara Metallurgic Plant JSC, Magnitogorsk Iron and Steel Works JSC (Magnitogorsk), Salda Metallurgic Plant JSC (Nizhnyaya Salda, Sverdlovskaya oblast), Mechel JSC (Chelyabinsk Metallurgic Plant) and Chelyabinsk Pipe Rolling Plant JSC (Chelyabinsk), Pervouralsk Novotrubny Plant JSC (Pervouralsk), Sinarsk Pipe Plant JSC (Kamensk-Uralskiy), Novosibirsk Metallurgic Plant JSC (Novosibirsk), "GAZ" JSC (Nizhny Novgorod), KAMAZ JSC (Naberezhnye Chelny), "EMK-Atommash" (Volgodonsk) and others.

Only a few companies responded to the information requests. Information on amounts of PCBs contained in operational equipment (as at April 2019) is presented in this report. Senior managers of the Ministry of Natural Resources of the Russian Federation and the Federal Supervisory Natural Resources Management Service (Rosprirodnadzor), as well as Rosprirodnadzor offices in the Volga, North-Western and Siberian federal districts did not respond to the information requests.

In the course of the IPEN project, eco-SPES (a non-governmental environmental organisation from Dzerzhinsk) conducted the first public inventory of PCBs-containing electrical equipment in Russia. At the territory of Nizhegorodskaya oblast, their amounts reached 985 tons in 1999. Then, in 2005, according to eco-SPES inventory data, the relevant figure for facilities of the region, reached only 120 tons, or 8% of initial PCBs amounts in 1999.

While in 1999, 336 transformers and about 14 thousand capacitors were used in Nizhegorodskaya oblast, in 2005, only 53 transformers and 984 capacitors were operational.

It is possible that PCBs-containing equipment was not “reported” in facility level records, but continues to be used due to loss of documentation or erased markings. Alternatively, such equipment might be decommissioned, and PCBs wastes might be illegally destroyed or transferred to private entrepreneurs for "utilisation". In addition, several facilities that previously had PCBs-containing equipment were made bankrupt or liquidated. [13].

In the course of the project implementation, on March 15,2019, at the territory of one of bulk supply facilities in Nizhniy Novgorod, several dozens of transformers were found, containing from 340 to 720 kg of oils each (see photo on the cover page). Samples of transformer oils were collected on the site. Analysis revealed that these transformer oils belong to mineral oils group (a mixture of branched saturated hydrocarbons containing 15 to 25 carbon atoms) and do not contain PCBs or residual quantities of PCBs.

According to GOST 16555-75, transformers filled by "sovtol" should be in working condition without major repairs during their entire service life. Practice shows that service life of such transformers reaches 25 to 30 years.

Conclusions

PCBs have the same toxic properties as dioxins, and mechanisms of their toxic impact on human health are the same. [16].

At the territory of the Russian Federation, officials and employees of legal entities, that own PCBs-containing electric equipment (facilities that store or lease such electrical equipment), decommissioned PCBs-containing equipment, as well as PCBs-containing waste, must manage these items in compliance with requirements of the legislation of the Russian Federation on waste management. These activities entail disciplinary, administrative, criminal or civil liability.

According to the due Russian legislation on waste management, measures for handling PCBs-containing equipment and wastes should be financed by owners of the waste, including their financial responsibility for elimination of adverse environmental impacts and remediation of contaminated areas.

However, since 2014, no amendments were introduced into the RF Code on Administrative Offenses (proposals to introduce Articles 8.48 and 8.49 into the Code) on liability for non-compliance with rules of handling PCBs-containing waste and equipment, that stipulated the following sanctions: administrative fines for officials (from ₽ 50,000 to ₽ 100,000); administrative fines for individual entrepreneurs operating without formation of a legal entity (from ₽ 100,000 to ₽ 300,000) or administrative suspension of activity for up to 90 days; administrative fines for legal entities (from ₽ 500,000 to ₽ 1,000,000) or administrative suspension of activities for up to 90 days.

Currently, the Federal Supervisory Natural Resources Management Service (Rosprirodnadzor) - as the leading environmental agency in Russia - does not maintain the due oversight of enterprises owning electric equipment containing PCBs and TCBs. This conclusion is confirmed by numerous facts of illegal transportation and illegal burial of PCBs-containing wastes in several regions of Russia, as provided in this survey.

As an example, in Nizhegorodskaya oblast, where the largest producers of PCBs in the USSR previously operated, it is worth to note still existing sources of environmental pollution by polychlorobiphenyls in bottom sediments of Volosyanikha channel - in the period from 1936 to 1995, chemical plants of Dzerzhinsk discharged their untreated wastewater flows into the channel.

According to results of previous research studies in the framework of IPEN projects, PCBs were found in bottom sediments of Volosyanikha channel. The same super-toxicants, in concentrations exceeding EU MACs, were found in chicken eggs of farms in Dzerzhinsk and Nizhny Novgorod, that are located within impact zones of chemical plants.

According to the inventory data of 1999, amounts of PCBs at the territory of Russia ranged from 28,000 to 30,000 tons. Currently, complete and reliable information on amounts of PCBs in equipment in use, or in reserve, as well as information on amounts of PCBs-containing production wastes is not available in state environmental agencies (the Russian Ministry of Natural Resources and Rosprirodnadzor).

The situation with pollution of environmental media by PCBs in Russia still remains relevant.

Annex

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[1]. 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 [2,3,9]. 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.[4,5,6].

---

[1] "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.

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

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

[4] "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.

[5] Environment Australia 1997

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

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 wastes with high concentrations of POPs, PCB containing transformers, batteries and spent oils[7,8].

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%[9,10].

Environmental performance: In the GPCR process, all emissions and particulate matter can be captured for analysis and further processing, if necessary[11,12]. 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[13].

---

[7] "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.

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

[9] "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.

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

[11] "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.

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

[13] 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[14].

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[15].

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[16,17,18].

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[19].

---

[14] "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.

[15] "Remediation Technologies Screening Matrix and Reference Guide", 3rd Edition October, 1997.

[16] "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.

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

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

[19] "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.

Technical parameters of the BCD process: Technical parameters of the BCD process: measurements of discharges and emissions from outdated plants with the BCD technology 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[20].

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[21].

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[22,23,24].

---

[20] "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.

[21] "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.

[22] "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.

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

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

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 ^{o}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[25,26].

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[27,28].

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[29].

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[30]. Gaseous

---

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

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

[27] Environment Australia 1997

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

[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.

[30] "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.

emissions are minor with low carbon monoxide levels of <10 ppm, without particulate matter, nitrogen oxides, hydrogen chloride or sulphur oxides[31]. Some studies have demonstrated that formation of PCDDs/Fs may occur under certain conditions in the course of PCBs decomposition by this technology,[32] 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[33].

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.[34]

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[35]. Destruction efficiency (DE) exceeds 99.999%, and destructive and removal efficiency (DRE) of 99.9999% was

---

[31] 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.

[32] 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.

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

[35] "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.

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[36].

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[37] 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[538,39]).

*** *** 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.

---

[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] 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.

[38] 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.

[39] 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.

Сокращения

АМАП – Программа Арктического мониторинга и оценки, Arctic Monitoring and Assessment Programme,

ЕС – Европейский Союз,

ПХБ – полихлорированные бифенилы,

Совол - смесь тетра- и пентахлорбифенила,

СОЗ – Стойкие органические загрязнители,

СПЭС – НКО Социально-правовое экологическое сотоварищество,

ТХБ – трихлорбифенилы,

IPEN – Международная сеть по ликвидации загрязнителей, International Pollutants Elimination Network,

References

1. AMAP Inventory Results, 2000.

2. UNEP/GEF project “Russian Federation - Support for the National Action Plan for Protection of the Arctic Marine Environment”. The final report on implementation of pilot project "Development of technological and logistics solutions for introduction of the system for collection and utilisation of polychlorinated biphenyls (PCBs) and PCBs-containing equipment in the Arctic zone of the Russian Federation." "Centre of Area Improvement and Waste Management" Research and Production Association JSC, pp. 22-23. St. Petersburg. 2010. (Rus.)

3. ibid, pp. 22-23.

4. "Find and neutralise" supplement to "Kommersant" newspaper #12 of 03.31.2017. Web resource https://www.kommersant.ru/doc/3249243 Accessed on 18.03.2019. (Rus.)

5. “Training toolkit for the program of training seminar on issues of: “Safe operation of PCBs equipment, its cleaning and elimination ”. pp. 48-51. REA-UNIDO. Moscow 2016. (Rus.)

6. "Safe operation of PCBs equipment, its cleaning and elimination". p. 37. REA-UNIDO Report. Moscow, 2016. (Rus.)

7. "PCBs Inventory in the Fuel and Energy Complex of Russia". Web-resource "Russian Energy Agency" of the RF Energy Ministry http://phb.ecdl.su/pcb/inventory. Accessed on 18.03.2019. (Rus.)

8. "Find and neutralise" supplement to "Kommersant" newspaper # 12 of 31.03.2017. Web-resource https://www.kommersant.ru/doc/3249243 . Accessed on 18.03.2019. (Rus.)

9. "In Omsk, a trial started against the company director who delivered cancer and mutations inducing waste from all over the country," Asker Abishov. "New Omsk" 08.28.2017. Web-resource https://newsomsk.ru/news/61954-v_omske_nachali_sudit_direktora_kompanii_svozivshe. Accessed on 18.03.2019. (Rus.)

10. "In Tyumen, 2.6 hectares of land poisoned by a toxic substance were found". Web-resource https://72.ru/text/gorod/427269864865792.html 04.05.2018. "In Zarek, 2.6 hectares of land are poisoned with a super-toxic substance: we ascertain why the chemical is hazardous for our health." (Rus.)

11. "Toxic Progress". 06.08.2018. Ilya Yushkov https://dailystorm.ru/obschestvo/yadovityy-progress Accessed on 18.03.2019. (Rus.)

12. “RUMO Nizhny Novgorod plant ”utilised more than 80 tons of hazardous waste after intervention of Rosprirodnadzor”. 15.12.2017. NIA "Nizhny Novgorod". Web-resource https://www.niann.ru/?id=518155 Accessed on 18.03.2019. (Rus.)

13. "Where have PCBs in Russia Disappeared? The Point of View of Local Non-governmental Organisations" Dmitriy Levashov. "PEN magazine". # 1 p. 53.Accessed on 18.03.2019. (Rus.)

14. Web-resource https://bronetractor.livejournal.com/2588.html Accessed on 18.03.2019.

15. Web-resource "Evrokom" JSC http://www.evk-dz.ru/product/2/price2 Accessed on 18.03.2019.

16. S.Yufit "Toxins around Us" M. 2001. p. 89. (Rus.)

17. "Polychlorinated biphenyls. Super-toxicants of XXI Century". The RF State Committee for Environment, VINITI. Information release ## 5. p. 3. M. 2000 (Rus.).

18. A. I. Nikitin, O. V. Sergeev, A. N. Suvorov. "Impacts of Adverse Environmental Factors on Reproductive, Endocrine System and Epigenome". pp. 141-143. M. Akvarel, 2016. - 346 p. (Rus.)