



An EU funded project

Development of the Special waste stream plan SWSP for wastes containing POPs

2nd Workshop
7th of December 2016

Data on Pesticides



Data on pesticides; former use

- **Pesticides are the biggest group of POPs and include 13 (14) substances:**
 - **9 old POPs: Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, DDT,**
 - **4 (5) new POPs: Chlordecone, HCH and Lindane, Pentachlorobenzene, Endosulfans, (PCP)**
- **Insecticide against termites, grasshoppers, ants, mosquitoes and flies, ticks and mites...,**
- **Biocides fighting worms, control rodents, fight ectoparasites**
- **fungicides, algaecides, disinfectants in products**

Data on pesticides; source of production

POP	production		trade and use		Import	
	number	time period	time period	ban	amount [t]	year
Aldrin	2	1960 - 1971	1957 - 1972	6.9.1976		
Dieldrin	3	1962 - 1971	1957 - 1972	1972		
Endrin			1957 - 1989	29.5.1989		
DDT	18	1957 - 1971 partly 1986	1944 - 1989	28.12.1989		
HCB			1962 - 1980	11.7.1980		
Heptachlor	1	1968 - 1973	1956 - 1973	1973		
Chlordane	1	1962 - 1971	1955 - 1971	1971		
Toxaphene	1	1957 - 1982	1957 - 1982	27.4.1989		
Lindan	32	1962 - 2007	1962 - 2007	31.12.2007	0.4	2004
Endosulfan	1	1980 - 2007	1970 - 2007	31.12.2007	40.1 46.7 41.3	2004 2005 2006

- **No use, placing on the market or use today in Serbia acc. to Ruklebook on...use of chemicals**
- **No exceptions or remarks in Stockholm Convention**

Data on pesticides; source of stockpiles

- Concentration of stockpile in certain stores and storage facilities
- Some bankruptcies; data about the current storage amounts
- Leaked and sand bound lindane
- Identification by labelling possible?
- Further intermediate use for intended purpose?
- Unknown sites???

POP	Inventory 2007		Inventory 2014	
	amount	sites	amount	sites
Lindane	5800 kg	11	1350 kg	5
DDT	450 kg	2	0	0
total	6250 kg	13	1350 kg	5

Data on pesticides; waste management

waste code	description	amount of generated wastes containing POPs pesticides [t]			
		2010	2011	2012	2013
02 01 08*	Agrochemical waste containing hazardous substances	-	-	-	-
15 01 10*	Packaging containing residues of or contaminated by hazardous substances	15.0	78.2	-	40.9
20 01 19*	pesticides contained in municipal waste	-	59.5	-	-

- **17 05 03*/04 soil and stones (binding material, remediation, C+D)**
- **Contaminated equipment (pumps, tanks, personal protectives)**
- **Total amount transboundary moved**
- **POPs pesticides are part of the total figures**

Data on pesticides; waste management

waste code	description	waste management activity				
		collection	transport	storage	treatment	disposal
Pesticides						
02 01 08*	Agrochemical waste containing hazardous substances	25	24	5	6	0
15 01 10*	Packaging containing residues of or contaminated by hazardous substances	82	85	21	14	0
20 01 19*	pesticides	39	37	8	1	0

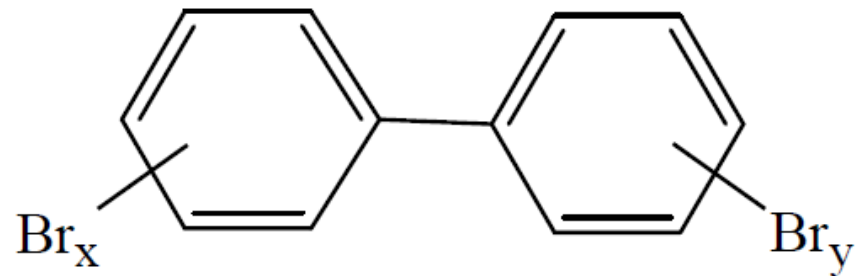
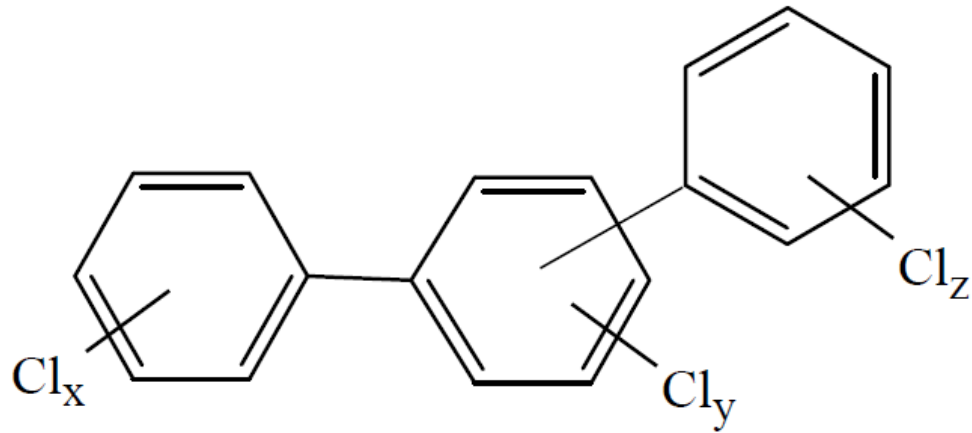
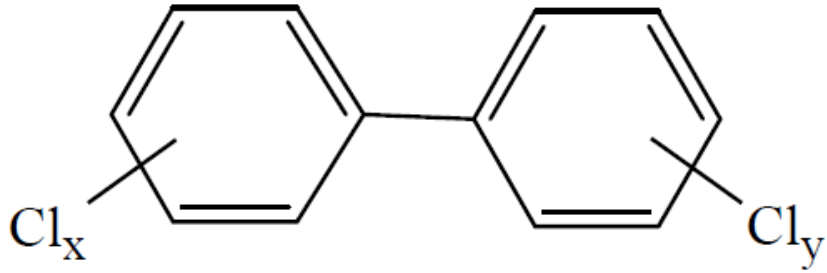
- **Kind of treatment plants???**
- **State of the art???**
- **Capacities???**

Data on pesticides; recommended measures

- Strengthen the inspection:
 - avoid further uncontrolled loss of pesticides and detect more stockpiles;
 - inventory for all pesticides (risk of other obsolete pesticides)
 - Re-packaging of obsolete pesticides and old packaging
 - Intermediate storage in plants acc. state of the art
 - Remediation of sites, especially leakages in soil, cleaning of devices
-
- Offering a concerted action collecting POPs-pesticides from storage areas
 - Beneficiary by the Ministry/administration
-
- **FAO guideline of pesticide disposal**



Data on PCB



Data on PCB; former use

- **209 congeners, 130 congeners as part of commercial formulations**
- **dl-PCP**

- **Main purpose (60-65 %) in closed systems**
- **Heat exchange fluids in transformers, capacitors and rotor resistors**

- **Semi-closed systems**
- **Hydraulic and engine oils**

- **open systems**
- **lubricants, inks and coatings, plastifiers, others**
- **PBB as flame retardant**

Data on PCB; source of production

- **Estimated 1 to 1.5 Mio tons PCB worldwide between 1929 and 1989**
- **Estimated 60000 tons PCT worldwide between 1955 and 1980**
- **At least 11000 tons PBB worldwide between 1970 and 2000 includes POP Hexabromobiphenyl (USA)**

- **No production of PCB in Serbia, just import of PCB-fluids and equipment**

- **Production of transformers in „Minel-Trafo“**
- **Production of capacitors in „Minel-Elektrooprema i postrojenja“**

Data on PCB; source of plants using equipment

- **Detected transformers: 767 with a total mass of PCB fluids of 1040 t (data partly incomplete because of missed data for almost 80 transformers)**
- **Respective 3300 t PCB transformer's devices**
- **Relevant for waste management: 27 transformers with total 90 t**

- **Detected 4394 capacitors: 22.1 t in 833 capacitors; 3561 capacitors with known total mass; summary total mass: 172.6 t**
- **Relevant for waste management: 4000 capacitors with total 121 t**

- **41 rotor resistors detected: 3.25 t**

- **C+D-material including contaminated soil from destroyed transformer station Bor 3: 100 capacitors and about 1300 m³ debris**

- **Unintended emission [kg]:**

POP	2006	2007	2008	2009	2010	2011	2012
PCB into air	202	203	205	195	186	201	189
leakages of PCB	644	644	644	644	644	644	644

Data on PCB; other sources

- **Use of PCB in semi closed and open systems**
- **Difficult to gain correct data**
- **Principle of precaution, analysis in case of suspicious PCB-contamination**
- **Wastes resulting from products with certain product data sheets**

purpose	products
lubricant	brake fluids, motor oil, compressor fluids, casting waxes
inks and coatings	paints, print inks, ship surface paints, textile surface agents, copy paper, flame retardants for furniture, walls and others
plastifiers	fillers for concrete joints, PVC, rubber seals
others	insulation material, adhesives, binding agents for anti-dust-protection, pesticides

Data on PCB; emissions

■ Tendency 1990 to 2014

Polychlorierte Biphenyle (PCB) in kg	1990	2000	2010	2014
Energiewirtschaft	340,9	299,7	99,4	104,7
Verarbeitendes Gewerbe	143,7	97,3	17,6	29,8
Verkehr	0,5	0,3	0,2	0,3
Haushalte und Kleinverbraucher	103,8	32,1	36,8	23,7
Andere (Militär)	0,0	0,0	0,0	0,0
Industrieprozesse	1.091,5	518,9	78,9	77,3
Abfallverbrennung	0,1	0,1	0,2	0,2
Gesamt	1.680,4	948,4	233,1	236,0
1990 = 100	100	56	14	14
Veränderung gegenüber 1990 in %	0	-44	-86	-86

Data on PCB; waste management

waste code	description	amount of wastes containing PCB [t]					
		generated				exported	
		2010	2011	2012	2013	2003-07	2013
13 01 01*	Hydraulic oils containing PCB	-	0.4	-	-	10.5	
13 03 01*	Insulation and heat transfer oils containing PCB	2.4	1.8	0.76	0.01		79.92
16 01 09*	Components containing PCB	-	-	-	-		
16 02 09*	Transformers and PCB-containing capacitors	20.5	39.4	12.47	34.4	267.2	277.85
16 02 10*	Disposed equipment containing or contaminated with PCB, other than these listed in 16 02 09*	-	-	-	-		4.97
17 09 02*	Waste generated from construction and demolition which contains PCB	-	-	-	-	206	2.08
total		22.9	41.6	13.23	34.41		364.82

- **Exported waste amount includes PCB-waste from storage units???**
- **Standard analytics: concentration PCB_{ges} is calculated as $\sum PCB_6 \times 5$ (DIN EN 12766-1 and 12766-2)**

Data on PCB; waste management

waste code	description	waste management activity				
		collection	transport	storage	treatment	disposal
PCB						
13 01 01*	Hydraulic oils containing PCB	52	57	12	6	0
13 03 01*	Insulation and heat transfer oils containing PCB	48	52	11	5	0
16 01 09*	Components containing PCB	45	47	6	2	0
16 02 09*	Transformers and PCB-containing capacitors	72	72	13	4	0
16 02 10*	Disposed equipment containing or contaminated with PCB, other than these listed in 16 02 09*	73	70	13	3	0
17 09 02*	Waste generated from construction and demolition which contains PCB	30	30	6	2	0

- **Easy to assign proper waste codes**
- **No facilities for permanent storage, decontamination of equipment and destruction of PCB-fluids**
- **Kind of treatment plants???**
- **State of the art???**
- **Capacities???**

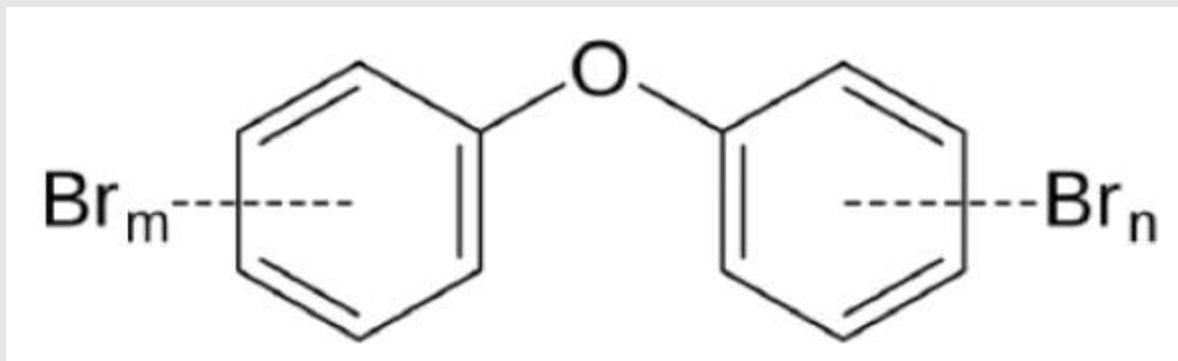
Data on PCB; recommended measures

- **Gap analysis for missing data on PCB-fluids in transformers**
- **Strengthen the inspection, report duties**
- **Plan for decontamination**

- **costs 1,35 up to 2,30 €/kg for small capacitors (input in some municipalities collecting stations)**



Data on PBDE



Data on PBDE; former use

- **Tetra-, Penta-, Hexa-, Hepta-BDE**
- **In future: Deca-BDE**

- **Flame retardant (protective coating), insulation and construction foam PUR-foam), plastic parts**
- **Electrical and electronic industry**
- **Furniture industry**

- **Use as mixtures of 209 congeners:**

Commercial Mixtures	PBDE congener groups and concentrations of active ingredient						
	tetraBDE	pentaBDE	hexaBDE	heptaBDE	octaBDE	nonaBDE	decaBDE
	BDE-47, etc.	BDE-99, etc.	BDE-153, BDE-154, etc.	BDE-175, BDE-183, etc.	BDE- 203,BDE -204, etc.	BDE- 207,BDE- 208	BDE-209
c-pentaBDE	24 – 38%	50 – 62%	4 – 12%	Trace	-	-	-
c-octaBDE	-	0.5%	12%	45%	33%	10%	0.7%
c-decaBDE	-	-	-	-	trace	0.3 – 3%	97 – 98%

Data on PBDE; former use

- C-OctaBDE was produced in F, Japan, Israel, NL, UK, USA
6000 t 1994 decreasing to 3800 t 2001
- C-pentaBDE was produced up to 2004 in Australia, EU, Israel, USA
85000 t USA, 15000 t Europe (D: 1985: 1800 t, 1988: 1200 t)
- Deca-BDE: 56.000 t/a (80 % in electric and electronic equipment)
- **Exemptions acc. to Stockholm Convention: EU has registered all relevant PBDE for the further use without expiry date**
- **Import of devices from countries without prohibition of PBDE**
- **No chemical but physical connection to the product's surface therefore easy release into the environment**

Data on PBDE; sources

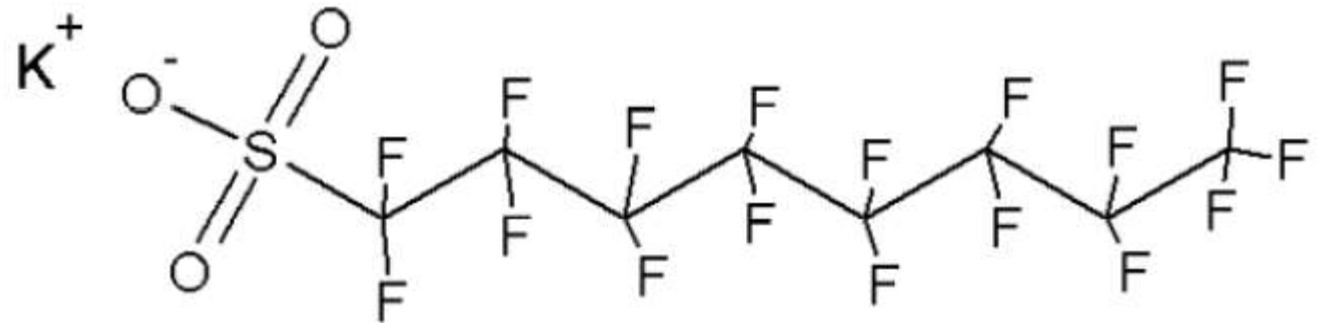
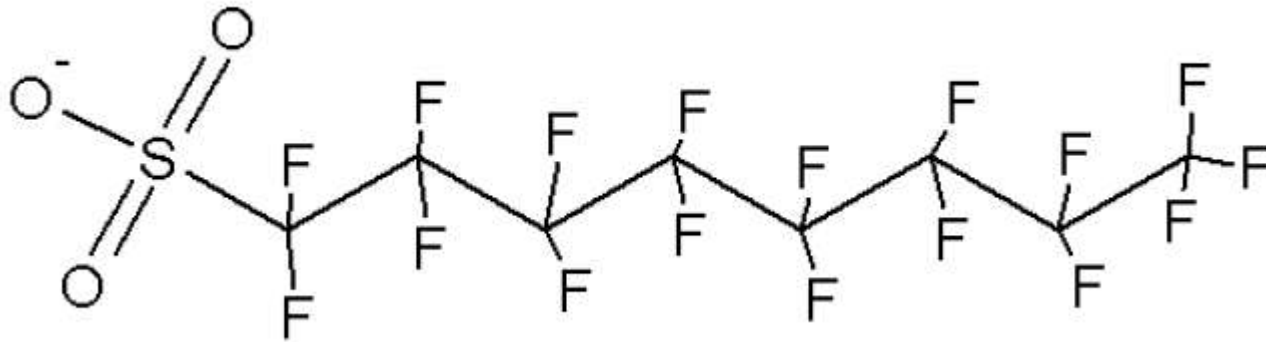
- **obsolete stockpiles in production plants**
- **products that become waste, especially WEEE, plastics, textiles**
- **construction material (PUR-foam)**
- **sewage sludge, landfill leachate**

- **from cradle to grave release into the environment**

Data on PBDE; recommended measures

- **build an inventory**
 - identify relevant sectors that use or produce PBDE
 - collecting and compiling statistical data on the production, use, import and export of PBDE
 - estimation, report, update
- **analytical methods**
- **monitoring in environment, health sector, production plants**
- **awareness rising in the public sector**

Data on PFOS and its salts



Data on PFOS; former use

- In future: PFOA
- Production of Teflon
- Hydrophob and lipophob coatings in textile and paper industry
- Galvanic
- Fire fighting foam

Table 1: Estimated Current Demand for PFOS Related Substances in the EU		
Industry Sector	Application	Quantity (kg/year)
Metal Plating	Chromium plating	10,000
	Anodising and Acid pickling	20-30
Photographic Industry	Paper products	<50
	Printing plates	<100
	Film products	>850
	Total	1,000
Semiconductor Industry	Photoresists	46
	Edge bead removers	86
	Top antireflective coatings	136
	Bottom antireflective coatings	8
	Developers (surfactant)	195
	Total	471 (assumed 500)
Aviation Industry	Hydraulic fluids	730

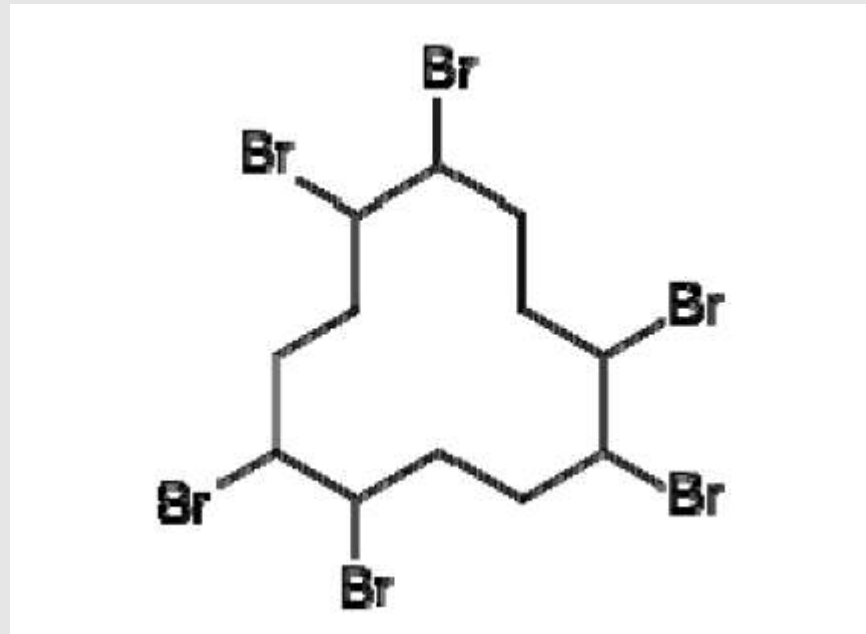
Data on PFOS; former use

- **EU-notification of further use (photo-imaging, photo coatings, etching agents, aviation hydraulic fluids, metal plating)**
- **Use of fire fighting foam (placed on market up to 2006) until 27.6.2011**
- **Production and use for metal plating expired 26.8.2015**
- **High concentration in indoor air (flats, offices): 30 to 570 times more than in outside air; coated carpets...**
- **Waste water from industry and households; waste water treatment plants do not degrade/destroy PFOS**
- **Result: PFOS is part of sewage sludge (30 % of plants > 100 µg/kg) and cleaned water**
- **Contamination of natural water resources including drinking water**
- **Contamination of soil by using sewage sludge for fertiliser**

Data on PFOS; recommended measures

- **Determination of limit values for drinking water (0,3 µg lifetime, 0,1 µg maximum annual average)**
- **Monitoring of natural water resources and organisms**
- **Limit values for fertilisers: 100 µg/kg**
- **Additional soil monitoring especially on sites where sewage sludges are used**
- **Obligation for production plants to reduce the release into the environment**
- **Restriction of PFOS in fire fighting foams**
- **Result of incineration: possibly generation of PBDD/PBDF**

Data on HBCD



Data on HBCD; former use

- Flame retardant for plastics
- Mainly in EPS (7000 mg/kg) and XPS (15000 mg/kg) foam insulation material, HIPS
- Partly in PS packaging material
- Polymer dispersions for textiles

- About 6000 t/a produced in EU
- Further 6000 t/a imported substances and preparations
- Net import within articles unknown

- Use of the 12000 t/a as follows:

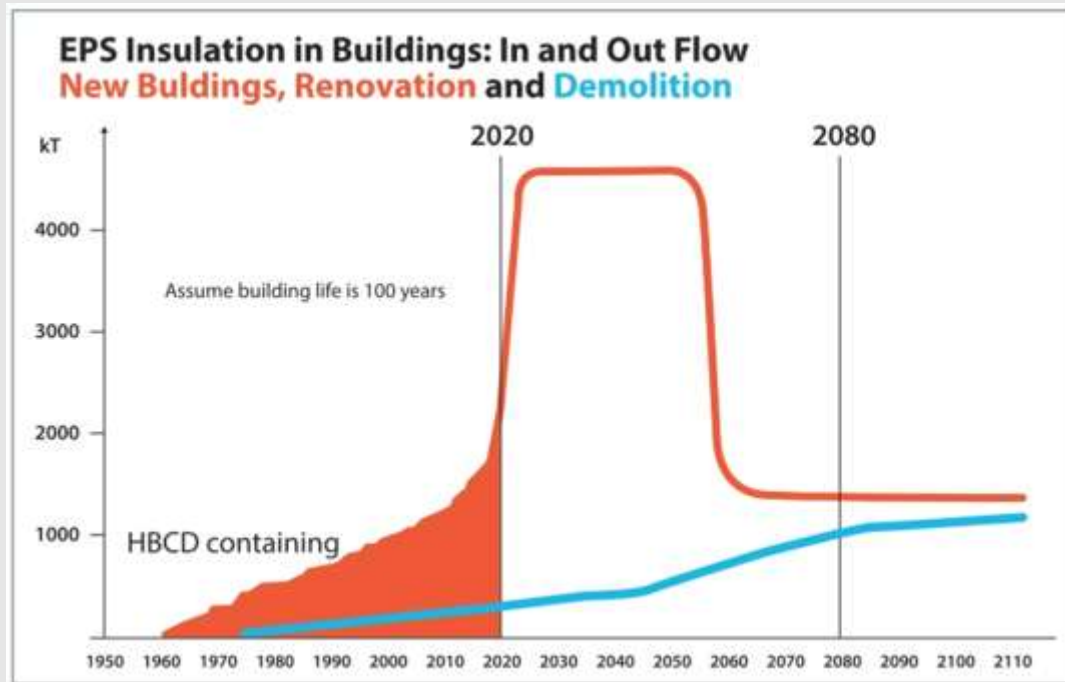
- Production and use in general prohibited since 03/2016
- Exceptional further use of EPS up to 02/2018

	Tonnes HBCDD /year	Number of sites
Expanded Polystyrene	5,300	21
Extruded Polystyrene	5,900	28
High Impact Polystyrene	200	3
Textile coating	200	16
Total	11,600	47

Data on HBCD; former use

- **one EU manufacturer (NL),**
- **small number of sites where micronising takes place,**
- **78 formulators for HBCDD in EPS (22 mainly D, NL, F) and XPS (56 mainly D, I, E)**
- **24 producers of textile coatings,**
- **about 600 EPS converters,**
- **unknown number of producers of articles containing HIPS,**
- **21 producers of XPS articles,**
- **1000s of end users installing insulation boards in construction (EPS and XPS),**
- **unknown number of recyclers of HIPS parts from electronic equipment and recyclers of insulation boards**

Data on HBCD; source of insulation material



waste code	description
17 06 03*	other insulation materials consisting of or containing dangerous substances
17 06 04	insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 09 03*	other construction and demolition wastes (including mixed wastes) containing dangerous substances
17 09 04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 1709 03

Data on HBCD; source of unintended emission

	Total HBCDD emissions from	Sources		Air (kg/year)	Waste-water (kg/year)	Surface water (kg/year)	All compartments (kg/year)
		Diffuse	point				
Manufacturing processes	Manufacture of HBCDD		X	2	< 1	0	3
	Micronising of HBCDD		X	< 1	0	0	< 1
Use of HBCDD in formulations	EPS and HIPS formulation		X	30	75	330	435
	XPS formulation		X	14	84	10	108
	Formulation of textiles		X	1	44	11	56
Industrial uses	Industrial use of EPS		X	159	128	31	318
	Installation of insulation boards	X		236	0	236	472
	Industrial use of XPS		X	146	63	16	225
	Industrial use of HIPS	X		6	5	1	12
	Industrial use of back-coating		X	< 1	1130	283	1413
Releases during service life	Use as building insulation	X		70	0	0	70
	Textiles during service life	X		0	21	5	26
	From washing of textiles	X		0	2	0	2
	Total	582	2559	665	1553	923	3141

Data on HBCD; waste management

Waste	Amount of HBCD in waste (in t)	HBCD concentration (in %)	Waste amount (in t)	Arisings after 2012 (in t)	Arisings until 2012 (in t)
EPS products construction	42,829	0.70	6,118,429	5,921,665	196,764
XPS products construction	19,102	1.5	1,273,470	1,252,026	21,444
EPS/XPS other	3,719	0.70*	531,286	0	531,286
HIPS products	1,306	4.00*	32,650	16,200	16,450
Textiles	4,114	8.00*	51,425	11,563	39,863
Total	71,070		8,007,259	7,201,453	805,806

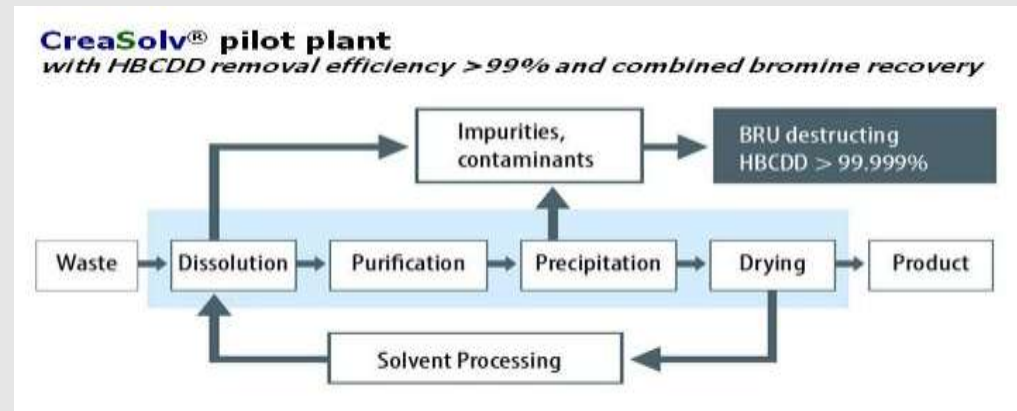
* no longer in use at present

■ expected amounts:

source	Product t/a	Waste t/a
EPS	1708	161
XPS	979	41
HIPS		70
Textile dispersions		290

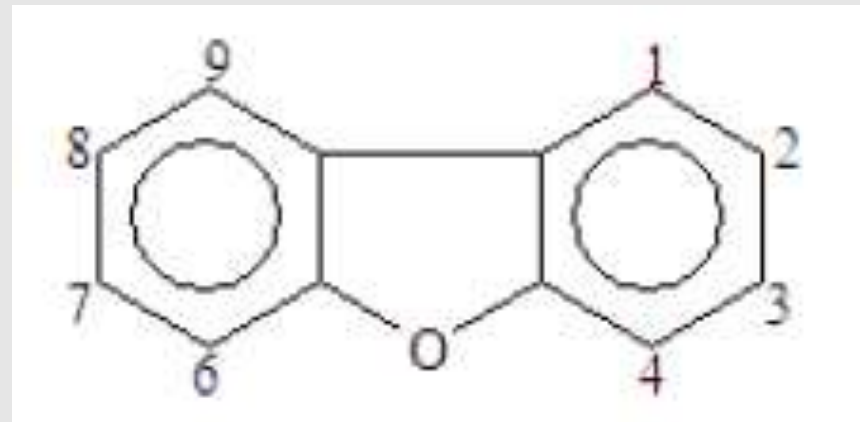
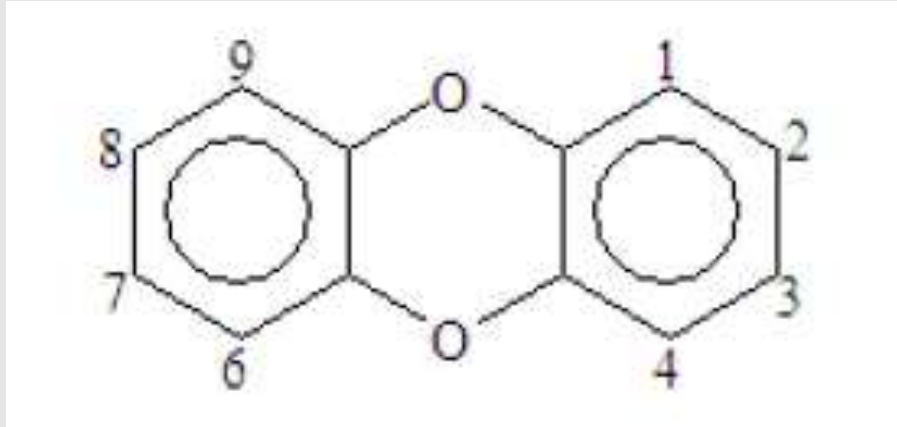
Data on HBCD; recommended measures

- Further recovery of PS from packaging material and from insulation material (< 100 mg/kg); cuttings for production of re-granulates
- X-ray fluorescence spectroscopy (XRF) to trace sources of HBCD; online form to check the HBCD-presence in products (<http://www.reach-info.de/auskunftsrecht.htm>)
- avoid the input from HBCD-fractions into the product cycle
- CreaSolv® pilot plant for PS-recycling (hierarchy!) using solvents



- Thermal treatment together with municipal wastes, but:
 - Only as part of mixed C+D-wastes (17 09 04) because of technical requirements (hot spots, huge parts, high calorific value...), need of pre-treatment plants
 - mixtures up to 20 Vol-% meet the requirements of limit value (1000 mg/kg related to the total mixture)
 - increasing costs up to 7000 €/t

Data on PCDD/PCDF



Data on PCDD/PCDF; source

- **no technical use, no intended production**
- **incomplete combustion in thermal processes**
 - **waste incineration**
 - **power stations**
 - **metallurgical processes**
 - **unintentional and agricultural fires**
- **emission from automobiles**
- **manufacture of pesticides (agent orange)**

Data on PCDD/PCDF; emissions

- air emission mainly (50-70 %) by open burning processes (forest, landfills, accidents...)
- soil contamination totally caused by open fires
- emission into water is caused by metallurgical processes
- use of PCB is responsible for PCDD/PCDF in products
- residues come from metallurgical processes, power plants, waste disposal plants

year	annual emissions of PCDD/PCDF [gTEQ]						
	total	share of					
		air	water	soil	products	residues	
2006	147	35.7	3.5	4.5	85.4	17.6	
2007	169	37.5	16.8	7.4	85.3	21.7	
2008	163	34.5	15.3	5.1	85.4	22.8	
2009	159	32.7	14	6.2	84.7	21.6	
2010	157	32.9	10.2	6.2	84.7	23.2	
2011	152	34.3	2.2	6.2	83.3	27.2	
2012	149	30.3	2.3	6.2	83.3	27.2	

Data on PCDD/PCDF; emissions

■ Tendency 1990 to 2014

Dioxine in g I-Teq	1990	2000	2010	2014
Energiewirtschaft	351,31	37,14	5,68	5,73
Verarbeitendes Gewerbe	111,86	9,19	1,36	1,34
Verkehr	6,35	4,91	4,59	4,90
Haushalte und Kleinverbraucher	37,16	26,41	30,04	24,81
Andere (Militär)	0,19	0,09	0,07	0,16
Diffuse Emissionen aus Brennstoffen	0,29	0,02	0,02	0,02
Industrieprozesse	241,33	71,47	28,63	23,79
Abfallverbrennung	1,22	1,34	0,85	0,99
Gesamt	749,71	150,57	71,24	61,73
1990 = 100	100	20	10	8
Veränderung gegenüber 1990 in %	0	-80	-90	-92

Data on PCDD/PCDF; recommended measures

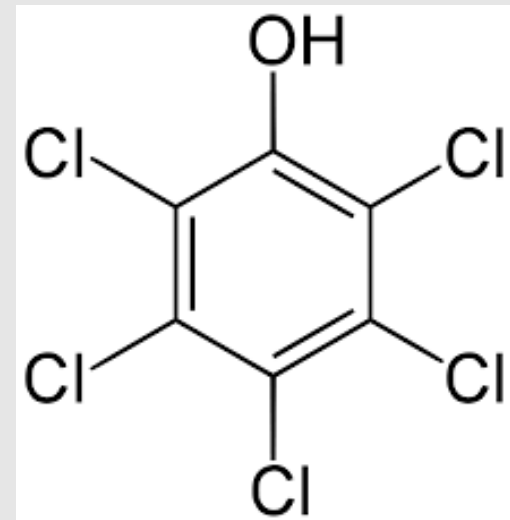
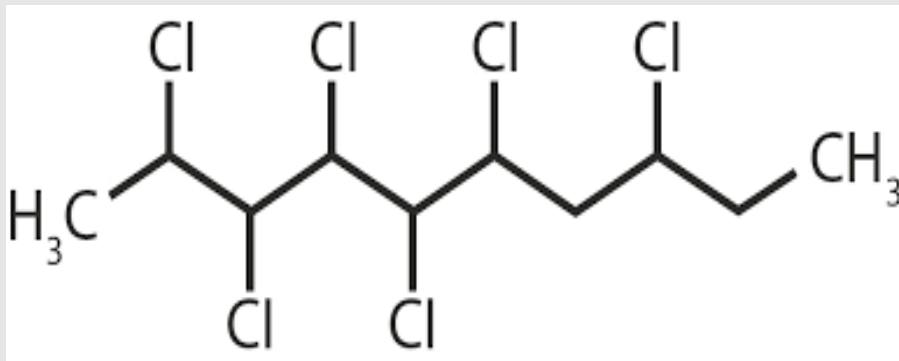
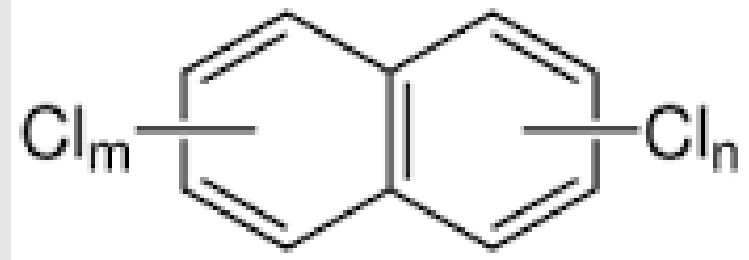
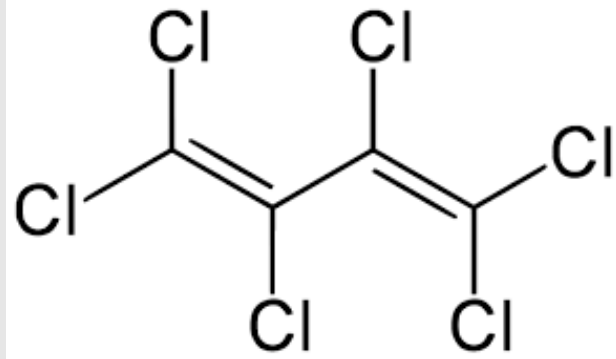
- **avoidance of uncontrolled open fires!!!**
- **technical measures in waste incineration plants (quench)**
- **reglementation of incineration in private households**
- **avoid additives in fuels, like 1,2-Dichloroethane or 1,2-Dibromoethane in order to reduce lead-covers in the motor**
- **environmental sound disposal of PCB-containing products**
- **environmental sound disposal of mineral residues (underground landfills)!**

Data on PCDD/PCDF; recommended measures

Safety storage for a long time

<https://www.youtube.com/watch?v=eH4zOdyjfpE>

Data on other POPs



Data on other POPs

POP	use	source	remarks
HCBD	Hydraulic liquid, Solvent for elastomers, Heat transformation and cooling liquid, Gas adsorbent, biocide	Byproduct in chemical industry incineration processes	Sources of emission, products and waste not very relevant; Basic principle: state of the art incineration
PCN	67 of 75 congeners Mixture, e.g. PCN- 33/34/37 Wood preservatives, Water resistant paints, Flame retardant, Softener, PCB substitute	150000 t worldwide until 1998 Products that become waste Stockpiles	Sources of emission, products and waste not very relevant; Basic principle: state of the art incineration

Data on other POPs

POP	use	source	remarks
SCCP	C ₁₀₋₁₃ Softener in plastics and coatings, Binding agent in paints, Greasing agent for leather and fur, Flame retardant, PCB substitute	Metal lubricants 9380 t/a Rubber 1310 t/a Paint 1150 t/a Sealants 695 t/a Leather 390 t/a Textiles 183 t/a Other 100 t/a Total 13208 t/a	Estimated waste amount (D) 176 t/a rubber industry 66 t/a sealants and glue Separation and state of the art incineration Dust protection
PCP	Wood preservatives, Textile and leather impregnation Associated with PCDD/PCD Half-life period 6 years	30-90000 t/a until 1983 Treated wood 50 > 1000 mg/kg untreated wood 50 < 5 mg/kg Migration into dust, furniture, textiles, wall papers 30 mg/kg	Estimated waste amount (D) 140 t/a Limit value for substantial recovery 3 mg/kg incineration

Thank you

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