Ministry of Environment and Water

UNEP CHEMICALS

GEF

INVENTORY

OF

POPs PESTICIDES

IN THE REPUBLIC OF BULGARIA

Sofia, November 2004,
Updated June 2006

Title:	**National Inventory of Persistent Organic Pollutants (POPs) Pesticides in the Republic of Bulgaria**
National Executing Agency:	**Ministry of Environment and Water of the Republic of Bulgaria**

Ministry of Environment and Water

67, W.Gladstone Str.

Sofia, 1000

www.moew.government.bg

The National Inventory of POPs Pesticides in the Republic of Bulgaria was developed with the financial support of United Nation Environmental Programme (UNEP) and Global Environmental Facility (GEF), as a part of Bulgarian sub-project GF/2732-02-4454 within the global project" GEF/UNEP: GF/2732-02-4452 "Deevelopment of 12 pilot country NIPs for the management POPs" by POPs team of experts of Ministry of Environment and Water (MoEW) and contribution of national consultants of „Balkan Science and Education Centre of Ecology and Environment"(BSECEE), Sofia

This WEB publication is endorsed by National Coordinating Committee (NCC) on 15 December 2004 and updated and amended in June 2006 after the approval by NCC of National Implementation Plan for the Management of Persistent Organic Pollutants (POPs) in the Republic of Bulgaria on 23 March 2006.

Project Manager	Dr. Dzhevdet Chakarov
	Minister of Environment and Water
National Coordinator	Prof. Georgi Antov, PhD, DMSc
Experts	Svetla Krapcheva, MSc,
MoEW	Department Chief of "Operative Control and Management of Hazardous Chemicals", MoEW
	e-mail: kraps@moew.government.bg
	eng. Tsvetanka Dimcheva, senior expert of MoEW
	e-mail: dimcheva@moew.government.bg
BSECEE	Prof. eng. Ivan Dombalov, PhD, Director BSECEE, Sofia
Consultants	e-mail: dombalov@uctm.edu
	eng.ecologist Evgeni Sokolovski, MSc, UCTM, Sofia
	e-mail: sokolovski@abv.bg
International Implementing Agency	United Nations Environmental Programme UNEP Chemicals, International Environment House 15 Chemin des Anémones, CH-1219, Châtelaine Geneva, Switzerland www.chem.unep.ch
Project Manager GEF/UNEP: GF/2732-02-4452 "12 pilot country NIPs for POPs"	Dr.David Piper, Task Manager "POPs enabling activities", Division of GEF Coordination UNEP Chemicals, Geneva, Switzerland e-mail: Dpiper@chemicals.unep.ch

First Edition, December 2004

Second updated and amended WEB Edition , June 2006

NATIONAL INVENTORY

OF

POPS PESTICIDES

IN THE REPUBLIC OF BULGARIA

MINISTRY OF ENVIRONMENT AND WATER OF THE REPUBLIC OF BULGARIA

Sofia, November 2004,
Updated June 2006

L I S T O F A B B R E V I A T I O N S

ADI	Acceptable Daily Intake
BAS	Bulgarian Academy of Sciences
BB Cube	A reinforced concrete container for storage of hazardous substances
DDD/DDE	Metabolites of DDT
DDT	Dichlorodiphenyltrichloroethane
EA BAS	Executive Agency Bulgarian Accreditation Service
EEA	Executive Environment Agency.
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organisation of the Unated Nations
GEF	Global Environment Facility
GVA	Gross Value Added
GDP	Gross Domestic Product
HCB	Hexachlorbenzene
IAC	Interagency Committee
IACEE	Inter-agency Council of Environmental Experts
IARC	International Agency for Research on Cancer
IHE (RIPHPC)	Institute of Hygiene and Epidemiology (Regional Inspectorate for Public Health Protection and Control).
K_{OW}	Octanol/ Water Partition Coefficient
LD_{50}	Median Lethal Dose
MDL	Minimum Detectable Level
MRL	Maximum Residue Limit
MoAF	Ministry of Agriculture and Forestry
MoEW	Ministry of Environment and Water
MoH	Ministry of Health
MoLSP	Ministry of Labour and Social Policy
NCHMEN	National Centre for Hygiene, Medical Ecology, and Nutrition
NEPF	National Environment Protection Fund at the MoEW
NPPS	National Plant Protection Service
POPs	Persistent Organic Pollutants, as defined in the Stockholm Convention.
RIEW	Regional Inspectorate of Environment and Water
SCEE	Supreme Council of Environmental Experts
SMSA	Standardisation and Metrology State Agency
UNEP	Unated Nations Environmental Programme
UNIDO	Unated Nations Industrial Development Organisation
WHO	World Health Organisation

Abbreviations and acronyms

ASE	Accelerated Solvent Extraction
ASTM	American Society for Testing and Materials
BAT	Best available techniques
BCD	Base catalysed decomposition
BEP	Best environmental practices
CEN	European Committee for Standardization
CHD	Catalytic hydro-dechlorination
CSIRO	Commonwealth Scientific Industrial Research Organization (Australia)
DDT	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (Dichlorodiphenyltrichloroethane)
DE	Destruction efficiency
DRE	Destruction removal efficiency
ECD	Electron capture detector
EPA	Environmental Protection Agency
ESM	Environmentally sound management
EU	European Union
FAO	Food and Agriculture Organization
FRTR	Federal Remediation Technologies Roundtable (United States of America)
GEMS	Global Environment Monitoring System
GEF	Global Environment Facility
GPCR	Gas phase chemical reduction
HCB	Hexachlorobenzene
HRGC	High resolution gas chromatography
HRMS	High resolution mass spectrometry
IATA	International Air Transport Association
IMO	International Maritime Organization
IPA	Isopropyl alcohol
ISO	International Organization for Standardization
LRMS	Low resolution mass spectrometry
LWPS	Liquid waste pre-heater system
MSD	Mass selective detectors
NIP	National Implementation Plan
OECD	Organization for Economic Cooperation and Development
OEWG	Open-ended Working Group of the Basel Convention
PBB	Polybrominated biphenyl
PCB	Polychlorinated biphenyl
PCD	Photo-chemical dechlorination
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzo-furan
PCT	Polychlorinated terphenyl
Pd/C	Palladium on carbon
POP	Persistent organic pollutant
QA	Quality Assurance
QC	Quality Control
SCWO	Super-critical water oxidation
SOP	Standard Operational Procedure
t-BuOK	Potassium tert-butoxide
TEQ	Toxic equivalent
TRBP	Thermal reduction batch processor
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme

Units of concentration

mg/kg	milligram(s) per kilogram. Corresponds to parts per million (ppm) by mass.
µg/kg	microgram(s) per kilogram. Corresponds to parts per billion (ppb) by mass.
ng/kg	nanogram(s) per kilogram. Corresponds to parts per trillion (ppt) by mass.
Mg	megagram (1,000 kg or 1 tonne)
kg	kilogram
mg	milligram
ng	nanogram
Nm^3	normal cubic metre; refers to dry gas, 101.3 kPa and 273.15 K
kW	kilowatt
kWh	kilowatt-hours
MJ	megajoule
million	10^6
billion	10^9
trillion	10^{12}
ppm	parts per million
ppb	parts per billion
ppt	parts per trillion

Table of Contents

1. Basic characteristics of POPs pesticides

1.1. Introduction

The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel.

Persistent organic pollutants (POP) are toxic chemical substances, resisting disintegration, and accumulating in organisms, transferred by air, water and, via migrating biological species, across international borders, and are deposited far from the location of their releasing, where they accumulate into the terrestrial and aquatic ecosystems and are very likely to have significant negative human health or environmental impacts close to, or far away from, their source.

The group of persistent organic pollutants that are subject to the Stockholm Convention includes the following pesticides: aldrin, dieldrin, endrin, mirex, toxaphene, hexachlorbenzene, heptachlor, chlordane and DDT. Large quantities of these POPs have been manufactured and used during the middle of the past century, and they accumulate in varying ways into the environment to become a long-term environmental problem not yet resolved throughout the world.

1.2. Basic Chemical Definitions, Properties and Use of POP pesticides *

1.2.1. Aldrin

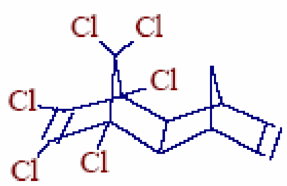
Chemical name: 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo,exo-5,8-dimethanenaphthalene

Synonyms and Trade Names (partial list):Aldrec; Aldrex; Aldrex 30; Aldrite; Aldrosol; Altox; Compound 118; Drinox; Octalene; Seedrin;

CAS №: 309-00-2

Empirical formula: $C_{12}H_8Cl_6$

Structural formula:



Appearance/Description: Aldrin are white, odourless crystals, when they are pure. Technical grades are tan to dark brown with a mild chemical odour *(Ritter, 1995)*.

Aldrin contains no less than 95 % 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-exo-1,4-endo-5,8-dimethanonaphtalene (HHDN). HHDN is a white, crystalline, odourless solid with a melting point of 104 to 104.5 °C. Technical aldrin is a tan to dark brown solid with a melting range from 49 to 60 °C. It is practically insoluble in water, moderately soluble in petroleum oil and stable to heat alkali and mild acids (*ATSDR, 2002; IPCS, WHO-FAO, 1979*). Pure aldrin is stable at < 200 °C and between a pH-range from 4 to 8, however, oxidizing agents and concentrated acids attack the unchlorinated ring under any conditions. Aldrin is non-corrosive or slightly corrosive to metals because of the slow formation of hydrogen chloride on storage. Aldrin is readily converted to dieldrin in the environment.

Properties: Molecular weight – 364.91; State of aggregation – crystals; Colour – white (chemically pure); beige to brown (technical substance); Odour – sweetish; Melting point – 104°C (pure); 49°C-60°C (technical); Boiling point: 145°C at 2 mm Hg; Relative density 1.6 g/l at 20°C; Solubility in water: 17 - 180 $\mu g.L^{-1}$ (25°C); Vapour pressure: 2,31 x 10^{-5} mm Hg (20°C); log K_{OW}: 5,17-7,4.

Use: Aldrin is an organochlorine pesticide. It has been manufactured commercially since 1950 and used throughout the world up to the early 1970s. to control soil insects such as termites, corn rootworm, wireworms, rice water weevil, and grasshoppers. It has been widely used to protect crops such as corn and potatoes. Aldrin also has been effectively used to protect wooden structures from termite, plastic and rubber coverings of electrical and telecommunication cables (*ATSDR, 2002; UNEP, 2002a*).

Persistence/Fate: Aldrin is readily metabolized to dieldrin by both plants and animals. As a result, aldrin residues are rarely found in foods and animals, and then only in small amounts. It binds strongly to soil particles and is very resistant to leaching into groundwater. Volatilization is an important mechanism of loss from the soil. Due to its persistent nature and hydrophobicity, aldrin is known to bioconcentrate, mainly as its conversion products. Aldrin is classified as moderately persistent with a half-life in soil and surface water of 20 days to 1, 6 years.

Toxicity: Aldrin is toxic to humans; the lethal dose of aldrin for an adult man has been estimated to be about 5g, equivalent to 83 $mg.kg^{-1}$ body mass (b.m.). Signs and symptoms of aldrin intoxication may include headache, dizziness, nausea, general malaise, and vomiting, followed by muscle twitchings, myoclonic jerks, and convulsions.

The acute oral LD_{50} for aldrin in laboratory animals is in the range of 33 $mg.kg^{-1}$ b.m. for guinea pigs to 320 $mg.kg^{-1}$ b.m. for hamsters. Reproductive effects in rats were observed when pregnant females were dosed with 1.0 $mg.kg^{-1}$ aldrin subcutaneously. There is, as yet, no evidence of a teratogenic potential for aldrin. IARC has concluded that there is inadequate evidence for the carcinogenicity of aldrin in humans, and there is only limited evidence in experimental animals. Aldrin is therefore not classifiable as to its carcinogenicity in humans (IARC, Group 3).

Aldrin has low phytotoxicity, with plants affected only by extremely high application rates. The toxicity of aldrin to aquatic organisms is quite variable, with aquatic insects being the most sensitive group of invertebrates - water fleas. The lethal concentration, LC_{50} values over 96 hours of exposure range from 1-200 $\mu g.L^{-1}$ for insects and from 2.2-53 $\mu g.L^{-1}$ for fish.

The acute toxicity of aldrin to avian species varies in the range of 6.6 $mg.kg^{-1}$ for bobwhite quail to 520 $mg.kg^{-1}$ for mallard ducks.

As aldrin is readily and rapidly converted to dieldrin in the environment, its fate is closely linked to that of dieldrin. Aldrin is readily metabolised to dieldrin in both animals and plants, and therefore aldrin residues are rarely present in animals and then only in very small amounts. Dairy products, such as milk and butter, and animal meats are the primary sources of exposure.

The maximum residue limits of aldrin in food, recommended by FAO/WHO, maximum admissible quantities of Aldrin vary from 0,006 $mg.kg^{-1}$ milk fat in dairy products to 0, 2 $mg.kg^{-1}$ meat fat in meat and meat products. The maximum residue limits of Aldrin residues in water vary within the range 0, 1 – 180 $\mu g.L^{-1}$.

1.2.2. Dieldrin

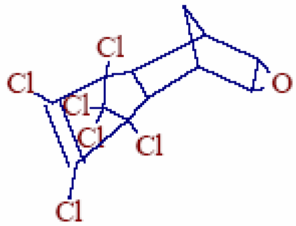
Chemical name: 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydroexo-1,4-endo-5,8-dimethane-naphtalene

Synonyms and Trade Names (partial list): Alvit; Dieldrite; Dieldrix; Illoxol; Octalox; Panoram D-31; Quintox; Red Shield

CAS №: 60-57-1

Empirical formula: $C_{12}H_8Cl_6O$

Structural formula:



Appearance/Description: Dieldrin is closely related to its metabolic precursor aldrin. A stereo-isomer of endrin, dieldrin may be present as white crystals or pale tan flakes, odourless to mild chemical odour. The pure dieldrin is a white crystalline solid with a melting point of 176 -177 °C. Technical dieldrin is a light tan flaky solid with a melting point of 150 °C. In water, it is practically insoluble and slightly soluble in alcohol. Pure dieldrin is stable in alkali and diluted acids, but reacts with strong acids. (*ATSDR, 2002; WHO-FAO, 1975*).

Properties: Molecular weight – 380.91; Melting point: – 176°C ÷ 177°C; Boiling point – decomposes; Relative density 1.75 $g.L^{-1}$ at 25°C; Solubility: in water - 140 $\mu g.L^{-1}$ (20°C), in organic solvents – moderate; Vapour pressure: 1,78 x 10^{-7} mm Hg at 20°C; log K_{OW}: 3,69-6,2.

Use: Dieldrin is the principal reaction product of aldrin, an important soil insecticide. Dieldrin appeared on the market in 1948 following World War II and has been used mainly for the control of soil insects such as fleas, beetles, corn rootworms, wireworms, catworms, etc. Dieldrin has been also used for the control of several insect vectors of disease but this latter use has been banned due to environmental and human health concerns. Principle contemporary uses are restricted to control termites and wood borers and against textile pests (WHO, 1989).

Persistence/Fate: Dieldrin exhibits high persistence in soil, with a half-life in moderate climate countries of 3-4 years, and accumulates in organisms. Dieldrin binds strongly to soil particles and hence is very resistant to leaching into groundwater. Persistence in air – 4-10 h. Volatilization is an important mechanism of loss from the soil and, because of its persistent nature and hydrophobicity, dieldrin is known to bioconcentrate. The half life of dieldrin in temperate soils is approximately 5 years. This persistence, combined with high lipid solubility, provides the necessary conditions for dieldrin to bioconcentrate and biomagnifyin organisms.

Dieldrin residues have been detected in air, water, soil, fish, birds and mammals, including Humans and human breast milk. As aldrin is readily and rapidly converted to dieldrin in the environment and in organisms, the levels of dieldrin detected likely reflect the total concentrations of both compounds.

Toxicity: Dieldrin has low phytotoxicity. Plants are affected only by application rates much higher than suggested use rates. The acute toxicity of dieldrin is quite variable for aquatic invertebrates, with insects being the most sensitive group (values range from 0.2-40 $\mu g.L^{-1}$).

Dieldrin is highly toxic for fish (LC_{50} values range from 1.1-41 $\mu g.L^{-1}$), and moderately so for warm blooded organisms (LD_{50} for mice and rats - 40 - 70 mg/kg b.m.). The daily oral inputs of Dieldrin at 0,6 mg/kg of b.m. reduces the longevity of rabbits. The main target of Aldrin and Dieldrin is the central nervous system. No direct evidence exists about carcinogenic effects on humans. The maximum residue limits of aldrin in food, recommended by FAO/WHO vary from 0,006 $mg.kg^{-1}$ milk fat in dairy products to 0, 2 $mg.kg^{-1}$ meat fat in meat and meat products. The maximum residue limits of Aldrin residues in water vary within the range 0, 1 – 18 $\mu g.L^{-1}$.

IARC has concluded that there is inadequate evidence for the carcinogenicity of dieldrin in humans, and limited evidence in experimental animals and has been classified by IARC in Group 3.

1.2.3. Endrin

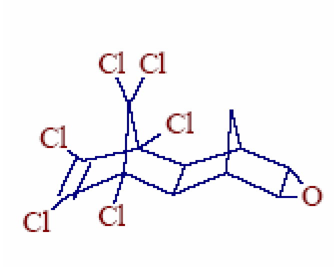
Chemical name: 2,3,4,10,10-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonapht[2,3-b]oxyrene

Synonyms and Trade Names (partial list): Compound 269; Endrex; Experimental insecticide 269; Hexadrin; Isodrin Epoxide;mMendrin; Nendrin.

CAS №: 72-20-8

Empirical formula: $C_{12}H_8Cl_6O$

Structural formula:



Appearance/Description: White, odourless, crystalline solid when pure; light tan colour with faint chemical odour for technical grade.

Endrin is a stereoisomer of dieldrin. Endrin, when pure, is a white crystalline solid and has a melting point of 200 °C. It is decomposed at temperatures above 245 °C (boiling point). The technical product is a light tan powder with a characteristic odour. It is practically insoluble in water and slightly soluble in alcohol. It is stable in alkali and acids, but it rearranges to less insecticidally active substances in the presence of strong acids, on the exposure to sunlight or on heating above 200 °C. *(ATSDR, 1996; IPCS, WHO-FAO, 1975).*

Properties: Molecular weight – 380.92; Melting point – 235°C; Boiling point – decomposes at 245°C; Relative density – 1.7 at 20°C; Solubility in water: - 220-260 μg.L^{-1} at 25 °C, in organic solvents – good; Vapour pressure – 2.7 x 10^{-7} mm Hg at 25°C; log K_{OW}: 3.21-5.34.

Use: Endrin is an organochlorine foliar insecticide, which has been used since the 50s to control various agricultural pests, mostly on cotton, rice, sugarcane, maize, tobacco, apple orchards, and grain.. It has also been used as a rodenticide to control cutworms, mice, voles, grasshoppers and borers. It was also used as an insecticide agent on bird perches, but has never been extensively used for termite-proofing or other applications in urban areas. *(ATSDR, 2002; Fiedler, 2000).*

Persistence/Fate: Endrin is highly persistent in soil (with a half-life of up to 12 years in some cases). Bioaccumulation rates of 14 to 18 000 have been registered during constant exposure of fish.

Endrin is rapidly metabolised by animals and does not accumulate in fat to the same extent as other compounds with similar structures. It can enter the atmosphere by volatilization, and can contaminate surface water from soil run-off.

The half life of endrin in soil may be up to 12 years, depending on local conditions. This persistence, combined with a high partition coefficient (log K_OW = 3.21-5.34), provides the necessary conditions for endrin to bioconcentrate in organisms.

Toxicity: Endrin is highly toxic for fish, aquatic invertebrates and phytoplankton, with acute LC_{50} values of less than 1.0 μg/l. The acute oral dose LD_{50} for laboratory animals is between 3-43 mg/kg of b.m., and the acute dermal dose LD_{50} is 5-20 mg/kg of b.m. for rats. A two-year chronic exposure test has identified a non-affecting daily dose of 0.05 mg/kg b.m. for rats.

The acute oral LD_{50} of endrin is in the range of 3 mg/kg body mass (b.m.) in monkeys to 36 mg/kg b.m. in guinea pigs. Male and female Long-Evans rats were fed endrin in the diet over three generations. No difference in appearance, behaviour, body weight, or number or size of litters was observed. The weights of liver, kidneys and brain were normal, and no histopathological abnormalities were observed in third generation weanlings.

Endrin was not teratogenic at levels that did not cause maternal toxicity. Endrin is metabolised rapidly by animals, and very little is accumulated in fat compared to compounds of similar structure (including its stereoisomer dieldrin).

IARC has concluded that there is inadequate evidence for the carcinogenicity of endrin in humans, and there is only limited evidence in experimental animals. Endrin is therefore not classifiable as to its carcinogenicity in humans (Group 3).

The chemical properties of endrin (low water solubility, high stability in the environment, and semi-volatility) favour its long range transport, and it has been detected in arctic freshwater. The main source of endrin exposure to the general population is residues in food however, contemporary intake is generally below the acceptable daily intake of 0.0002 mg/kg body mass recommended by FAO/WHO.

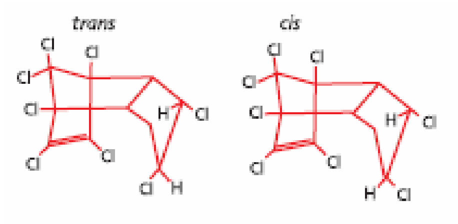
1.2.4. Chlordane

Chemical name: 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene;
1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1H-indene

Synonyms and Trade Names (partial list): Aspon, Belt, Chloriandin, Chlorkil, Chlordan, Corodan, Cortilan-neu, Dowchlor, HCS 3260, Kypchlor, M140, Niran, Octachlor, Octaterr, Ortho-Klor, Synklor, Tat chlor 4, Topichlor, Toxichlor, Veliscol-1068.

CAS №: 57-74-9
Empirical formula: $C_{10}H_6Cl_8$

Structural formula:



Appearance/Description: colourless to amber-coloured viscous liquid with an aromatic, pungent odoursimilar to chlorine;

Pure chlordane has a melting point of 104 °C, is not soluble in water and stable in most organic solvents, including petroleum oils. It is unstable in the presence of weak alkalis.

Technical chlordane is a viscous mixture of at least 23 different components, including chlordane isomers, other chlorinated hydrocarbons and by-products. The main constituents of technical chlordane are trans-chlordane (gamma-chlordane, share of about 25 %), cis-chlordane (alpha-chlordane, share of about 70 %), heptachlor, trans-nonachlor, and cis-nonachlor (share less than 1 %). Heptachlor is one of the most active components of technical chlordane. *(ATSDR, 1994; EXTOXNET; Holoubek, 2004; IPCS; UNEP, 2002a; WHO-FAO, 1979).*

Properties: Molecular weight – 409,78; (479.76 - chemically pure substance); Melting point - cis - chlordane- 106°C ÷107° C, *trans* – chlordane - 104°C ÷105° C; Boiling point – 175°C at 2 mm Hg; Relative density: 1.59 ÷1.63 g/cm^3 at 25°C; Solubility in water – 56 µg.L^{-1} at 25°C, organic solvents – mixable with hydrocarbon solvents; Vapour pressure: 0,98 x 10^{-5} mm Hg at 25 °C; log K_{OW}: 4,58-5,57.

Use: Chlordane has been used since 1945 mainly as insecticide for control of cockroaches, ants, termites, and other household pests. Chlordane is a broad spectrum contact insecticide that has been used on agricultural crops including vegetables, small grains, maize, other oilseeds, potatoes, sugarcane, sugar beets, fruits, nuts, cotton and jute. It has also been used extensively in the control of termites.

Persistence/Fate: Chlordane is highly persistent in soil with an approximate half-life of 4 years. Its persistence and high distribution ratio allow this substance to bind to sediments in water and to accumulate in organisms. Chlordane is highly insoluble in water, and is soluble in organic solvents. It is semi-volatile and can be expected to partition into the atmosphere as a result. It binds readily to aquatic sediments and bioconcentrates in the fat of organisms as a result of its high partition coefficient (log K_{OW} = 6.00). The chemical properties of chlordane (low water solubility, high stability, and semi-volatility) favour its long range transport, and chlordane has been detected in arctic air, water and organisms.

Toxicity: The acute LC_{50} for aquatic organisms is between 0,4 mg/l (prawns) to 90 mg/l (rainbow trout). The acute oral dose, LD_{50}, is 200 – 590 mg/kg of b.m., and that for oxychlordane is 19,1 mg/kg of b.m. The maximum residue limits of Chlordane in food, recommended by FAO/WHO vary from 0,002 $mg.kg^{-1}$ milk fat in dairy products to 0, 5 $mg.kg^{-1}$ meat fat in meat and meat products. The maximum residue limits of Chlordane residues in water vary within the range 1, 5 – 6 $\mu g.L^{-1}$.

1.2.5. Heptachlor

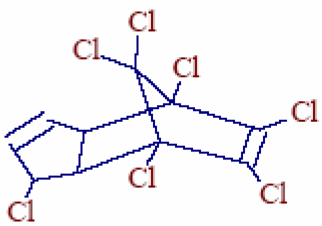
Chemical name: 1,4,5,6,7,8,8-heptachlor-3a,4,7,7a-tetrahydro-4,7-methanoindene
1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanol-1H-indene.

Synonyms and Trade Names (partial list): Aahepta; Agroceres; Baskalor; Drinox; Drinox H-34; Gold Grest H-60; Heptachlorane; Heptagran; Heptagranox; Heptamak; Heptamul; Heptasol; Heptox; Rhodiachlor; Soleptax; Termide; Veliscol 104; Veliscol heptachlor.

CAS №: 76-44-8

Empirical formula: $C_{10}H_5Cl_7$

Structural formula:



Appearance/Description: White to light tan, waxy solid or crystals with a camphor-like odour.

Pure heptachlor is a white crystalline solid with a melting point of 95/96 °C. Technical heptachlor is a soft waxy solid with a melting range between 46 and 74 °C. It is practically insoluble in water and slightly soluble in alcohol. It is stable up to temperatures between 150 and 160 °C as well as towards light, air moisture, alkalies and acids. It is not readily dechlorinated, but is susceptible to epoxidation *(ATSDR, 1993; WHO-FAO, 1975).*

Properties: Molecular weight – 373.32; State of aggregation – crystals; Colour – white (chemicall pure substance); Odour – camphoric; Melting point – 95°C ÷ 96°C (pure); 46-74° C (technical); Boiling point: 135 – 145°C at 1-1.5 mm Hg, decomposes at 760 mm Hg; Relative density – 1.57 g/cm^3 at 9°C; Solubility in water – 180 µg/l at 25°C, good in organic solvents; Vapour pressure: 0.3 x 10^{-5} mm Hg at 20°C; log K_{OW}: 4.4 - 5.5.

Use: Heptachlor is a persistent dermal insecticide with some fumigant action. It is nonphytotoxic at insecticidal concentrations. Heptachlor was used extensively from 1953 to 1974 as a soil and seed treatment to protect corn, small grains, and sorghum from pests. Heptachlor is a non-systemic stomach and contact insecticide, used primarily against soil insects and termites. It has also been used against cotton insects, grasshoppers and mosquitoes, some crop pests and to combat malaria.

It was used to control ants, cutworms, maggots, termites, thrips, weevils, and wireworms in both cultivated and uncultivated soils. Heptachlor was also used nonagriculturally during this time period to control termites and household insects *(ATSDR, 1993; Fiedler, 2000).* Its metabolite – cheptachloroepoxy – is significantly more persistent.

Persistence/Fate: Heptachlor is highly insoluble in water, and is soluble in organic solvents. It is quite volatile and can be expected to partition into the atmosphere as a result. It binds readily to aquatic sediments and bioconcentrates in the fat of living organisms. The half-life of heptachlor in soil in moderate climates varies between 0.75 and 2 years. Heptachlor is metabolised in animals to heptachlor epoxide, whose toxicity is similar to that of heptachlor, and which may also be stored in animal fat. This persistence, combined with a high partition coefficient (K_{OW} = 4.4-5.5), provides the necessary conditions for heptachlor to bioconcentrate in organisms. Bioconcentration factors of heptachlor and heptachlor epoxide in fathead minnows (Pimephales promelas) were 9,500 and 14,400, respectively. The chemical properties of heptachlor (low water solubility, high stability, and semi-volatility) favour its long range transport, and heptachlor and its epoxide have been detected in arctic air, water and organisms. WHO suggests that food is the major source of exposure of heptachlor to the general population.

Toxicity: Heptachlor is moderatel toxic for mammlas (the accurate oral dose, LD_{50}, varying between 40 mg/kg of b.m in rats to 116 mg/kg of b.m. in rabbits.). No adverse effects were observed in the lower dose levels. WHO has reported no evidence of teratogenicity of heptachlor in rats and rabbits. This pesticide is toxic for aquatic organisms – LC_{50} for shrimps reaching 0, 11 $\mu g.L^{-1}$. Comparatively scarse data exist about the impact and the carcinogenic effect of heptachlor for humans and this does not allow for definite conclusions. The FAO/WHO recommended maximum admissible quantities of Heptachlor residue in food vary between 0,006 $mg.kg^{-1}$ in milk fats and 0, 2 $mg.kg^{-1}$ in bird fats.

IARC has concluded that, while there is inadequate evidence for the carcinogenicity of heptachlor in humans, there is sufficient evidence in experimental animals. IARC has classified heptachlor as a possible human carcinogen (Group 2B).

1.2.6. DDT (Dichlorodiphenyltrichloroethane)

Chemical name:

***p,p'*- DDT**: 1,1,1-trichloro-2,2-bbis-(4-chlorophenil)-ethane;
***p,p'*- DDE**: 1,1-dichloro-1,1-bis-(*p*-chlorophenil) ethylene;
***p,p'*- DDD**: 1,1-bis(4-chlorophenyl)-2,2-dichloroethane;

Synonyms and Trade Names (partial list):

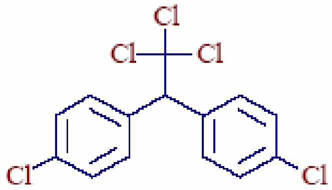
***p,p'*- DDT**: Agritan, Anofex, Arkotine, Azotox, Bosan Supra, Bovidermol, Chlorophenothan, Chloropenothane, Clorophenotoxum, Citox, Clofenotane, Dedelo, Deoval, Detox, Detoxan, Dibovan, Dicophane, Didigam, Didimac, Dodat, Dykol, Estonate, Genitox, Gesafid, Gesapon, Gesarex, Gesarol, Guesapon, Gyron, Havero-extra, Ivotan, Ixodex, Kopsol, Mutoxin, Neocid, Parachlorocidum, Pentachlorin, Pentech, PPzeidan, Rudseam, Santobane, Zeidane, Zerdane.
***p,p'*- DDE**: No data
***p,p'*- DDD**: DDD; Rothane; Dilene, TDE

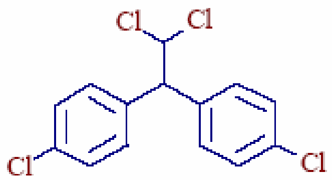
CAS №: *p,p'*- **DDT**: 50-29-3.
p,p'- **DDE**: 72-55-9
p,p'- **DDD**: 72-54-8

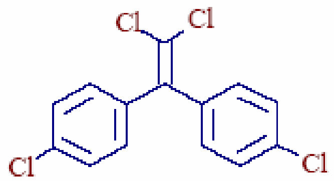
Agritan

Empirical formula: *p,p'*- **DDT**: $C_{14}H_9Cl_5$;
p,p'- **DDE**: $C_{14}H_8Cl_4$;
p,p'- **DDD**: $C_{14}H_{10}Cl_4$

Structural formula:







***p,p'*- DDT – $C_{14}H_9Cl_5$** ***p,p'*- DDD - $C_{14}H_{10}Cl_4$** ***p,p'*- DDE - $C_{14}H_8Cl_4$**

Appearance/Description: Odourless to slightly fragrant colourless crystals or white powder. The substance DDT (CAS No.: 50-29-3) was synthesized by Zeidler in Switzerland for first time in 1874. It does not occur naturally in the environment, its pesticides properties were recognized in 1939 by Paul Muller.

Pure p,p'-DDT (or 4,4'-DDT) is a colorless crystalline or powderlike substance with a melting point of 109 °C and a boiling point of 260 °C. It is nearly insoluble in water but soluble in many organic solvents. Because of its lipophilicity (log Kow = 6.36), it enriches in sediments and shows bioaccumulation in adipose tissues and biomagnification. Furthermore, it is a flammable substance (flash point 72 – 75 °C). Technical DDT consists of different isomers with similar properties. If released to the terrestrial compartment, DDT will adsorb very strongly to soil and be subject to evaporation and photo oxidation near the surface. It will not hydrolyse and will not significantly biodegrade in most waters. If released to the air it will be subject to direct photo degradation and reaction with photo chemically produced hydroxyl radicals. DDT was regarded as an ideal pesticide, because it was toxic to a wide range of insects but it was relatively harmless to mammals, fish, and plants, particularly in comparison to other pesticides commonly used at the time, such as lead arsenate.

Properties: Molecular weight: *p,p'*- **DDT**: 354.49; *p,p'*- **DDE**: 318.03; *p,p'*- **DDD**: 320.05; State of aggregation: *p,p'*- **DDT**: powder; *p,p'*- **DDE**: crystals; *p,p'*- **DDD**: powder; Colour: *p,p'*- **DDT**: colourless crystals, white powder; *p,p'*- **DDE**: white; *p,p'*- **DDD**: colourless crystals, white powder; Odour: *p,p'*- **DDT**: none or weak; *p,p'*- **DDE**: no data; *p,p'*- **DDD**: none; Meltingpoint: *p,p'*- **DDT**: 109°C; *p,p'*- **DDE**: 89°C; *p,p'*- **DDD**: 109°C ÷ 110°C; Boilingpoint: *p,p'*- **DDT**: decomposing; *p,p'*- **DDE**: 336°C; *p,p'*- **DDD**: 350°C; Relative density: *p,p'*- **DDT**: 0.98 ÷ 0.99 g/cm^3; *p,p'*- **DDE**: no data; *p,p'*- **DDD**: 1.385 g/cm^3; Solubility in water: 1.2 ÷ 5.5 µg/l at 25°C; *p,p'*- **DDT**: weak – in ethanol, strong – in ethyl ether and acetone; *p,p'*- **DDE**: in fats and in organic solvents; *p,p'*- **DDD**: no data; Vapour pressure: 0.2 x 10^{-6} mm Hg at 20°C; log K_{OW}: 6.91 for *pp*'- **DDT**, 6.02 for *pp'*- **DDD** and 6.51 for *pp'*- **DDE**.

Use: DDT was widely used during the Second World War to protect the troops and civilians from the spread of malaria, typhus and other vector borne diseases. After the war, DDT was widely used on a variety of agricultural crops and for the control of disease vectors as well. Later, it was used widely in agriculture to control various agricultural pests. It is still being produced and used for vector control.Growing concern about adverse environmental effects, especially on wild birds, led to severe restrictions and bans in many developed countries in the early 1970s. The largest agricultural use of DDT has been on cotton. DDT is still used to control mosquito vectors of malaria in numerous countries. The technical products represents a mixture of 85% pp'-DDT and 15% *op'*-isomer DDT.

Persistence/Fate: DDT is highly insoluble in water and is soluble in most organic solvents. It is semi-volatile and can be expected to partition into the atmosphere as a result. Its presence is ubiquitous in the environment and residues have even been detected in the arctic. It is lipophilic and partitions readily into the fat of all living organisms and has been demonstrated to bioconcentrate and biomagnify. The breakdown products of DDT, 1,1-dichloro-2,2-bis(4-chlorophenyl)ethane (DDD or TDE) and 1,1-dichloro-2,2bis(4-chlorophenyl)ethylene) (DDE), are also present virtually everywhere in the environment and are more persistent than the parent compound.

DDT is highly persistent in soil and its half-life extends up to 15 years, and to 7 days in air. DDT exhibits high bio-concetration capacity – between 50000 for fish and 500000 for dipterans. In the environment DDT metabolises mainly to DDD and DDE.

DDT and related compounds are very persistent in the environment, as much as 50% can remain in the soil 10-15 years after application. This persistence, combined with a high partition coefficient (log K_{OW} = 4.89-6.91) provides the necessary conditions for DDT to bioconcentrate.

It has been suggested that higher accumulations of DDT at higher trophic levels in aquatic systems results from a tendency for organisms to accumulate more DDT directly from the water, rather than by biomagnification. The chemical properties of DDT (low water solubility, high stability and semi-volatility) favour its long range transport and DDT and its metabolites have been detected in arctic air, water and organisms.

Toxicity: DDT is not highly acutely toxic to laboratory animals, with acute oral LD_{50} values in the range of 100 mg/kg body mass for rats to 1,770 mg/kg for rabbits. The lowest DDT concentration in the food of ducks causing thinning of the eggshell is 0, 6 mg/kg b.m. LC_{50} for perch and Guppy are 1, 5 mg/l and 56 mg/l, respectively.

DDT is highly toxic to fish, with 96-hour LC50 values in the range of 0.4 μg/L in shrimp to 42 μg/L in rainbow trout. It also affects fish behaviour. Atlantic salmon exposed to DDT as eggs experienced impaired balance and delayed appearance of normal behaviour patterns. DDT also affects temperature selection in fish.

DDT is acutely toxic to birds with acute oral LD50 values in the range of 595 mg/kg body weight in quail to 1,334 mg/kg in pheasant, however it is best known for its adverse effects on reproduction, especially DDE, which causes egg shell thinning in birds with associated significant adverse impact on reproductive success.

In the human organism, DDT exhibits estrogen-resembling and probable carcinogenic properties. The FAO/WHO recommended maximum admissible quantities of DDT residue in food vary between 0, 02 $mg.kg^{-1}$ in milk fats and 5 $mg.kg^{-1}$ in bird fats. The maximum admissible quantities of DDT residue in drinking water, as set by the WHO, is 18 μg/l. DDT and its metabolites have been detected in food from all over the world and this route is likely the greatest source of exposure for the general population .

IARC has concluded that while there is inadequate evidence for the carcinogenicity of DDT in humans, there is sufficient evidence in experimental animals. IARC has classified DDT as a possible human carcinogen (Group 2B).

1.2.7. Toxaphene

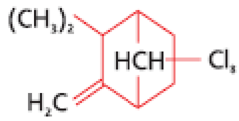
Chemical name: polychlorinated bornanes and camiphenes

Synonyms and Trade Names (parital list): Agricide Maggot Killer; Alltex; Alltox; Attac 4-2; Attac 4-4; Attac 6; Attac 6-3; Attac 8; Camphechlor; Camphochlor; Camphoclor; Camphofene Huilex ; Chemphene M5055; Chlorinated camphene; Chloro-camphene; Clor chem T-590; Compound 3956; Geniphene; Hercules 3956; Hercules Toxaphene; Kamfochlor; Melipax; Motox; Octachlorocamphene; Penphene; Phenacide; Phenatox; Phenphane; Polychlorocamphene; Synthetic 3956; Strobane-T; Strobane T-90; Texadust; Toxakil; Toxon 63; Toxyphen; Vertac 90%.

CAS №: 8001-35-2

Empirical formula: $C_{10}H_{10}Cl_8$

Structural formula:



Appearance/Description: In its original form, Toxaphene is a yellow to amber waxy solid with a chlorine/ turpentine-like odour.
Toxaphene is an insecticide containing over 670 polychlorinated bicyclic terpenes consisting predominantly of chlorinated camphenes. Toxaphene formulations included wettable powders, emulsifiable concentrates, dusts, granules, baits, oils, and emulsions (*IARC, 1979; ATSDR, 1996*). Its melting range is from 65 to 90 °C. Its boiling point in water is above 120 °C, which is the temperature where it starts to decompose. Toxaphene tends to evaporate when in solid form or when mixed with liquids and does not burn. *(ATSDR, 1996; Fiedler, 2000; USEPA, 2000b).*

Properties: Molecular weight: 413.82; State of aggregation: crystals; Colour/Shape: Yellow wax; amber; Odour: light chlorine and camphor; Melting temperature: 65°C ÷ 90°C; Boiling point: releases chlorine at 155°C; Relative density at 25°C: 1.65 g/cm^3; Solubility in water: 550 µg.L^{-1} at 20°C; Easily soluble in aromatic hydrocarbons and in organic solvents; Vapour pressure: 3.3 x 10^{-5} mm Hg at 25°C; log K_{OW}: 3.23-5.50.

Use: Toxaphene was introduced in 1949 and became the most heavily used organochlorine pesticide. It has been available in various forms: a solid containing 100 % technical toxaphene; a 90 % solution in xylene or oil; a wettable powder containing 40 % toxaphene; dusts containing 5 to 20 and 40 % toxaphene; granules containing 10 or 20 % toxaphene; emulsifiable concentrates in concentrations of 4, 6, 9 % toxaphene; baits containing 1 % toxaphene; a 2:1 toxaphene:DDT emulsion; and a dust containing 14 % toxaphene and 7 % DDT. Technical toxaphene is a complex mixture of more than 300 congeners, and contains 67- 60% of chlorine. *(ATSDR, 1996; Fiedler, 2000; USEPA, 2000b).*

Toxaphene was formerly used as a nonsystemic stomach and contact insecticide with some acaricidal activity. Being nonphytotoxic (except to cucurbits), it was used to control many insects thriving on cotton, corn, fruit, vegetables, and small grains and to control the Cussia obtusifola soybean pest. Toxaphene was also used to control livestock ectoparasites such as lice, flies, ticks, mange, insects spreading fever, and horse-infesting ticks and scab mites. Its relatively low toxicity to bees and its long-persisting insecticidal effect made it particularly useful in the treatment of flowering plants.

Persistence/Fate: Toxaphene is highly insoluble in water and the half-life of toxaphene in soil varies between 100 days and 12 years. Its accumulation in aquatic organism has been proven and is known to undergo atmospheric transport. This persistence, combined with a high partition coefficient (log K_{OW} = 3.23-5.50) suggests that toxaphene is likely to bioconcentrate. Bioconcentration factors of 4,247 and 76,000 have been recorded in mosquito fish and brook trout, respectively. The chemical properties of toxaphene (low water solubility, high stability, and semi-volatility) favour its long range transport, and toxaphene has been detected in arctic air. Exposure of the general population is most likely through food, however levels detected are generally below maximum residue limits.

Toxicity: Toxaphene is highly toxic for fish: a 96-hour exposure exhibits LC_{50} for rainbow trout and perch of 1,8 µg/l and, respectively, 22 µg/l. Prolonged exposure to Toxaphene in concentrations of 0,5 µg/l in water leads to complete reduction of egg vitality. The acute oral dose LD_{50} for rats, dogs, and Guinea pigs are, respectively, 60 - 293 mg/kg b.m., 49 mg/kg b.m., and 365 mg/kg b.m. Chornic exposure experiments with rats have exhibited a non-acting dose of 0, 35 mg/kg/day. Convincing evidence exists that Toxaphene may cause damage of the ductless glands in humans. Toxaphene has a carcinogenic effect on rats and mice and represents a carcinogenic risk for humans, with a carcinogenic activity ratio for oral exposure of 11 mg/kg b.m. /day. Toxaphene is essentially nontoxic to plants.

IARC has concluded that while there is inadequate evidence for the carcinogenicity of toxaphene in humans, there is sufficient evidence in experimental animals. IARC has classified toxaphene as a possible human carcinogen (Group 2B).

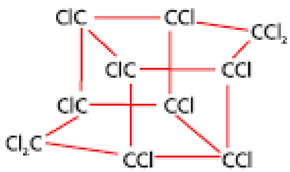
1.2.8. Mirex

Chemical name: 1,1a,2,2a,3,3a,4,5,5a,5b,6-dodecachloroacta-hydro-1,3,4-metheno-1H-cyclobyta[cd]pentalene
Synonyms and Trade Names (partial list):Dechlorane, Ferriamicide, GC 1283; HRS1276; ENT 257 19;

CAS №: 2385-85-5

Empirical formula: $C_{10}Cl_{12}$

Structural formula:



Appearance/Description: Mirex is a white, odourless crystalline solid with a melting point of 485 °C and as such fire resistant. It is soluble in several organic solvents including tetrahydrofuran (30 %), carbon disulfide (18 %), chloroform (17 %), and benzene (12 %), but is practically insoluble in water. Mirex is considered to be extremely stable. It does not react with sulfuric, nitric, hydrochloric or other common acids and is unreactive with bases, chlorine or ozone. In the environment, it degrades to photomirex, when exposed to sunlight *(ATSDR, 1995; IPCS, 1997; USEPA, 2000b).*

Properties: Molecular weight: 545.5; State of aggregation: crystals; Colour: snow white; Odour: none; Melting point: 485°C (decomposes); Solubility in water: 0.07 µg/L at 25°C, practically insoluble; Vapour pressure: 3 x 10^{-7} mm Hg at 25°C; log K_{OW}: 5.28

Use: Mirex is a stomach insecticide with little contact activity. Mirex in pesticide preparations was first used in the mid 60-ies most commonly to control fire ants. Mirex was also used successfully in controlling populations of leaf cutter ants , harvester termites, harvester ants, mealybugs in pineapples and yellowjacket wasps. Mirex has been included in lures based on coarse grain cornflour and soy bean oil.

Because it is nonflammable Mirex has also been marketed as a flame retardant for use in various coatings,in plastics, rubber, paint paper and electrical goods. The technical brands involve 95, 19% Mirex and 2, 58% chlordecon (the remaining constituents are not quoted). *(ATSDR, 1995; IPCS, 1997; USEPA, 2000b).*

Persistence/Fate: Mirex is regarded as one of the most persistent pesticides. Mirex is very resistant to breakdown, is very insoluble in water and has been shown to bioaccumulate and biomagnify. Due to its insolubility, mirex binds strongly to aquatic sediments. Its half-life in soil extends to 10 years. This persistence, combined with lipophilicity, provides the conditions necessary for mirex to bioconcentrate in organisms. Bioconcentration factors of 2,600 and 51,400 have been observed in pink shrimp and fathead minnows, respectively. The chemical properties of mirex (low water solubility, high lipid solubility, high stability, and semi-volatility) favour its long range transport, and mirex has been detected in arctic freshwater and terrestrial organisms.

Contamination of plants is primarily a surface phenomenon resulting from aerial deposition of emissions or deposition of compound that has volatilized from the surface of the soil.

Toxicity: The acute oral toxicity of Mirex for mammals is moderate - LD_{50} for rats is 235 mg/kg b.m., while the acute dermal dose LD_{50} for rabbits is 80 mg/kg b.m. Mirex is toxic for fish and affects their behaviour - LC_{50} at 96 hours of exposure for rainbow trout and perch is, respectively, 0, 2 mg/l and 30 mg/l. Lethal outcomes for shellfish is observed at later stages following exposure to 1 µg/l of mirex. The existing data show that Mirex changes the functions of the ductless glands.

The main route of exposure of mirex to the general population is through food, especially meat, fish and wild game, and intake is generally below established residue tolerances.

IARC has concluded that while there is inadequate evidence for the carcinogenicity of mirex in humans, there is sufficient evidence in experimental animals. IARC has classified mirex as a possible human carcinogen (Group 2B).

1.2.9. Hexachlorbenzene (HCB)

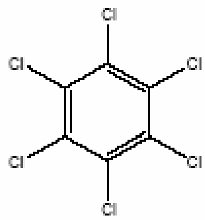
Chemical name: Hexachlorobenzene

Trade names: (partial list): Amaticin; AntiCarie; Bunt-cure; Bunt-no-more; Ceku C. B.; Co-op hexa; Granox; No bunt; Sanocide; Smut-go; Sniecotox.

CAS №: 118-74-1

Empirical formula: C_6Cl_6

Structural formula:



Appearance/Description: HCB is white monoclinic crystals or crystalline solid.

Hexachlorobenzene (HCB) is a chlorinated monocyclic aromatic compound in which the benzene ring is fully substituted by chlorine. HCB is a white crystalline solid (melting point 231°C) that is virtually insoluble in water, but is soluble in ether, benzene and chloroform (NTP, 1994). It has a high octanol/water partition coefficient, low vapour pressure and low flammability. HCB is found almost exclusively in the gas phase (as is predicted by its vapour pressure), with less than 5% associated with particles in all seasons except winter, where levels are still less than 10% particle-bound *(Cortes et al, 1998).*

Properties: Molecular weight: 284.78; State of aggregation: crystals; Colour: white; Melting point: 227 - 231°C; Boiling point: 323 - 326°C(sublimes); Relative density at 23°C: 2.044; Solubility in water - 40 µg/l at 20°C, practically insoluble, and in organic solvents – slightly soluble in ethanol, soluble in ethyl ether and highly soluble in benzene; Vapour pressure: 1.09 x 10^{-5} mm Hg at 20°C; log K_{OW}: 3.03-6.42.

Use: Historically, the major use of HCB has been as a fungicide, first introduced in 1945. It was used worldwide as an agricultural fungicide from early in the twentieth century, particularly as a seed dressing to prevent fungal diseases of grain and other field crops. HCB was used extensively as a fungicide to control Bunt in wheat, representing a major breakthrough for this disease. HCB was applied as a dust. It is a known impurity in several pesticide formulations, including pentachlorophenol and dicloram and may be present as an impurity in others.

Industrial uses, including as a chemical intermediate, represent a relatively small proportion of cumulative global production. The relatively small remaining production is probably mostly for non-pesticide use, particularly as a chemical intermediate.

Historically there were a number of potentially dispersive non-pesticide end-uses for HCB. It has been used as a wood preservative, for impregnating paper, as a means of controlling porosity in the manufacture of graphite electrodes for electrolytic processes, as a fluxing agent in the manufacture of aluminium and in the formulation of military pyrotechnic products and tracer bullets. (ATSDR, 1996).

HCB is a byproduct of the manufacture of industrial chemicals including carbon tetrachloride, perchlorethylene, trichloroethylene and pentachlorbenzene. Also, it is used in the manufacturing of fireworks, ammunitions and synthetic rubber. Presently, it is a by-product of a large number of chlorine containing substances, in particular low-content chlorbenzenes, solvents and some pesticides.

It is quite volatile and can be expected to partition into the atmosphere as a result. Hexachlorbenzene reaches the atmosphere along with the flue gases generated by waste incinerators and by metallurgical companies.

Persistence/Fate: HCB is highly insoluble in water, and is soluble in organic solvents.The estimated half-life of hexachlorbenzene in soils from aerobic and anaerobic degradation ranges between 2.7 and 22.9 years, and between 0.5 and 4.2 years in air. It has a comparatively high bioaccumulation potential and a long half-life in the biota.

It is very resistant to breakdown and has a high partition coefficient (K_{OW} = 3.03-6.42), and is known to bioconcentrate in the fat of living organisms as a result. HCB is ubiquitous in the environment, and has been measured in foods of all types.

Toxicity: The acute toxicity of HCB to laboratory animals is quite low, with acute oral LD_{50} values in the range of more than 2,6 mg/kg body mass in rabbits and 4,0 mg/kg in mice. The acute oral LD_{50} for rats is 3,5 mg/kg b.m. Porphyria, skin lesions, hyperexcitability and changes in weight, enzyme activities and morphology of the liver have been reported in association with subchronic toxicity of HCB. HCB has also been reported to stimulate the immune system in rats, and suppress the immune system of mice. HCB may also produce adverse effects on reproduction and reproductive tissue.

HCB is unlikely to cause direct toxicological effects in aquatic animals at or below saturation concentrations (approximately 5 µg/L) in water.LC_{50} of hexachlorobenzene varies between 50 and 200 µg/l for various fish species. Some insignificant liver problems have been observed in rats at daily exposure of 0, 25 mg/g b.m. It is a fact that hexachlorbenzene causes liver diseases in humans too (porphyria cutanea tarda).

IARC has concluded that while there is inadequate evidence for the carcinogenicity of HCB in humans, there is sufficient evidence in experimental animals. IARC has classified HCB as a possible human carcinogen (Group 2B).(*Regionally Based Assessment of Persistent Toxic Substances, Global Report 2003, Annex I. Basic chemical definitions. Stokholm POP Pesticieds, pp 192 – 195, UNEP Chemicals, Switzerland)*

2. INSTITUTIONAL AND REGULATORY FRAMEWORK FOR THE MANAGEMENT OF POP PESTICIDES IN THE REPUBLIC OF BULGARIA

2.1. INSTITUTIONAL RESPONSIBILITIES

The Ministry of Agriculture and Forests (MAF) sets forth the requirements for plant protection chemicals, the control of chemical and biological pollutants in plants and plant products, the regime of testing and registration of plant protection chemicals, and their control; monitoring of chemical pollutants in soil and in irrigation water.

The Minister of Agriculture and Forests keeps a Public Registry of Pesticides whose import and use are allowed, and issues permits for their marketing.

Marketing and use of plant protection chemicals are allowed with an order by the Minister of Agriculture and Forests upon proposal by the Council on Plant Protection Products

Pursuant to the Plant Protection Act, state control authorities control plant protection preparations on the market.

The Plant Protection Products Council makes proposals based on the reports from the evaluation of efficiency, toxicological and ecotoxicological impacts of the plant protection chemicals.

Permits for plant protection chemicals are issued by:

- **The National Plant Protection Service (NPPS)** assesses the data about the biological record of plant protection chemicals; data about residual pesticides in the making of plant products; data about the physical and chemical properties of plant protection chemicals related to their application; the methods for analysis of active substances, traces and other components of plant protection chemicals and their residue;
- **The Ministry of Health (MoH)** evaluates the toxicological data from the product documentation in order to determine the human-health risks.
- **The Ministry of Environment and Water (MoEW)** evaluates the data from the plant protection chemical documentation in order to determine the risk for plant and animal organisms, and for the environment

Ministry of Health (MH). The Minister of Healthcare or officials authorised by him/her exercise control over chemical substances and preparations, as follows: their classification, packaging and labelling; notified chemical substances; hazardous chemicals that are prohibited for trading or use; the production of goods which may contain hazardous chemicals, and whose use is restricted or prohibited; Pursuant to the Plant Protection Act, state control authorities control plant protection preparations on the market. The Minister of Healthcare carry out expert assessment of human-health risks.

The Ministry of Environment and Water (MOEW) controls the chemical substances and preparations from the perspective of environmental protection. The Minister of Environment and Water or officials authorised by him/her control the following: intermediate products for which limited research programmes are allowed; hazardous chemicals that are subject to import and export restrictions; the storage conditions specified by the manufacturer in the material safety data sheet. The Minister of Environment and Water conducts expert environmental risk assessment.

2.2. EXISTING POLICY

The management of POPs pesticides in R Bulgaria is implemented in conformity to the adopted and effective regulations, mechanisms and procedures. Their enforcement guarantees prevention to the maximum extends the negative impact of POPs pesticides on human health and the environment.

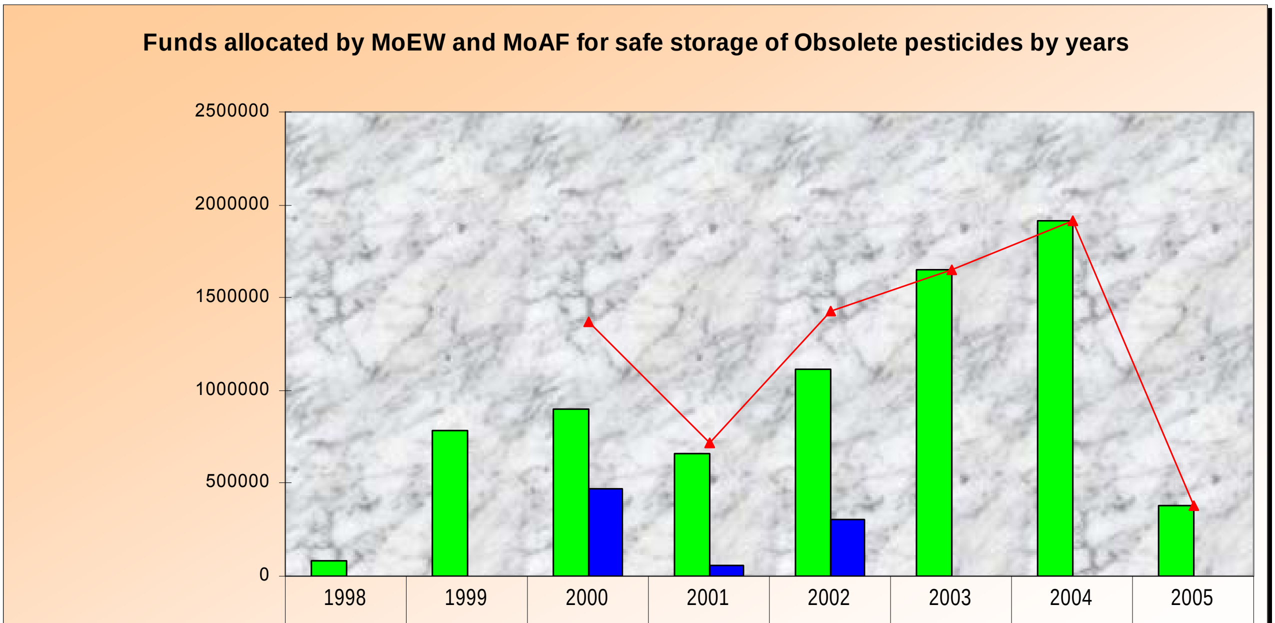
The storage facilities for obsolete and unusable pesticides are one of the sources for local environmental pollution and pose health risk

To solve the problem of safe storage of obsolete and unusable pesticides in Bulgaria, with Order RD-159/12.05.1998 of the Ministry of Environment and Water and Order RD-09-991/11.05.1998 of the Ministry of Agriculture and Forests it was created an Inter-Agency Expert Committee for the management of "prohibited, obsolete and unusable pesticides stockpiles".

The responsible institutions for POPs pesticides management are the Ministry of Agriculture and Forestry (MoAF), the Ministry of Environment and Water (MoEW), and their regional structures. The main regulatory framework applied are the Waste Management Act (promulgated in the SG 86/24.09.2003, amended SG 70/10.08.2004), Regulation 12 on the Requirements for the Sites for Waste Treatment Facilities, SG 152/22.12.1998 and Regulation 13 on the Conditions and Requirements for Construction and Operation of Waste Landfills, SG 152/22.12.1998 and the National Waste Management Programme.

The construction of centralized municipal warehouses and BB cubes conforming to the legislative requirements for safe disposal, liable storage of available obsolete pesticides stockpiles and cleaning up of emptied warehouses are activities that illustrate consistency in environmental protection policy and sustainable management of obsolete pesticides.

The funds allocated by the Enterpise for Management of Environmental Protection Activities (EMEPA) and National Plant Protection Service (NPPS) have been increasing constantly during the peirod 1998 - 2004 for safe storage of obsolete & unusable pesticides, repairing of warehouses, cleaning up of premises and sites, collection, re-packing, and shifting of chemicals from warehouses in the small urban centres to municipal and centralised warehouses, or disposal in BB cubes. The decreasing of old warehouses and the environmentally sound storage of obsolete pesticides has reduced the threat of environmental pollution and human health risk (*Fig.1)*.



	1998	1999	2000	2001	2002	2003	2004	2005
Funds allocated by MoEW	80799	780042	899000	657000	1115580	1651683	1915974	377236
Funds allocated by MoAF			468900	61000	308700			
Total			1367900	718000	1424280	1651683	1915974	377236

Figure 1 Funds allocated by MoEW and MoAF for safe storage of obsolete pesticides in BGN by years

During the period 2001- 2004, steady positive trends toward the management of warehouse for banned and obsolete pesticides and the surrounding areas are observed as a result of:

- restriction of existing and prevention of future pollution in cosequence of the effective enforcement of national legislation;
- restriction of negative impact of warehouses and obsolete pesticide stored there upon environmental quality and human health by re-packing, and shifting in centralised municipal warehouses and cleaning up of emptied premises (*photo 1 and 2*);

Photo 1 Unrepaired municipal warehouses for obsolete pesticides

- permanent disposal of obsolete pesticides in BB cubes with upto 300 years waste storage term (*photo 3*);
- maintaining and annual updating of Obsolete pesticides stockpiles data base, stored in warehouse and BB cubes on national (in EEA) and regional (in RIEWs) level;
- finacing of project proposals /programmes for improvement of storage facilities status and safe and environmentally sound storage of Obsolete pesticides;

Photo 2 Repaired storages for obsolete pesticides

Photo 3 BB cube and BB cubes site

- public awareness rising and providing public access to the available information.

To improve the storage conditions of obsolete and unusable pesticides, the following measures have been taken:

- In 2003 are concluded 18 contracts for repairing of warehouse in municipalities: Hisar, Brezovo, Saedinenie, Loznitza, Kardjali, Rodopi, Samoil, Belene, Haskovo, Dimitrovgrad, Svishtov, Lukovit, Antonovo, Kneja, Zavet, Kozloduy and Pleven. Obsolete pesticides encapsulated in BB cubes in municipalities: Aksakovo, Sliven, Avren, Krichim, Opaka, Suvorovo, Gorna Malina, Sungurlare, Samokov, Shumen, Veliki Preslav, Nikola Kozlevo, Vidin, Kaspichan and Novi Pazar.
- In 2004 are concluded 7 contracts for repairing of warehouse in municipalities: Saedinenie, Rakovski, Radnevo, Vetrino, Kaloyanovo, Maritza and Asenovgrad. In BB cubes obsolete pesticides are stored in the municipalities: Kula, Boichinovtzi, Pravetz, Varna, Nessebar, Kubrat, Karnobat, Chuprene, Sofia city, Opaka, Sredetz, Montana, Opan, Stara Zagora, Rakitovo, Shabla, Bansko, Kostenetz, Lom, Medkovetz, Isperih, Kavarna and Ruen;
- In 2005 are concluded 6 contracts for repairing of warehouse in municipalities: Lukovit, Radnevo, Hisar, Nikopol, Haskovo and district Stara Zagora. In BB cubes obsolete pesticides are stored in the municipalities: Gramada, Ardino, Stara Zagora, Kubrat, Berkovitza, Balchik, Novi Pazar, Dolna Mitropolia, Pleven, Boinitza, Karnobat, V.Preslav, Blagoevgrad and Polski Trambej.
- The total allocated funds by MoEW/EMEPA for safe storage of obsolete pesticides for the period 1998-2005 amount to 7, 5 million BGN, as only for 2004 they are almost 2 million BGN.

Nevertheless the annually constantly increased funds allocated by state budget for the management of POPs and obsolete pesticides , the Republic of Bulgaria can not cope alone with final solving of POPs and Obsolete pesticides stockpiles without international financial support, due to limited national funding available and the fact that Bulgaria is in Currency Board. To reduce the risk of POPs pesticides impacts on human health and the environment measures should be taken for safe storage and/or environmentally sound disposal abroad, due to absence of appropriate disposal facility in the country. For this purpose the Republic of Bulgaria needs to be supported by providing financial resources from GEF and other international, bilateral, regional and multilateral twinning programmes.

2.3. REGULATORY FRAMEWORK

Pesticides are registered in the Republic of Bulgaria in accordance with regulations and ordinances that are within the competencies of various ministries. The main legislation is presented in Table 1.

Table 1 Regulatory Framework related to the releasing onto the market, import, export, use, storage, disposal and destruction of pesticides

No	NATIONAL LEGISLATION
	CONVENTIONS
1	**Basel Convention** on the control of Transboundary Movement of Hazardous Wastes and their Disposal ratified by the National Assembly with a law, promulgated in the SG 8/26.01.1996, effective in Bulgaria since 16.05.1996.
2	**Rotterdam Convention** on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, ratified with a law adopted by the 38th National Assembly, promulgated in the State Gazette 55/07.07.2000, effective since 24.02.2004.
3	**Stockholm Convention** on Persistent Organic Pollutants, signed by the Republic of Bulgaria on May 23, 2001 in Stockholm, ratified by the National Assembly with a Law on 30.09.2004, SG 89/12.10.2004, in force from 20.03.2005.
	LAWS
1	**Environment Protection Act**, SG, 91/2002, amended SG 98/2002, supplemented SG 86/2003, amended SG 70/2004, effective 1.01.2005.
2	**Protection against the Harmful Impact of Chemical Substances, Preparations and Products Ac**t, SG 10/2000, amended and supplemented in SG 114/30.12.2032003.
3	**Plant Protection Act**, SG 91/1997, amended and supplemented in the SG 96/09.11.2002, supplemented in the SG 18/05.03.2004.
4	**Medicinal Plants Act** , SG 77/2000.
5	**Veterinary Medicine Act**, SG 42/05.05.1999, amended and supplemented in the SG 83/19.09.2003, supplemented in the SG 18/05.03.2004.
6	**Law of Health,** SG 70/2004, effective since 01.01.2005.
7	**Law on Health and Safe Work Conditions**, SG 124/23.12.1997, amended SG 114/2003, effective 31.01.2004, amended and supplemented SG 70/2004, effective 01.01.2005.
8	**Agricultural Land Protection Act,** SG 35/24.04.1996, supplemented and amended SG 28/23.03.2001, amended and supplemented SG 112/23.12.2003.
9	**Law on foods**, SG 90/1999, amended and supplemented SG 102/2003; amended SG 70/2004; amended and supplemented SG 87/01.11.2005, effective 01.05.2006.
10	**Law on Fodders,** SG 82/1999; amended and supplemented SG 101/2000; SG 58/2003; SG 69/23.08.2005; SG 87/01.11.2005, effective 01.01.2006.
11	**Law on the Protection of Soil against Pollution,** SG 67/27.07.1999, effective 28.01.2000, amended SG 113/28.12.1999.
12	**Water Act,** SG, 67/1999, effective 28.01.2000, amended and supplemented SG 91/25.09.2002, effective 1.01.2003, amended and supplemented SG 84/23.09.2003, amended SG 107/09.12.2003, SG 6/16.04.2004, amended SG 70/2004, effective 1.01.2005
13	**Waste Management Act**, SG 24.09.2003, amended SG 70/10.08.2004.
14	**Forests Act** , SG 125/29.12.1997, latest amendment SG 107/09.12.2003.
	REGULATIONS
1	**Regulation** on the Procedures and Manner of Import and Export of Hazardous Substances and Preparations in the Territory of the Republic of Bulgaria, adopted with Decree of the Council of Ministers 129/01.07. 2002, SG 66/ 09.07.2002, amended SG 63/20.07.2004.
2	**Regulation** on the Hazardous Chemical Substances, Preparations and Products that are Subject to Prohibitions or Limitations for Trading or Use, Decree of th eCouncil of Ministers 130/01.07. 2002, SG 69/17.07.2002, amended in the SG 62/16.07.2004.
3	**Regulation** on the Procedures and Manner of Classification, Packaging and Labelling of Existing and New Chemical Substances, Preparations and Products, Decree of the Council of Ministers 316/20.12.2002, SG 5/17.01.2003, amended in the SG 66/30.07.2004.
4	**Regulation No 8** on the Procedures and Conditions for Carrying out of Disinfection and Pest Control, SG 49/02.06.1992.
5	**Regulation No 17** on the Operations of the Disinfection, Insect and Pest Control Stations, SG 87/27.10.1992.

6	**Regulation No 35** on the Hygienic Requirements for Household Chemicals, SG 83/1995.
7	**Regulation** on the Procedures and Manner of Using of Waste-Water Treatment Sludge in Agriculture, SG 112/23.12.2004.
8	**Regulation 24** for maximum admissible concentration of unacceptable substances and products in fodders, SG 56/20.06.2003.
9	**List** of permitted for use in Republic of Bulgaria preparations for disinfection, disinfection and deratization, published annually by MoH.
10	**List** of permitted for marketing and use of plant protection preparations, registered fertilizers and soil improvement chemicals, published annually by MoAF
11	**List** of Substances Prohibited for Use in Plant Protection Chemicals, order RD-12-28 of the Ministry of Agriculture and Forests dated 21.05.2004; Order RD 09-457 of the MAF dated 13.07.2004; Order RD 590 of the MOEW dated 15.06.2004.
12	**Regulation** on the Permitting of Plant Protection Chemicals, SG 93/01.10. 2002, amended in the SG 114/30.12.2003.
13	**Organization rules** of National Plant Protection Service, promulgated in the SG 71/29.08.2000, amended and supplemented in the SG 39/25.04.2003.
14	**Regulation No 32/09.07.2001** on the Control of Plants and Plant Products, Fertilizers and Nutritional Media and on the Testing, Registration and Control of Plant Protection Chemicals, SG 67/31.07.2001, supplemented and amended SG 34/03.04.2002, amendment SG 40/19.04.2002 and SG 44/29.04.2002, last amendment SG 28/28.03.2003, last amendment SG 87/05.10.2004.
15	**Regulation** on the Terms and Procedures for Labelling of Plant Protection Chemicals, SG 54/13.06.2003.
16	**Regulation No 1/07.07.2000** on the Studying, Use and Protection of Ground Water, SG 57/14.07.2000.
17	**Regulation No 6** for the control measures on residues of veterinary medicinal products and environmental pollutants in life animals and foodstuffs of animal origin, SG 32/29.03.2002
18	**Regulation No 4** on the quality of waters supporting fish and shellfish organisms' life , SG 88/27.10.2000.
19	**Regulation No 9/16.03.2001** on the Quality of Water Meant for Drinking and Household Use, SG 30/21.05.2001.
20	**Regulation No 12/18.06.2002** on the Quality Requirements for Surface Water Meant for Drinking Water Supply, SG 63/28.06.2002.
21	**Rules** on the Implementation of the Veterinary Medicine Act, SG 55/07.07.2000, amended SG 4/12.01.2001.
22	**Procedural Rules** of the National Veterinary Service, SG 16/20.02.2001, amended in the SG 10/06.02.2004, supplemented in the SG 10/06.02.2004.
23	**Regulation No 3** on the Admissible Content of Harmful Substances in Soils, SG 36/08.05.1979, amended SG 54/1997, last amendment SG 39/16.04.2002.
24	**Regulation No 27** on the Import of Goods of Public Health, SG 75/1995, amended in the SG78/02.09.2003, supplemented in the SG 4/16.01.2004 and SG 25/24.02.2004.
25	**Regulation No 31** on the maximum admissible quantities of pollutants in food, SG 88/08.10.2004.
26	**Regulation No 31/29.12.2003** on the maximum admissible quantities of pesticide residue in food, SG 14/2004, effective 20.02.2004.
27	**Regulation No 13/30.12.2003** on the Protection of Workers from Risks Related to Occupational Exposure to Chemicals, SG 8/20.01.2004.
28	**Regulation No 3** on waste classification, SG 44/25.04.2004.
29	**Regulation No 12** on the Requirements for the Sites for Waste Treatment Facilities, SG 152/22.12.1998.
30	**Regulation No 13** on the Conditions and Requirements for Construction and Operation of Waste Landfills, SG 152/22.12.1998.
31	**Regulation** on the Principles, Inspection and Certification of Good Laboratory Practices, SG 74/24.08.2004.
32	**Regulation No 36** on the Terms and Procedures for Biological Testing, Registration, Use and Control of Fertilizers, Soil Improvement Preparations, Biologically Active Substances and Nutritional Substrata, SG 87/05.10.2004.
33	**Regulation No 44** on the Terms and Procedures for Marketing of Biocide Preparations, SG 113/28.12.2004.

2.4. STANDARDS FOR POP-PESTICIDES IN BULGARIA

The observation of existing national legislation in regard with POPs pesticides management guarantee the reducing of POPs negative impacts on environment and human health

Standards for POP pesticides in soils

- **Regulation No 3** on the Admissible Content of Harmful Substances in Soils, SG 36/08.05.1979, amended SG 54/1997, last amendment SG 39/16.04.2002.(*Table 2 and 3).*

Table 2 Half-Life of POP-Pesticides in Soil and Admissible Limit Values (ALV)

Pesticide	**Half-life in soil**	**ALV in the Republic of Bulgaria, mg/kg**	**ALV in Germany*, mg/kg**
Aldrin	5 years		0,05
Toxaphene	3 months – 12 years		
Chlordane	2 – 4 years		0,0043
DDT	10 – 15 years	1,5	
Dieldrin	5 years		0,05
Endrin	up to 12 years		0,029
Hexachlorobenzene	3 – 6 years	0,25	
Heptachlor	up to 2 years		0,0007

* *Plassche E., V.Bashkin, R.Guardans, K.Johnson and J.Vrubel (1998).Overview of critical limits for heavy metals and POPs. Proceedings of UN-ECE Convention on long-range transboudary air pollution, Unweltbundesamt, Germany, p.p. 1-25, p.p. 1-91.*

Table 3 Reference Values for Content of Chlororganic Pesticides in Soils

Reference Values for the Content of Prohibited Chloroorganic Pesticides in Soils (mg/kg dry soil)					
No.	**Name**	**1***	**2****	**3*****	**4******
1	Hexachlorobenzene	-	0.025	0.25	10
2	Dichlorodiphenykalogenoethane/DDX (sum) DDT,DDD,DDE	-	0.3	1.5	4
3	2,4' и 4,4" –Dichlorodiphenildichloroethylene/ -o,p' p,p'-DDE	-	0,1	0,5	-
4	2,4' и 4,4" –Dichlorodiphenil-2,2- dichloroethane/ -o,p' и p,p'-DDD	-	0.1	0.5	-
5	2,4' и 4,4" –Dichlorodiphenil-2,2,2-trichloroethane/ -o,p' и p,p'-DDT	-	0.1	0.5	-

* *Reference background levels*
** *Precautionary Levels*
*** *Admissible Limit Values*
**** *Intervention Value*

Limit Values for POPs Pesticides in Water

- **Regulation 12** on the Quality Requirements for Surface Water meant for Drinking Water Supply, SG 63/28.06.2002.*(Table 4).*

Table 4 ALVs for POP pesticides in drinking water and the mandatory levels in surface water

POP pesticide	**Drinking water ALV, (µg/l)***	**Mandatory values for surface water, (mg/l)****		
		Categories		
		A_1	A_2	A_3
Aldrin	0.03	0.001	0.0025	0.005
Toxaphene	0.1	0.001	0.0025	0.005
Chlordane	0.1	0.001	0.0025	0.005
DDT	0.03	0.001	0.0025	0.005
Dieldrin	0.1	0.001	0.0025	0.005
Endrin	0.1	0.001	0.0025	0.005
Hexachlorobenzene	0.03	0.001	0.0025	0.005

* *The ALVs for POP pesticides in drinking water will become effective as of 01.01.2007.*
** *The categories A1, A2 and A3 relate to different quantities of surface water based on physical, chemical and microbiological parameters.*

- **Regulation 4** on the quality of waters supporting fish and shellfish organisms' life , SG 88/27.10.2000 (Tables 43 & 44).

Annex № 1 to Article 2, i 1

Table 5 Quality values for surface fresh water inhabited by fish

<table>
<tr><th rowspan="2">Parameter</th><th colspan="2">Salmonid waters</th><th colspan="2">Cyprinid waters</th><th>Reference Methods of analysis</th><th>Minimum sampling and analysis frequency</th><th>Comments</th></tr>
<tr><td>Guide (G)</td><td>Mandatory (M)</td><td>(G)</td><td>(M)</td><td></td><td></td><td></td></tr>
<tr><td>DDT - total, (μg/l)</td><td colspan="4">10,0 (for para-para-DDT)
25,0 (for total DDT)</td><td>GC</td><td>Quarterly</td><td>-</td></tr>
<tr><td>Aldrin, (ng/l)</td><td colspan="4">10,0</td><td>GC</td><td>Quarterly</td><td>(1)</td></tr>
<tr><td>Hexachlorobenzene (μg/l) HCB</td><td colspan="4">0,03</td><td>GC</td><td>Quarterly</td><td>(1)</td></tr>
</table>

(1) Aldrin & HCB concentration in the sediment and fish should not show significant increase over time.

Annex № 1 to Article 2, i 2

Table 6 Quality values for surface fresh water inhabited by shellfish organisms

<table>
<tr><th>Parameter</th><th colspan="2">Guide (G)</th><th>Mandatory (M)</th><th>Reference Methods of analysis</th><th>Minimum sampling frequency</th></tr>
<tr><td>Chloroorganic compounds</td><td colspan="2">The concentration of each substance in shellfish flesh must be so limited in accordance with Article 1 that it contributes to the high quality of shellfish products (Regulation on the limit values for concentrations of harmful /dangerous/substances in products for human consumption based on Article5 of the Foods Act)</td><td>The concentration of each substance in the shellfish water or in shellfish flesh must not reach or exceed a level which has harmful effects on the shellfish and larvae.</td><td>GC</td><td>Six-monthly</td></tr>
<tr><td>DDT - total (μg/l)</td><td colspan="2">10,0 for para-para-DDT
25,0 total DDT for estuary, internal and territorial sea waters</td><td>-</td><td>GC</td><td>Quarterly</td></tr>
<tr><td>Dieldrine (ng/l)

Endrine (ng/l)</td><td>10,0

5,0</td><td>for estuary internal and territorial sea waters</td><td>-</td><td>GC</td><td>Quarterly</td></tr>
</table>

- **Regulation No 1** on the Studying, Use and Protection of Ground Water,SG 57/14.07.2000

Table 7 Recommended Parameters for Protection of Ground Water against Pollution with POP Pesticides

Pesticide	Ecological threshold, (μg/l)	Pollution threshold, (μg/l)
Aldrin	0.01	0.1
Dieldrin	0.01	0.1
Endrin	0.01	0.1
DDT/DDD/DDE	0.01	0.1
Chlordane	0.01	0.2
Heptachlor	0.01	0.2
Hexachlorobenzene	0.1	5

Maximum admissible concentration of POPs pesticides in fodders

- **Regulation 24** for maximum admissible concentration of unacceptable substances and products in fodders, SG 56/20.06.2003 *(Table 46)*.

Annex to Article 2, paragraph 2

Table 8 Maximum admissible concentration of POPs pesticides in fodders

№	Unacceptable Substances or Product	FODDERS	Maximum admissible concentration of unacceptable substances and products , expressed in mg/kg (ppm), referred to fodders with moisture 12 %
17.	**Aldrin**	All fodders with exception of fats	0,01
18.	**Dieldrin** (separately or in combination with aldrin, expressed as dieldrin)	All fodders with exception of fats	0,2
19.	**Toxaphene** (camphechlor)	All fodders	0,1
20.	**Chlordane** (sum of cis- and trans-isomers of oxychlordane, expressed as chlordane)	All fodders with exception of : - fats	0,02 0,05
21.	**ДДТ** (sum of DDT-, TDE- and DDE-isomers, expressed as DDT)	All fodders with exception of : - fats	0,05 0,5
23.	**Endrine** (sum of endrin and delta-keti-endrine, expresses as endrine)	All fodders with exception of : - fats	0,01 0,05
24	**Heptachlor** (sum of heptachlor and heptachloroxide, expressed as heptachlor)	All fodders with exception of : - fats	0,01 0,2
25.	**Hexachlorobenzene (HCB)**	All fodders with exception of : - fats	0,01 0,2

Standards for POP pesticides in food

- **Regulation No 6** for the control measures on residues of veterinary medicinal products and environmental pollutants in life animals and foodstuffs of animal origin, SG 32/29.03.2002

Annex № 1 to Article 2

Residues groups, subject to control

Group B - veterinary medicinal products and environmental pollutants

3. Other substances and environmental pollutants:

a) Chloroorganic compounds, including PCBs;

Table 9 Groups of substances to be detected by animal species and products of animal origin

GROUP OF SUBSTANCES	ANIMAL SPECIES AND FOODSTUFFS OF ANIMAL ORIGIN						
	Bovine, Ovine, Caprine, Swine & Horse meat	Poultry meat	Fishery and Aquaculture products	Row Milk	Eggs	Rabbit meat, meat from wild animals* and farmed game	Bee Honey
B (3) a : Chloroorganic compounds, including PCBs	X	X	X	X	X	X	X

(*) For the wild animals only the chemical elements are subject to control.

- **Regulation 31/29.12.2003** on the maximum admissible quantities of pesticide residue in food, SG 14/2004, effective 20.02.2004 *(Table 48)*.

Table 10 Daily admissible human doses /DDD/ in Bulgaria and maximum admissible residual concentrations /MARC/ of pesticides in food

No.	Pesticide	DDD* mg/day/kg b.m.*	MARC mg//kg	Food type
1	**Aldrin /separately or with dieldrin/**	0.0001	0.2 0.02 0.01 0.006	Meat and meat products; Eggs and egg products; Cereal crops, vegetables; Milk and dairy products
2	**Dieldrin /separately or with aldrin/**	0.0001	0.2 0.02 0.01 0.006	Meat and meat products Eggs and egg products Cereal crops, vegetables Milk and dairy products
3	**DDT and metabolites**	0.01	1.0 0.05 0.04	Meat and meat products Eggs and egg products, vegetables and oil yielding and cereal crops, nuts and seed fruits Milk and dairy products
4	**Endrin**	0.0002	0.05 0.01 0.0008 0.005	Meat and meat products Cereal crops, fruits, and vegetables Milk and dairy products Eggs and egg products
5	**Heptachlor**	0.0001	0.2 0.01 0.02 0.004	Meat and meat products Cereal, citrus, and nut-bearing crops, fruits and vegetables Eggs and egg products Milk and dairy products
6	**Hexachlorobenzene**	0.0006	0,01 0,01 0,02 0.2	Milk and dairy products Cereal crops, tea, dry and oil yielding plants fruits, vegetables Eggs and egg products Meat and meat products
7	**Toxaphene /camphor chloriner/**		0.1	Citrus crops, nuts and fruits
8	**Chlordane**	0.0005	0.05 0.01 0.02 0.006	Meat and meat products Cereal crops, fruits, and vegetables Eggs and egg products Milk and dairy products

* *b.m - body mass*

* IPCS, WHO/PCS/02.3, Inventory of IPCS and other WHO pesticide evaluations and summary of toxicological evaluations performed by the Joint Meeting on Pesticide Residues, 2002.

2.4. LABORATORY INFRASTRUCTURE

A number of laboratories exist in the Republic of Bulgaria that could become involved in the management of chemical substances, including persistent chlororganic pesticides, at various stages of their "lifecycle". These laboratories are capable of analysing chemical quality during the manufacturing process, analysing and controlling of waste products, identifying unknown substances, studying of possible harmful effects, etc. Some of these laboratories are accredited according to Bulgaria's current legislation.

Decree 270/30.12.1999 of the Council of Ministers establishes an Executive Agency "Bulgarian Accreditation Service" (EABAS) at the Ministry of Economy. During its four years of existence, the EABAS has established itself as a national accrediting authority, and has established a national accrediting system in accordance with the European practices, and was adopted in 2001 as a full member of the European Accreditation Agency.

The EABAS has accreditated under the Bulgarian State Standard EN ISO/IEC 17025:2001, BSS EN 45000 and ISO/IEC 17000 a number of laboratories working in the field of persistent chlororganic pesticides (Table 11).

Table 11 Accredited Laboratories for Analysis of POPs

№	Name/ Location	Personnel	Laboratory equipment	Analysis of:	POPs
1	Laboratory for analysis of organic pollutants, Executive Agency Environmental Protection, Ministry of Environment and Water, Sofia	3	1 GC/MS system "Hewlett Packard 5890/5972", 1 GC/MS system "Termo Finnigan DSQ" 2 HPLC systems with DAD, FLD, UV, 1 GC/FID/ECD system Agilent	Water, sediments, soil, oils	POPs pesticides, PCB and HCB
2	Regional Laboratory, EA Environmental Protection, Ministry of Environment and Water, Russe	2	1 GC/MS system "Hewlett Packard", 1 LC system "Hewlett Packard"	Water, sediments, soil	POPs pesticides, PCB and HCB
3	Regional Laboratory, EA Environmental Protection, Ministry of Environment and Water, Plovdiv	2	1 GC/MS system "Termo Finnigan DSQ", 1 GC/MS system "Hewlett Packard", 1 GC/FID system "Perkin Elmer"	Water, sediments, soil	POPs pesticides, PCB and HCB
4	Regional Laboratory, EA Environmental Protection, Ministry of Environment and Water, Varna	1	1 GC/FID system "Perkin Elmer", 1 GC/MS system Agilent	Water, sediments, soil, oils	POPs pesticides, PCB and HCB
5	Regional Laboratory, EA Environmental Protection, Ministry of Environment and Water, Burgas	1	1 GC/MS system "Hewlett Packard", 1 GC/MS system Agilent	Water, sediments, soil	POPs pesticides, PCB and HCB
6	Chemical studies, Inspectorate of Hygiene and Epidemiology, Sofia	5	1 GC system "Perkin Elmer", 1 UV-VIS Specter Photometer "Perkin Elmer", Thin-layer Chromatography	food, water	POPs pesticides
7	Toxicology, Inspectorate of Hygiene and Epidemiology, Sofia	3	V-VIS Specter Photometer "Lomo", Thin-layer Chromatography kit	Food	POPs pesticides
8	Laboratory Studies, Inspectorate of Hygiene and Epidemiology, Razgrad	3	VIS Specter Photometer	Food	POPs pesticides
9	Toxicology of food, Inspectorate of Hygiene and Epidemiology, Varna	3	1 GC system "Perkin Elmer", Thin-layer Chromatography kit	Food, water	POPs pesticides
10	Laboratory Studies, Inspectorate of Hygiene and Epidemiology, Burgas	5	1 GC system "Perkin Elmer", Thin-layer Chromatography kit	Food, water	POPs pesticides
11	Laboratory Studies, Inspectorate of Hygiene and Epidemiology, Pleven	5	1 GC system "Perkin Elmer", Thin-layer Chromatography kit	Food, water	POPs pesticides

12	Laboratory Studies, Inspectorate of Hygiene and Epidemiology, Plovdiv	5	1 GC system "Perkin Elmer", Thin-layer Chromatography kit	Food, water	POPs pesticides
13	Laboratory Studies, Inspectorate of Hygiene and Epidemiology, Stara Zagora	4	Thin-layer Chromatography kit	Food, water	POPs pesticides
14	Central Laboratory for Monitoring of Pesticides, Nitrates, and Heavy Metals. National Plant Protection Service, Sofia	10	3 GC systems 2 GC/MS system 1 LC system, 2 HPLC, 1 UV-VIS Specter Photometer	Plant products, soil, sediments	POPs pesticides, PCB and HCB
14	Chemistry of Food, National Centre for Hygiene, Medical Ecology, and Nutrition, Sofia	24	2 GC systems, 1 HPLC, 1 UV-VIS Specter Photometer	Food	POPs pesticides, PCB and HCB
15	Environmental Chemistry, National Centre for Hygiene, Medical Ecology, and Nutrition, Sofia	35	2 GC systems, 1 GC/MS system 1 HPLC system, IR Specter Photometer, UV-VIS Specter Photometer	Soil, water, air	POPs pesticides, PCB and HCB

Note: The EABAS has accredited under the Bulgarian State Standard EN ISO/IEC 17025:2001, BSS EN 45000 and ISO/IEC 17000 a number of laboratories working in the field of persistent organic pollutants.

3. METHODS, APPROACH AND OBJECTIVE OF THE INVENTORY

3.1. Inventory Methods

The objective of the inventory is to identify the available POP pesticide quantities that are subject to the Stockholm Convention, including prohibited and obsolete plant protection chemicals (PPC) in the Republic of Bulgaria.

The inventory of pesticides subject to the Stockholm Convention was based on:

- inventories of prohibited and obsolete plant protection chemicals, conducted by the Interagency Commission of Experts on Management of Prohibited and Obsolete Plant Protection Chemicals, the Interagency Council on Disposal of Past Pesticide Pollution, the Council on Plant Protection Chemicals, the Ministry of Environment and Water, the Civil Protection State Agency, the regional permanent commissions for protection of the population during calamities, emergencies and accidents;
- data from the National Institute of Statistics (NIS);
- available data (archives) about import, export and use of plant protection chemicals (PPC) in the Republic of Bulgaria since 1945;
- auditing the condition of storage facilities and of the prohibited and obsolete plant protection chemicals stored there;
- implemented projects for safe storage of PPC;

The information about quantities and location of the PPC that are the subject of this study, the number of storage facilities by areas, the number of BB Cubes and the quantities of PPC they contain, as well as other data, were collected using:

- ✓ available data (archives) about imports and use of POPs pesticides;
- ✓ data submitted by the Executive Environmental Protection Agency (EEPA) at the MOEW;
- ✓ data submitted by the Regional Inspectorates of Environment and Water (RIEW) at the MOEW;
- ✓ data submitted by the Civil Protection State Agency;
- ✓ data submitted by the National Plant Protection Service (NPPS) at the MAF;
- ✓ data submitted by the Inter-Agency Committee on Disposal of Past Pesticide Pollution;
- ✓ data from the Ministry of Environment and Water on other POPs pesticide related projects;
- ✓ MOEW published State of the Environment reports for previous years;
- ✓ POPs pesticide data available on-line.

The analysis of the 2001 -2004 data was conducted following agreement with the interested institutions by grouping of information by area, quantity, number of storage facilities, and number of BB cubes.

3.2. Subject of the Iventory

The subject of inventory is municipal and centralized storage facilities and the BB cubes storing prohibited and obsolete pesticides.

This inventory covers the period 2001 – 2003 but also data from previous inventories are commented.

The storage facilities are divided into two groups:

- Centralised – repaired or new buildings with air vents, metal doors, shelves with arranged packages of plant protection chemicals, reliable control and responsible storage of the products.
- Storage facilities in operation since early in the 60s. Despite the maintenance, these can not guarantee full protection of environmental media and of human health.

Photo 4 Unrepaired storage facility for obsolete or expired pesticides

Financial assistance by the MOEW and the MAF has allowed for several years to encapsulate certain quantities of prohibited and obsolete plant protection chemicals into the so-called BB cubes. The BB cubes represent reinforced steel containers 195x195x195 cm in size, hermetically sealed, with an effective storage capacity of 5 m^3. The prohibited and obsolete plant protection chemicals are pre-mixed with suitable absorbents guaranteeing environmentally sound storage of the encapsulated pesticides. The BB cube container structure allows welding and hermetic (water tight) sealing of the lid to the main body once the internal volume is filled with waste. This allows for reliable and safe isolation of the waste from the environment and the population – disposal using operation D12 of the Basel Convention. The BB cube containers are designed and rated as follows:

- operation period for transportat and handling – up to 50 years.
- waste storage period – up to 300 years.

The BB cubes are radioactive-waste storage and transport containers licensed by the Committee for Utilization of Nuclear Energy for Peaceful Purposes at the Council of Ministers, and conform to Standard OH 01 85755-92, patented, protected as industrial trade mark sample allowed for transport of hazardous waste by the MOEW. The BB cubes are kept outdoors on specialised depot sites.

Photo 5 BB cube manufactured by BalBok Engineering

Photo 6 BB cube site

All obsolete pesticides in the Republic of Bulgaria are subject to control by the institutions responsible for them: the Ministry of Agriculture and Forests and the plant protection services; the Ministry of Environment and Water and the Regional Inspectorates of Environment and Water; the Civil Protection State Agency and its branches in the administrative areas; municipal administrations.

An interagency commission of expert for th emanagement of prohibited and obsolete plant protection chemicals was established in 1998 with representatives of all interested institutions.

The obsolete pesticide disposal technology using BB cube® containers comprises the following steps:

Photo 7 Obsolete and unusable PPC, some of which may be mixed with POPs pesticides

Step One

Determining the quantities of unusable PPC according to the technology.

Photo 8 Obsolete pesticides of “unknown” origin, some of which may be mixed with POPs

Step Two

Re-packing of solid obsolete pesticides

Photo 9 Repacking of solid obsolete pesticides

Step Three
Solidification of liquid obsolete pesticides

Photo 10 Solidification of liquid obsolete pesticides

Step Four
Filling of BB cube® containers.

Photo 11 Filling of BB cube® containers

Step Five
Placing of filled BB cubes® in a suitable site meeting the requirements.

Photo 12 Placing of filled BB cubes in a suitable site

Step Six

Cleaning of emptied warehouses and polluted surrounding areas, using the clean-up methodology developed by BalBok Engineering.

Photo 13 Cleaning of emptied warehouses and polluted surrounding areas, using the clean-up methodology

Photo 14 Repaired storage facility for obsolete or expired pesticides

Photo 15 Guarded state storage facilities for obsolete pesticides

4. INVENTORY OF PROHIBITED AND OBSOLETE PESTICIDES IN BULGARIA

The group of persistent organic pollutants that are subject to the Stockholm Convention includes the following pesticides: **aldrin, dieldrin, endrin, mirex, toxaphene, hexachlorbenzene, heptachlor, chlordane and DDT.**

4.1. MANUFACTURING, USE, IMPORT AND EXPORT

4.1.1. Manufacturing

Chloroorganic persistent pesticides subject to the Stockholm Convention have never been manufactured in the Republic of Bulgaria.

4.1.2. Use

POPs pesticides like **Aldrin, Dieldrin, Endrin, Chlordane, DDT, Heptachlor, Chlordecone, Mirex, Toxaphene** have been produced in large quantities and were extensively used as insecticides for crop and wood protection and for malaria prevention.

Large quantities of these POPs have been manufactured and used worldwide during the middle of the past century (*Table 12)*.

Table 12 Use of POPs pesticides

Chemical	POPs pesticides use	
Aldrin **CAS № 309-00-2**	Local ectoparasiticide Insecticide	**Aldrin**: In the 1950s, aldrin was used primarily to treat termites and beetles on a variety of crops, such as corn, potatoes, and cotton, as well as to guard wood structures. As a pesticide to treat soil insects, it has been frequently used to kill rice-water weevils, corn rootworms, wireworms, and grasshoppers.
Chlordane **CAS № 57-74-9**	Local ectoparasiticide Insecticide Termiticide Termiticide in buildings and dams Termiticide in roads Additive in plywood adhesives	**Chlordane**: Since 1945, chlordane has been used as an insecticide. Its major function was to control termites and insects birthed from the soil. Farmers used chlordane for many years as a pesticide on crops, such corn, small grains, maize, fruits, nuts, cotton, sugarcane, etc. Chlordane also is used in livestock, home gardening, and control of fire ants near power transformers. **Not used in Bulgaria.**
Dieldrin **CAS № 60-57-1**	In agricultural operations Insecticide	**Dieldrin**: It was introduced on the market in 1948 after Second World War. This pesticide has been used on cotton, corn, potatoes, and other crops. It also can be used for vector control, wood treatment, control of termites and textile pests, and mothproofing of wool products.

Endrin **CAS № 72-20-8**	In agricultural operations Insecticide	**Endrin**: This pesticide has been used in agriculture on crops, such as cotton, sugarcane, grains, apples, and ornamentals. Since its introduction in 1951, Endrin has been used as a rodenticide and insecticides for controlling mice, voles, and insects that invade orchards and fields. Its use has been banned or restricted in many countries since the 1980s.
Heptachlor **CAS № 76-44-8**	Termiticide Termiticide in structures of houses Termiticide (subterranean) Wood treatment In use in underground cable boxes	**Heptachlor**: The main function of heptachlor is to treat termites and soil insects. Other uses include control of malaria, cotton insects, and crop pests.
Hexacholobenzene **CAS № 118-74-1**	Intermediate Solvent in pesticide Closed system site limited intermediate Fungicide & microbiocide	**HCB**: When introduced in 1945, it was used as a fungicide for the treatment of the seeds of onions, wheat and sorghum. The chemical also was used as a manufacturing intermediate and solvent in the production of synthetic rubber, PVC plastics, dyes, etc. While these uses have been banned or severely restricted in many countries, HCB is still produced as a byproduct in the manufacturing of industrial chemicals and the burning of municipal waste. **Not used in Bulgaria.**
Mirex **CAS № 2385-85-5**	Termiticide	**Mirex**: The application of Mirex started in the middle of 50-ies of XX century as an insecticide. Dominant uses were for killing fire ants, leaf cutter ants, harvester termites, Western harvester ants, and mealy bug of pineapple. Mirex also has been widely used as a fire retardant in rubber, paper, plastics, and paint. **Not used in Bulgaria.**
Toxaphene **CAS № 8001-35-2**	Insecticide	**Toxaphene**: After its introduction to the market in 1949, toxaphene was used as insecticide. Toxaphene has been used mainly to kill insects on cotton, fruits, nuts, cereal grain, and vegetables; control ticks and mites on livestock and poultry. Toxaphene is now banned or severely restricted in many countries.
DDT (1,1,1-trichloro-2,2-bis(4-chorophenyl) ethane **CAS № 50-29-3**	Insecticide **<u>Acceptable purpose:</u>** Disease vector control in accordance with Part II of Annex B **<u>Specific exemption:</u>** Production of dicofol Intermediate	**DDT**- Perhaps one of the most infamous of the POPs, DDT was hailed by society as an effective insecticide in the 1930s. It was used to control vector-borne diseases, such as malaria and typhus, and some countries are still dependent upon it. DDT also has been effective on a variety of crops, especially cotton, but is widely restricted because of its adverse health and environmental effects.

The use of POP pesticides in R Bulgaria has been largest in the 60-s. They had been used on more than 20 million decares of agricultural land, forests, etc. during this period. The negative effects for humans and for the environment evidenced throughout the world, and the prohibitive and restrictive measures, have reduced and almost discontinued the use of POP pesticides in Bulgaria. Irrational planning and overstocking nationwide during the 60-s have resulted in overstocking of pesticides that are now obsolete, and controlled by the authorities of the Ministry of Internal Affairs.

Two stages are characteristic for the use of POP pesticides in Bulgaria:

- 1950-1970 – a period of intensive supply and use of chlororganic POP pesticides and subsequent ban for most of them in 1969, except for toxaphene, which was banned in 1985 and heptachlor in 1991.
- 1970 – 1990 – unofficial data show that an insignificant amount of the pesticides used comprises POPs.

The use of POPs pesticides in R Bulgaria is shown on *Table 13.*

Table 13 Use of POPs pesticides in R Bulgaria

POPs pesticide	POPs pesticides use	
Aldrin CAS № 309-00-2	Insecticide	**Aldrin** had been used early in the 60-s of past century primarily to control soil pests (fleas, beetles, weevils and grasshoppers) on a variety of crops, such as corn, potatoes and cotton in annual quantities of 150-200 tons. **Banned for import & use in 1969.**
Chlordane CAS № 57-74-9		**Not imported & used in Bulgaria.**
Dieldrin CAS № 60-57-1	Insecticide	**Dieldrin** had been used early in the 60-s of past century to control soil insects(fleas, beetles, etc.) on cotton, corn, potatoes, and other crops in annual quantities of approx. 100 tons. **Banned for import & use in 1969.**
Endrin CAS № 72-20-8	Insecticide	**Endrin** had been used early in the 60-s of past century to control various agricultural pests on cotton, rice, apples, maize and other crops, and as a rodenticide in annual quantities of approx.100 tons. **Banned for import & use in 1969.**
Heptachlor CAS № 76-44-8	Insecticide	**Heptachlor** had been used till the 90-s of past century as cotton-infesting insects and to control crop pests. in annual quantities of approx.100 tons. During 1988-1990 it was included in the list of Ministry of Agriculture and Forests`s for plant protection preparations (containing up to 10% technical product), allowed for agricultural use for treatment of seeds of maize, sunflower, wheat and sugar beet. **Banned for import & use in 1991.**
Hexacholobenzene CAS № 118-74-1		**Not imported & used in Bulgaria.**
Mirex CAS № 2385-85-5		**Not imported & used in Bulgaria.**

Toxaphene **CAS № 8001-35-2**	Insecticide	**Toxaphene** had been used till the 80-s of past century mainly to kill insects – ticks on cotton, fruits, cereal grain, and vegetables in annual quantities of 100-150 tons. **Banned for import & use in 1985.**
DDT (1,1,1-trichloro-2,2-bis(4-chorophenyl) ethane **CAS № 50-29-3**	Insecticide Biocide (dicofol)	**DDT** had been used in the 50-s of past century in various preparations (technical product content in the range of 5 ÷ 20%, of 20%, most usually 5,5%). Later DDT was widely applied in agriculture to control various pests on cotton. Its use was restricted in the 60-s. **DDT was completely banned for import and use in 1969.***

* *The are no official statistics data in R Bulgaria for the used quantities of DDT by years, including those after its official ban.*

In the WHO report *"Health risks of persistent organic pollutants from long-range transboundary air pollution" (2003)* are given data for Usage of DDT in former socialist Central and Eastern European Countries (tonnes), including Bulgaria for the period 1970-1990 (*Table 14).*

Table 14 Usage of DDT in former socialist Central & Eastern European Countries (t) (Pacyna, 1999)*

Country	1970	1975	1980	1985	1990
Albania	90.00	12.00	6.66	3.00	0
Belarus	872.25	95.22	67.19	29.07	12.21
Bulgaria	**600.00**	**63.00**	**59.20**	**27.70**	**0**
Czechoslovakia	270.00	33.30	28.00	13.00	
Estonia	106.08	11.58	8.17	3.54	1.49
Eastern Germany	1 500.00	33.99	2.78	4.03	
Hungary	20.60	0.60	0	0	0
Latvia	306.47	33.46	23.61	10.22	4.29
Lithuania	365.40	39.89	28.15	12.18	5.12
Poland	2 528.00	16.70	8.78	0	0
Moldova	695.44	75.92	53.57	23.18	9.74
Romania	196.00	26.20	12.00	0	0
Russian Federation	6 000.00	654.99	462.22	200.00	83.99
Ukraine	5 150.97	562.31	396.81	171.70	72.11
Yugoslavia	3 150.60	311.40	80.00	50.00	31.56
TOTAL CEE countries	**21851.81**	**1970.56**	**1237.14**	**547.62**	**220.51**

4.1.3. Import

POPs pesticides have been imported in R Bulgaria witjin the period 1960 ÷1990, most intensively in early 60-ies of past century. The first appearance of evidence of their harmful impacts has served as the cause for their banning for import and agricultural use (*Table 15).*

* WHO-Europe,"Health risks of persistent organic pollutants from long-range transboundary air pollution", World Health Organization 2003, p.41.

Table 15 Data about imports, registration and year of ban for POP pesticides

POPs pesticides	Import/ registration period	Imported quantities, t/y	Year of ban	Remark
Aldrin	1960-1969	135 - 220	1969	
Dieldrin	1960-1969	100	1969	
Endrin	1960-1969	100	1969	
Mirex	**Not imported**			
Toxaphene	1960-1985	100 - 150	1985	
Hexachlorobenzene	**Not imported**			
Heptachlor	1960-1990	100	1991	
Chlordane	**Not imported**			
DDT	1950-1969		1969	**Specific exemption** Import of dicofol containing less than 78% of p,p'-dicofol or less than 1 g/kg DDT and DDT derivates is permitted under PIC procedure.

After the ban of POPs pesticides for import and use, the country took measures for their replacement in agriculture with registered in Bulgaria insecticides, suitable for application in any specific case. (*Table 16).*

Table 16 Alternatives for replacement of POPs in Bulgaria

Pesticide	Alternatives
Aldrin, Dieldrin, Endrin, Toxaphene, Heptachlor	Organophosphates, synthetic pyrethroids, phosphides, benzimidazoles, carbamates, benzoylphenylureates, etc.
DDT	Organophosphates, synthetic pyrethroids, etc.
Chlordane, Mirex, HCB	Not imported & used in Bulgaria.

4.1.4. Export

Chlororganic POPs pesticides have never been exported.

4.2. POPs PESTICIDES STOCKPILES

Since 1990 the banned POPs pesticides issues went deeper due to reduced control over the stored stockpiles in the facilities of former cooperative farms, agro-industrial complexes, etc. and had created prerequisites for carelessness, improper storing, illegal use, increased risks for human health and pollution of the environment.

The documentary – based inventories of prohibited and obsolete plant protection preparations carried out in 1993 and in 1995 (without on-site visits and analyses) by the National Plant Protection, Quarantine and Agrochemistry Service (NPPQAS) and in 1996 by Ministry of

Agriculture and Forestry showed that in the country approx. 47267 kg of obsolete POPs pesticides stockpiles exist in 1995, the greatest amount being DDT (29234 kg), followed by heptachlor (11156 kg). Probably the available stocks of POPs pesticides in Bulgaria are bigger, due to lack of data, robbering the abandoned old storage places and insufficient control, impossibility for identification because of damaged packages and missing labels. The Invetory in 1996 found out the availability of 77215 kg POPs pesticides with gratest amount being Toxaphene (34954 kg) (*Table 17).*

Table 17 Available POPs pesticides stockpiles in Bulgaria in 1995 & 1996

POPs pesticides	Declared POPs pesticides by documentary inventory in 1995, kg	Declared POPs pesticides by documentary inventory in 1996, kg
Aldrin	4926	1563
Dieldrin	1726	528
Endrin	20	200
Toxaphene	205	34954
Heptachlor	11156	11156
DDT	29234	28814
POPs total	**47267**	**77215**

The inventory done by Ministry of agriculture and forestry in 2000 identified 954 storage places with about 5820 t obsolete pesticides stocks in the country. More than 1/3 of them were in bad condition. It is important to notice that 60% (3492 t) of the stock could not be identified due to lack of labels or damaged packages. The major part (89%) of the storehouses was located in rural regions.

- **The inventory found out availability of obsolete POPs pesticides and mixtures, containing or contaminated with POPs, but the amounts differed from those declared in 1995 and 1996.**

The total amount of identified POPs pesticides was about 58 t stored in 99 sites on the territory of 22 districts. A part of them- 22.25 t was identified as POPs and the balance of 35.6 t were mixture of pesticides consisting of or contaminated with POPs stored in 38 sites, on the territory of 10 districts. (*Table 18).*

Table 18 POPs pesticides stockpiles in Bulgaria in 2000*

POPs pesticides	Number of Storehouses	Districts	Total quantity, kg
Aldrin	8	8	1395
Dieldrin	7	6	1595
DDT	22	11	10749
Endrin	3	2	204
Heptachlor	57	16	7592
Toxaphene	2	1	720
POPs total	**99**	**44**	**22255**
Mixtures	38	10	35591
Total amount			**57846**

* *Inventory, carried out by Ministry of Agriculture and forestry*

The greatest amount were the mixtures of POPs pesticides with unknown composition, followed up by DDT and heptachlor.These figures were not considered as definitive due to absence of data on the quantity of banned OC pesticides stored on the territory of 6 districts (Sofia & Sofia district, Burgas, V.Tarnovo, Targovishte & Sliven) and damaged packages and missing labels.

In August 2000, samples were taken from 8 warehouses for prohibited or obsolete pesticides in 4 regions of Bulgaria of approximately 41,2 tons of POP pesticides with assumed content of DDT, aldrin, dieldrin, toxaphene and endrin. The sample analysis has proven presence of DDT, aldrin, and dieldrin in approx. 28 t of POP pesticides. The identified POP pesticides have been re-packed in new drums, labelled in compliance with the European requirements, and transported to a base site. Under the project "Destruction of Risk Pesticides from Bulgaria in the Netherlands", 27680 kg of POP pesticides such as DDT, aldrin and dieldrin from Bulgaria's regions Sofia, Plovdiv, Shumen and Burgas have been exported to Netherlands, and destroyed in an incinerator in Rotterdam.

Table 19 summarizes the date for available the POP pesticide stocks existing in Bulgaria by 1995 , 1996 and 2000 (according to the document-based inventory, without on-site analyses and visits), the POP pesticides exported in July 2000 for disposal abroad and the probable POPs pesticides stockpiles existing by 2003.

Table 19 Assumed POPs stocks and mixtures, consisting of or contaminated with POPs at end of 2003

POPs pesticides and mixtures	Documentary declared POPs pesticides in 1995[2]	POPs Pesticides Inventory 1996[3]	Documentary declared POPs pesticides in 2000[4]	Assumed total POPs pesticides stockpiles in 2000,	Exported for disposal in Hollandi, July 2000	Assumed stocks of POPs pesticides and mixtures, after export to Holland, December 2003	
	kg	kg	kg	kg	kg	kg	
ALDRIN	4926	1563	1395	4926	3531	1395	**22 255÷25 819**
DIELDRIN	1726	528	1595	1726	131	1595	
ENDRIN	20	200	204	204	-	204	
TOXAPHENE	205	34954	720	720	-	720	
HEPTACHLOR	11156	11156	7592	11156	-	7592	
DDT	29234	28814	10749	29234	18485	10749	
POPs total	**47267**	**77215**	**22255**	**47966**	**22147**	**22255**	
Mixture	n.a.	n.a.	35591	35591	5533	30058	30058
TOTAL	**47267**	**77215**	**57846**	**83557**	**27680**	**52313**	**52313÷55877**

From the assessment of available data for POPs pesticides stockpiles, collected by the Inventories carried out within the years, it could be assumed the following:

2 Documentary inventory in 1995 ("Analysis and prospects for use of POPs in Bulgaria ,1995 IVECOL Sole Proprietor, Sofia, 1997)
3 Tasheva M, POPs Inventory 1996, National Centre of Hygiene, Medical Ecology & Nutrition,Training Workshop on POPs Inventories regarding NIPdevelopment, Dec.2003,Sofia,Bulgaria
4 Documentary inventory in 2000 (Kamburova V.,"Impact of Obsolete pesticides on rural environment", Journal of Balkan Ecology, Vol.7, No4, 2004, p.425)

The assumed POPs stockpiles at the end of 2003 are in the range of 22.25 t ÷ 25.82 t and the mixtures, consisting of or contaminated with POPs comprise of approx. 30.06 t, totaling the assumed POPs stockpiles between 52.3 t ÷ 55.88 t. Due to different data declared within the POPs Invetories, carried out in 1995, 1996 and 2000 by various authorities, it is strongly required a detailed POPs Inventory to be carried out in Bulgaria. To identify the specific POPs amount in the obsolete stockpiles and mixtures, it is necessary to determine the actual POPs content by sampling and analysis.

Concusions:

- **The assumed POPs pesticides stockpiles at the end of 2003 in Bulgaria are in the range of 22.25 t ÷ 25.82 t.**
- **The obsolete pesticides mixtures, consisting of or contaminated with POPs comprise of approx. 30.06 t.**
- **The assumed POPs pesticides stockpiles are totaling between 52.3 t ÷ 55.9 t**
- **To identify the specific POPs pesticides it is strongly required a detailed POPs Inventory to be carried out in Bulgaria.**

4.3 Inventory of Prohibited and Unusable Obsolete Pesticides in Bulgaria for the period 2001 – 2004

The storage facilities for unusable and obsolete pesticides are a source of local environmental pollution. The sites are subject to annual inventorying and the condition of warehouses and of the plant protection chemicals stored there are monitored. The construction of centralized municipal warehouses and BB cubes conforming to the legislative framework, responsible storage of available quantities, cleaning up of emptied warehouses are activities that illustrate consistency and sustainable management of the issue of prohibited and obsolete pesticides.

The institutions responsible for the issue are the Ministry of Agriculture and Forests (MAF), the Ministry of Environment and Water (MOEW), and their branches. The main regulations used in this work are the Waste Management Act (promulgated in the SG 86/24.09.2003, amended SG 70/10.08.2004), Regulations 10, 12, 13, promulgated in the SG issues 151 and 152 of 1998, and The National Waste Management Programme.

The MOEW through its EEPA and RIEW has monitored in the period 2001 – 2003 the state of the warehouses and of the plant protection chemicals stored there. Using information cards, the RIEW collect annually and submit to the EEPA information about the condition of warehouses and of the plant protection chemicals stored there. The Interagency Committee of Experts at the MAF, with representatives of the MOEW, considers and decides on all activities regarding the facilities for storage of prohibited and obsolete pesticides.

4.3.1. Quantities of prohibited and obsolete PPC stored in warehouses and in BB cubes in 2001

The 2001 data of number of warehouses and BB cubes, and the quantities of prohibited and obsolete PPC stored in them are presented in Tables 20 and 21. The total quantity of PPC comprises:

- "known" pesticides – documented appearance and preserved packaging;
- "unknown" pesticides – mixtures of various PPC part of which are probably polluted with pesticides that are subject to the Stockholm Convention, of unknown type and composition, with torn packaging, if any, and missing labels.

The analysis of the data from inventorying of prohibited and obsolete PPC in 2001 shows:

- **The total number of storage facilities is 772, located in 746 areas/ 209 municipalities.**
- **The ownerhip of these storage facilities is state – 4%, municipal – 27%, cooperative – 56%, and private – 13%.**
- **Approximately 32% of all warehouses are guarded.**
- **All prohibited and obsolete PPC are stored in 16 centralised facilities, in 756 facilities, and in 468 BB cubes, distributed in 9 areas of Bulgaria.**
- **The approximate quantity of obsolete and unusable pesticides stored in Bulgaria and comprising hazardous waste, amounts to 7415 tonnes of which 14% are liquids.**
- **Most PPC warehouses are located in the following areas: Pleven – 89, Stara Zagora – 80, Lovech – 56, and Montana – 55. Approximately 34% of them are in an unsatisfactory or poor condition. Some warehouses have been walled up until a solution is found for the pesticides they contain.**
- **The total quantity of PPC in warehouses is 5564.5 t.**
- **The "known" PPC in storage facilities are solid, 1773,7 tonnes, and liquid, 364 tonnes.**
- **The "unknown" PPC in storage facilities are 3426,7 tonnes, of which approximately 20% is liquid.**
- **The approximate quantity of "unknown" PPC encapsulated in 468 BB cubes is 1851 tonnes, on 20 sites.**

The difference of quantities as compared to former years is due, on the one hand, to increasingly better accounting and identification of stored chemicals and, on the other, on discoveries of new quantities of abandoned pesticides.

In comparison to the year 2000, significant positive results have been registered, and:

- **Only 33% of the warehouses are in a poor condition and represent potential sources of environmental pollution;**
- **There is an increasing number of BB cubes and of PPC quantities disposed in them (468 with 366 cubes in the previous year). The emptied warehouses have been cleaned up;**
- **There are 33 emptied warehouses storing 1711 tonnes of pesticides, and are disposed in BB cubes;**
- **156 storage facilities containing 140 tonnes of pesticides have been cancelled;**
- **The process of safe storage has concluded entirely in areas such as Veliko Tarnovo, Gabrovo, Smolyan, Burgas (except for Karnobat municipality), Kyustendil and, partially, Pernik, and several other areas have reached satisfactory levels.**

By decision of the board of managers of the NEPF, in the year 2001 an approximate amount of 655 thousand levs was allocated for safe storage of 1 017 obsolete pesticides. The funds submitted by the NPPS for the same year amount to 61 thousand levs. These funds have been spent on repair of storage facilities, cleaning up of sites, collection, re-packing, and moving of chemicals from warehouses in small settlements into municipal warehouses.

Table 20 Quantities of obsolete PPC stored in warehouses and in BB cubes in 2001

Area	Storage facilities	Quantities							BB cubes		
		solid, kg			liquid, kg			Total, kg	Sites	pcs	kg
		known	unknown	Total	known	unknown	Total	solid+liquid	per BB cube		unknown
Blagoevgrad	21	28345	24570	52915	6300	12320	18620	71535			
Burgas	40	22940	298171	321111	0	44262	44262	365373	2	33	165000
Varna	42	1300	236980	238280	6	21800	21806	260086	3	44	57150
Veliko Tarnovo	15	381346	0	381346	106816	0	106816	488162	2	11	30000
Vidin	25	89500	82950	172450	1000	130	1130	173580			
Vratsa	28	159670	210000	369670	43415	9000	52415	422085			
Gabrovo	4	70374	0	70374	12605	0	12605	82979			
Dobrich	35	0	123008	123008	0	61850	61850	184858	1	26	26200
Kardzhali	24	20217	104624	124841	3770	6480	10250	135091			
Kyustendil	4	15092	235097	250189	1050	3435	4485	254674			
Lovech	56	99241	22945	122186	0	4700	4700	126886			
Montana	55	265575	0	265575	57730	0	57730	323305			
Pazardzhik	24	25059	4151	29210	14682	2400	17082	46292			
					0	17747	17747	78186	1	35	140000
Pleven	89	815	259600	260415	0	128764	128764	389179			
Plovdiv	46	257836	108178	366014	0	21376	21376	387390			
Razgrad	8	92024	4661	96685	40354	24376	64730	161415			
Russe	26	65307	6184	71491	31323	14116	45439	116930			
Silistra	29	21571	56525	78096	6695	47455	54150	132246			
Sliven	6	0	100	100	0	550	550	650	5	175	862000
Smolyan	6	48150	45950	94100	1800	3220	5020	99120			
Sofia											
Stara Zagora	80	5746	167778	173524	4017	85851	89868	263392			
Targovishte	18	11000	137000	148000	6440	34500	40940	188940			
Haskovo	36	8223	188060	196283	2665	37350	40015	236298	1	50	250000
Shumen	33	79410	48150	127560	23380	280	23660	151220	4	48	85300
Yambol	7	0	336810	336810	0	87790	87790	424600	1	46	235000
Total	**772**	**1773741**	**2756931**	**4530672**	**364048**	**669752**	**1033800**	**5564472**	**20**	**468**	**1850650**

Table 21 Quantities of "unknown" obsolete PPC stored in warehouses and in BB cubes in 2001

Areas	Storage facilities	Quantities of "unknown" PPC in storage facilities			Quantities of "unknown"OP in BB cubes	Total "unknown"OP quantity in warehouses and BB cubes	BB cubes
	pcs	solid, kg	liquid, kg	Total kg	kg	kg	pcs
Blagoevgrad	21	24570	12320	36890		**36890**	
Burgas	40	298171	44262	342433	165000	**507433**	33
Varna	42	236980	21800	258780	57150	**315930**	44
Veliko Tarnovo	15	0	0	0	30000	**30000**	11
Vidin	25	82950	130	83080		**83080**	
Vratsa	28	210000	9000	219000		**219000**	
Gabrovo	4	0	0	0		**0**	
Dobrich	35	123008	61850	184858	26200	**211058**	26
Kardzhali	24	104624	6480	111104		**111104**	
Kyustendil	4	235097	3435	238532		**238532**	
Lovech	56	22945	4700	27645		**27645**	
Montana	55	0	0	0		**0**	
Pazardzhik	24	4151	2400	6551		**6551**	
					140000	**213186**	35
Pleven	89	259600	128764	388364		**388364**	
Plovdiv	46	108178	21376	129554		**129554**	
Razgrad	8	4661	24376	29037		**29037**	
Russe	26	6184	14116	20300		**20300**	
Silistra	29	56525	47455	103980		**103980**	
Sliven	6	100	550	650	862000	**862650**	175
Smolyan	6	45950	3220	49170		**49170**	
Sofia							
Stara Zagora	80	167778	85851	253629		**253629**	
Targovishte	18	137000	34500	171500		**171500**	
Haskovo	36	188060	37350	225410	250000	**475410**	50
Shumen	33	48150	280	48430	85300	**133730**	48
Yambol	7	336810	87790	424600	235000	**659600**	46
Total	**772**	**2756931**	**669752**	**3426683**	**1850650**	**5277333**	**468**

4.3.2. Quantities of obsolete PPC stored in warehouses and in BB cubes in 2002

Tables 22 and 23 present processed 2002 data of the number of warehouses and BB cubes, and the quantities of prohibited and obsolete PPC by area.

Table 22 **Quantities of obsolete PPC stored in warehouses and in BB cubes in 2002**

Area	Storage facilities	PPC in storage							PPC in BB cubes		
		solid, kg			liquid, kg			Total, kg	BB cube sites	pcs	kg
		known	unknown	Total	known	unknown	Total	solid+liquid			unknown
Blagoevgrad	22	28345	27070	55415	6300	12320	18620	**74035**			
Burgas	37	9200	284770	293970	0	48300	48300	**342270**	2	33	165000
Varna	22	1300	237770	239070	6	21300	21306	**260376**	4	64	87150
Veliko Tarnovo	14	365146	600000	965146	102012	0	102012	**1067158**	2	11	30000
Vidin	23	53500	100650	154150	0	130	130	**154280**	1	18	40000
Vratsa	23	384326	63720	448046	47130	18231	65361	**513407**			
Gabrovo	4	70374	0	70374	12605	0	12605	**82979**			
Dobrich	35	0	183248	183248	0	59868	59868	**243116**	2	26	26200
Kardzhali	7	2240	213859	216099	1670	17480	19150	**235249**			
Kyustendil	3	15092	234424	249516	1050	4135	5185	**254701**			
Lovech	54	99241	22945	122186	0	4700	4700	**126886**			
Montana	27	101100	700	101800	22105	0	22105	**123905**	7	119	476000
Pazardzhik	24	25059	4151	29210	14682	2400	17082	**46292**			
					1800	20267	22067	**168506**	1	35	140000
Pleven	89	2815	262600	265415	1000	128764	129764	**395179**			
Plovdiv	46	257836	108178	366014	0	21376	21376	**387390**			
Razgrad	8	85047	36228	121275	22446	41297	63743	**185018**			
Russe	28	50971	23253	74224	22670	5500	28170	**102394**			
Silistra	29	25271	40660	65931	7610	33980	41590	**107521**			
Sliven	6	0	100	100	0	550	550	**650**	5	175	862000
Smolyan	6	48150	46000	94150	1800	3220	5020	**99170**			
Sofia	50	5363	73858	79221	1538	7348	8886	**88107**	5	40	56500
Stara Zagora	82	0	295775	295775	0	76124	76124	**371899**			
Targovishte	5	0	147600	147600	440	33600	34040	**181640**	1	8	27000
Haskovo	30	4400	227390	231790	600	36750	37350	**269140**	1	50	250000
Shumen	20	0	65000	65000	0	15180	15180	**80180**	8	85	171600
Yambol	6	0	336810	336810	0	87790	87790	**424600**	1	46	235000
Total	**715**	**1687926**	**3730048**	**5417974**	**267464**	**700610**	**968074**	**6386048**	**40**	**710**	**2566450**

Table 23 **Quantities of "unknown" obsolete PPC stored in warehouses and in BB cubes in 2002**

Areas	Storage facilities	Quantities of "unknown" PPC in storage facilities			Quantities of "unknown" PPC in BB cubes	Total quantity of "unknown" PPC in warehouses and in BB cubes	BB cubes
	pcs	solid, kg	liquid, kg	Total kg	kg	kg	pcs
Blagoevgrad	22	27070	12320	**39390**		**39390**	
Burgas	37	284770	48300	**333070**	165000	**498070**	33
Varna	22	237770	21300	**259070**	87150	**346220**	64
Veliko Tarnovo	14	600000	0	**600000**	30000	**630000**	11
Vidin	23	100650	130	**100780**	40000	**140780**	18
Vratsa	23	63720	18231	**81951**		**81951**	
Gabrovo	4	0	0	**0**		**0**	
Dobrich	35	183248	59868	**243116**	26200	**269316**	26
Kardzhali	7	213859	17480	**231339**		**231339**	
Kyustendil	3	234424	4135	**238559**		**238559**	
Lovech	54	22945	4700	**27645**		**27645**	
Montana	27	700	0	**700**	476000	**476700**	119
Pazardzhik	24	4151	2400	**6551**		**6551**	
					140000	**253556**	35
Pleven	89	262600	128764	**391364**		**391364**	
Plovdiv	46	108178	21376	**129554**		**129554**	
Razgrad	8	36228	41297	**77525**		**77525**	
Russe	28	23253	5500	**28753**		**28753**	
Silistra	29	40660	33980	**74640**		**74640**	
Sliven	6	100	550	**650**	862000	**862650**	175
Smolyan	6	46000	3220	**49220**		**49220**	
Sofia	50	73858	7348	**81206**	56500	**137706**	40
Stara Zagora	82	295775	76124	**371899**		**371899**	
Targovishte	5	147600	33600	**181200**	27000	**208200**	8
Haskovo	30	227390	36750	**264140**	250000	**514140**	50
Shumen	20	65000	15180	**80180**	171600	**251780**	85
Yambol	6	336810	87790	**424600**	235000	**659600**	46
Total	**715**	**3730048**	**700610**	**4430658**	**2566450**	**6997108**	**710**

The analysis of the data from inventorying of prohibited and obsolete PPC in 2002 shows:

- **The total number of storage facilities is 715, located in 691 areas/ 227 municipalities.**
- **The ownerhip of these storage facilities is state, municipal, cooperative, and private – 15%.**
- **Approximately 35% of all warehouses are guarded.**
- **All prohibited and obsolete PPC are stored in 37 centralised facilities, in 678 facilities, and in 710 BB cubes, distributed in 13 areas of Bulgaria.**
- **The approximate quantity of obsolete and unusable pesticides stored in Bulgaria and comprising hazardous waste, amounts to 8952,5 tonnes of which 11% are liquids.**
- **Most PPC warehouses are located in the following areas: Pleven – 89, Stara Zagora – 82, Lovech – 56, Sofia – 50, and Montana – 46.**
- **Approximately 29% of them are in an unsatisfactory or poor condition.**
- **The total quantity of PPC in warehouses is 6386 t.**
- **The "known" PPC in storage facilities are solid, 1688 tonnes, and liquid, 267 tonnes.**
- **A substantial part of the total quantity (69% for solid and 72% for liquid) comprises chemicals of unknown origin. Part of these are likely to be polluted with pesticides that are subject to the Stockholm Convention. The "unknown" PPC in storage facilities are 4431 tonnes, of which approximately 16% is liquid.**
- **The obsolete and unusable PPC encapsulated in BB cubes in 40 sites amounto to approximately 2566 tonnes.**

The difference of quantities as compared to former years is due, on the one hand, to increasingly better accounting and identification of stored chemicals and, on the other, on discoveries of new quantities of abandoned pesticides. In comparison to the year 2001, significant positive results have been registered, and:

- **The number of storage facilities in poor and satisfactory condition has decreased from 33% to 29%;**
- **The number of BB cubes and the quantities of disposed PPC have increased to a significant extent (710 BB cubes, and 468 for the previous year).**
- **128 storage facilities have been cleaned, with 62 being moved to centralised facilities and 66 disposed in BB cubes; The emptied warehouses have been cleaned up;**
- **In 37 municipalities the process of safe storage has completed and the chemicals are stored in centralised facilities.**
- **The funding from EPAME has increased in the year 2002. The expenses for safe storage of prohibited and obsolete pesticides amount to approximately 1075 thousand levs. The funds submitted by the NPPS amount to 309 thousand levs.**
- **The control over the state of warehouses and of the chemicals stored there has been made stricter.**

4.3.3. Quantities of obsolete PPC stored in warehouses and in BB cubes for the Year 2003

Tables 24 and 25 present processed 2003 data about the number of warehouses and BB cubes, and the qualities of obsolete PPC by area, while Table 26 presents the PPC quantities stored in centralised and currently unrepaired storage facilities and in BB cubes, by area.

Table 24 Quantities of obsolete PPC stored in warehouses and in BB cubes in 2003

Areas	Storage facilities	quantities in storage							quantities in BB cubes, kg			Quantities of PPC in warehouses and in BB cubes
		solid, kg			liquid, kg			Total, kg	Sites	BB cubes	PPC	
		known	unknown	Total	known	unknown	Total	solid+liquid	pcs	pcs	unknown	Total, kg
Blagoevgrad	22	12000	51240	63240		26550	26550	89790	1	4	20000	**109790**
Burgas	45		311280	311280		41685	41685	352965	3	41	197000	**549965**
Varna	17		244430	244430		48000	48000	292430	4	64	137150	**429580**
Veliko Tarnovo	13		972392	972392		104546	104546	1076938	3	22	60000	**1136938**
Vidin	22		197820	197820		11110	11110	208930	1	27	108000	**316930**
Vratsa	22		398100	398100		55985	55985	454085				**454085**
Gabrovo	3		70374	70374		12605	12605	82979				**82979**
Dobrich	31		212020	212020		53990	53990	266010	2	89	353600	**619610**
Kardzhali	12		290104	290104		38080	38080	328184				**328184**
Kyustendil	3		393579	393579		424703	424703	818282				**818282**
Lovech	43		205320	205320		35430	35430	240750				**240750**
Montana	21		172530	172530		23255	23255	195785	7	119	476000	**671785**
Pazardzhik	23		36285	36285		17886	17886	54171				**54171**
Pernik	11		820950	820950		32200	32200	853150	3	63	252000	**1105150**
Pleven	94		320945	320945		109748	109748	430693				**430693**
Plovdiv	29		483484	483484		34316	34316	517800				**517800**
Razgrad	9		113843	113843		88167	88167	202010				**202010**
Russe									7	85	190897	**190897**
Silistra	22		93825	93825		24195	24195	118020				**118020**
Sliven	4	225	1880	2105	250	1100	1350	3455	5	175	862000	**865455**
Smolyan	6		93750	93750		6220	6220	99970				**99970**
Sofia	40		329622	329622		37792	37792	367414	7	64	256000	**623414**
Stara Zagora	90		242839	242839		91789	91789	334628				**334628**
Targovishte	6		155650	155650		44365	44365	200015	1	8	27000	**227015**
Haskovo	40		566675	566675		85231	85231	651906	1	50	103000	**754906**
Shumen	18		114669	114669		53374	53374	168043	9	100	281300	**449343**
Yambol	5		338910	338910		87790	87790	426700	1	46	235000	**661700**
Total	**651**	**12225**	**7232516**	**7244741**	**250**	**1590112**	**1590362**	**8835103**	**55**	**957**	**3558947**	**12394050**

Table 25 Quantities of "unknown" obsolete PPC stored in warehouses and in BB cubes in 2003

Areas	Storage facilities	Quantities of "unknown" PPC in storage facilities			BB cubes	Quantities of "unknown" PPC in BB cubes	Total quantity of "unknown" PPC in warehouses and in BB cubes
	pcs	solid, kg	liquid, kg	Total, kg	pcs	kg	kg
Blagoevgrad	22	51240	26550	**77790**	4	20000	**97790**
Burgas	45	311280	41685	**352965**	41	197000	**549965**
Varna	17	244430	48000	**292430**	64	137150	**429580**
Veliko Tarnovo	13	972392	104546	**1076938**	22	60000	**1136938**
Vidin	22	197820	11110	**208930**	27	108000	**316930**
Vratsa	22	398100	55985	**454085**			**454085**
Gabrovo	3	70374	12605	**82979**			**82979**
Dobrich	31	212020	53990	**266010**	89	353600	**619610**
Kardzhali	12	290104	38080	**328184**			**328184**
Kyustendil	3	393579	424703	**818282**			**818282**
Lovech	43	205320	35430	**240750**			**240750**
Montana	21	172530	23255	**195785**	119	476000	**671785**
Pazardzhik	23	36285	17886	**54171**			**54171**
					63	252000	**1105150**
Pleven	94	320945	109748	**430693**			**430693**
Plovdiv	29	483484	34316	**517800**			**517800**
Razgrad	9	113843	88167	**202010**			**202010**
Russe				**0**	85	190897	**190897**
Silistra	22	93825	24195	**118020**			**118020**
Sliven	4	1880	1100	**2980**	175	862000	**864980**
Smolyan	6	93750	6220	**99970**			**99970**
Sofia	40	329622	37792	**367414**	64	256000	**623414**
Stara Zagora	90	242839	91789	**334628**			**334628**
Targovishte	6	155650	44365	**200015**	8	27000	**227015**
Haskovo	40	566675	85231	**651906**	50	103000	**754906**
Shumen	18	114669	53374	**168043**	100	281300	**449343**
Yambol	5	338910	87790	**426700**	46	235000	**661700**
Total	**651**	**7232516**	**1590112**	**8822628**	**957**	**3558947**	**12381575**

At the end of 2003 the total number of storage facilities is 651, located on 618 lands of 198 municipalities.It has been identified totally 72 centralized storages - repaired or new buildings, complying with the requirement of safe storage of hazardous wastes as well as 55 sites with 957 BB-cubes. 579 unrepaired operating since 60-ies of past century storages for obsolete and useless pesticides are located on 550 lands of 154 municipalities. The latter do not comply with the requirements for safe storage and are a potential source of environmental pollution.

At the end of 2003 total stockpiles of obsolete pesticides are 12394 t, as 28% of them are permanently disposed in 957 BB-cubes, and 39% are re-packed and transferred in 72 centralized storage facilities.

The largest share **in 2003** was held by the cooperative property – 52%, followed by municipal – 30%, private – 14%, and state – 4%.

In 2003 approximately 46% of all warehouses are safe-guarded. Approx. 52% of storages are in an unsatisfactory or poor condition. 66% of all obsolete and useless pesticides stockpiles are stored safely in centralised storages and in BB cubes. The remaining 34% are stored in operating unrepaired warehouses which will be repaired and cleaned gradually, and those in poor status will be liquidated, and their sites and buildings sanitated.*(fig.2)*.

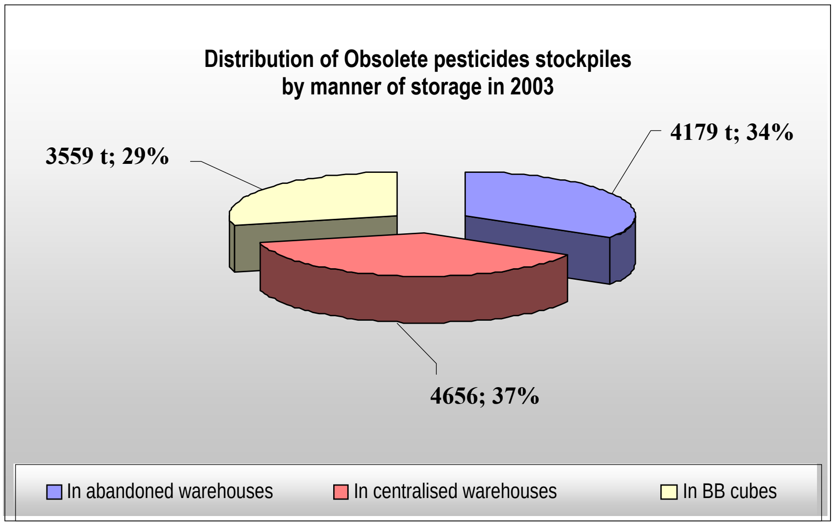


Figure 2 Distribution of Obsolete pesticides stockpiles by manner of storage for 2003

In 2003 were repaired warehouses in municipalities: Hisar, Brezovo, Saedinenie, Loznitza, Kardjali, Rodopi, Samoil, Belene, Haskovo, Dimitrovgrad, Svishtov, Lukovit, Antonovo, Kneja, Zavet, Kozloduy and Pleven. Obsolete pesticides encapsulated in BB cubes in municipalities: Aksakovo, Sliven, Avren, Krichim, Opaka, Suvorovo, Gorna Malina, Sungurlare, Samokov, Shumen, Veliki Preslav, Nikola Kozlevo, Vidin, Kaspichan and Novi Pazar and Ruse district. More than 80 warehouses have been eliminated and cleaned up in 2003, and due to improved control and better identification more than 90 new storages have been discovered. The problem for safe storage of obsolete pesticides has been completely solved in the following administrative areas: Yambol, Smolyan, Russe, Gabrovo. Almost completely it is solved in Veliko Tarnovo, Kardzhali, Razgrad, Sliven, Targovishte.

In 2003 , 15 new sites with 247 new BB cubes with approx. 993 t of obsolete pesticides capsulated, had been established. At the same time the number of centralized newly built or totally repaired warehouses for obsolete pesticides, complying with the requirements for safe storage increases from 37 in 2002 to 72 in 2003. At the same time the number of unrepaired warehouse in bad status decrease respectively from 678 to 579 .

The “unknown” obsolete pesticides stockpiles in warehouses and in BB cubes have been increasing constantly in the period **2001-2003**, due to annual discoveries of new quantities of obsolete pesticides, being hazardous waste. The “unknown” obsolete pesticides **in 2003** have increased to 12382 tonnes (*Fig. 3).*

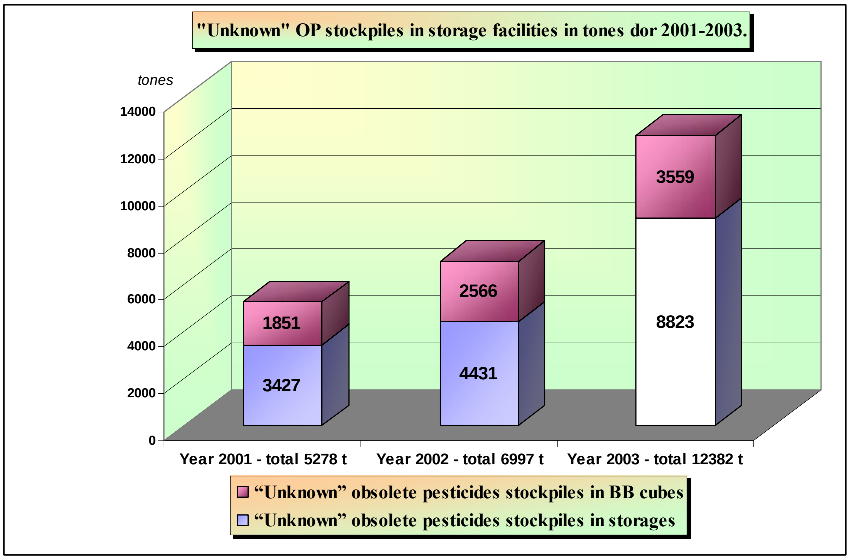


Figure 3 “Unknown” Obsolete pesticides stockpiles in storage facilities in tones for 2001 ÷ 2003

In 2003, the obsolete pesticides stored in centralized 72 warehouses, located in 18 administrative districts amount to 4656 tonnes, that encapsulated in 957 BB cubes on 55 sites is 3559 tonnes, located in 15 administrative districts. The total obsolete pesticides stockpiles stored in safe warehouses, conforming to all requirements and in BB cubes is 8215 tonnes. The quantity of "unknown" obsolete pesticides is 4167 tonnes, stored in 579 unrepaired warehouses *(table 26).*

Table 26 OP stored in centralised and currently unrepaired warehouses and in BB cubes in 2003, by area

Area	in centralised storage facility		in currenly unrepaired storage facilities		in BB cubes			Total, kg
	warehouses, No.	Quantity, kg	warehouses, No.	Quantity, kg	sites, No.	cubes, No.	Quantity, kg	
Blagoevgrad			22	89790	1	4	20000	**109790**
Burgas	4	212215	41	140750	3	41	197000	**549965**
Varna	6	212330	11	80100	4	64	137150	**429580**
Veliko Tarnovo	7	1043075	6	33863	3	22	60000	**1136938**
Vidin			22	208930	1	27	108000	**316930**
Vratsa	1	291185	21	162900				**454085**
Gabrovo	3	82979						**82979**
Dobrich			31	266010	2	89	353600	**619610**
Kardzhali	8	316849	4	11335				**328184**
Kyustendil	1	432371	2	385911				**818282**
Lovech	1	66400	42	174350				**240750**
Montana	1	92000	20	103785	7	119	476000	**671785**
Pazardzhik			23	54171				**54171**
Pernik			11	853150	3	63	252000	**1105150**
Pleven	3	105951	91	324742				**430693**
Plovdiv	9	389055	20	128745				**517800**
Razgrad	5	126417	4	75593				**202010**
Russe					7	85	190897	**190897**
Silistra	1	39225	21	78795				**118020**
Sliven			4	3455	5	175	862000	**865455**
Smolyan	6	99970						**99970**
Sofia			40	367414	7	64	256000	**623414**
Stara Zagora	2	34000	88	300628				**334628**
Targovishte	3	105745	3	94270	1	8	27000	**227015**
Haskovo	5	571340	35	80566	1	50	103000	**754906**
Shumen	1	8054	17	159989	9	100	281300	**449343**
Yambol	5	426700			1	46	235000	**661700**
Total	**72**	**4655861**	**579**	**4179242**	**55**	**957**	**3558947**	**12394050**

Conclusions:

The analysis of the data from inventorying of prohibited and obsolete pesticides in 2003 shows:

- **The total quantity of obsolete and unusable pesticides stored in centralised and currently unrepaired storage facilities and BB cubes in Bulgaria, comprising hazardous waste, amount to approximately 12394 tonnes, and approximately 13% of these are liquid.**
- **The total number of storage facilities is 651, located in 618 areas/ 198 municipalities.**
- **All unusable and obsolete PPC are kept in 72 centralised warehouses, in 579 active and unrepaired warehouses, and in 957 BB cubes.**
- **The total quantity of PPC in warehouses is 8835 tonnes.**
- **The "unknown" PPC in storage facilities are 8823 tonnes, of which approximately 18% is liquid.**
- **The centralised storage facilities and BB cubes conform to all European requirements regarding the safe and environmentally sound storage of hazardous waste.**

- **The obsolete PPC stored in centralized 72 warehouses in 18 areas amount to approximately 4656 tonnes.**
- **The quantities of obsolete PPC encapsulated in 957 BB cubes on 55 sites amount to approximately 3559 tonnes, in 15 administrative areas.**
- **The total quantity of obsolete PPC stored in safe warehouses and BB cubes that conform to all requirements, is 8215 tonnes.**
- **The quantity of "unknown" obsolete PPC stored in 579 active and unrepaired warehouses is approximately 4167 tonnes. These quantities are an environmental hazard and measures are required for their safe storage: repairing and cleaning up of the warehouses. Of the 579 warehouses, 52% are in a poor condition and require immediate measures.**
- **The ownership of these storage facilities is state, municipal, cooperative, and private – 14%.**
- **Approximately 36% of all warehouses are guarded.**
- **Most PPC warehouses are located in the following areas: Pleven – 94, Stara Zagora – 90, Burgas – 45, Lovech – 43, Sofia – 40, and Haskovo – 46. Approximately 52% of them are in an unsatisfactory or poor condition. Some warehouses have been walled up until a solution is found for the pesticides they contain.**

The higher quantities of obsolete pesticides established in 2003 are due to strict control and better accounting and identification of the chemical in storage, as well as discovering of new quantities of abandoned pesticides. In comparison to the year 2002, significant positive results have been registered, and:

- **The number of storage facilities in poor and satisfactory condition has decreased;**
- **The number of BB cubes and the quantities of disposed PPC have increased to a significant extent (957 BB cubes, and 710 for the previous year).**
- **80 warehouses have been discontinued. The emptied warehouses have been cleaned up;**
- **The unusable pesticides in 70 municipalities have been collected safely, processed with inert materials, re-packed, transported and stored in reinforced concrete containers – BB cubes – or in repaired warehouses The matter has been completely resolved in the following administrative areas: Yambol, Smolyan, Russe, Gabrovo. The matter has been almost completely resolved in the following administrative areas: Veliko Tarnovo, Kardzhali, Razgrad, Sliven, Targovishte.**
- **18 contracts for neutralization of obsolete PPC have been concluded. The funding from EPAME and the NPPS has increased in the year 2003. The expenses for safe storage of prohibited and obsolete pesticides amount to approximately 1652000 levs from the EPAME and 287427 levs from the NPPS.**
- **The condition of the warehouses and of the chemicals stored in them is subject to contstant monitoring.**

4.3.4. Quantities of obsolete PPC stored in warehouses and in BB cubes for the Year 2004

In the period 2001 – 2004 MOEW through its EEA and RIEWs continued the monitoring of the warehouses status and of the obsolete pesticides stored there *(fig.4)*.

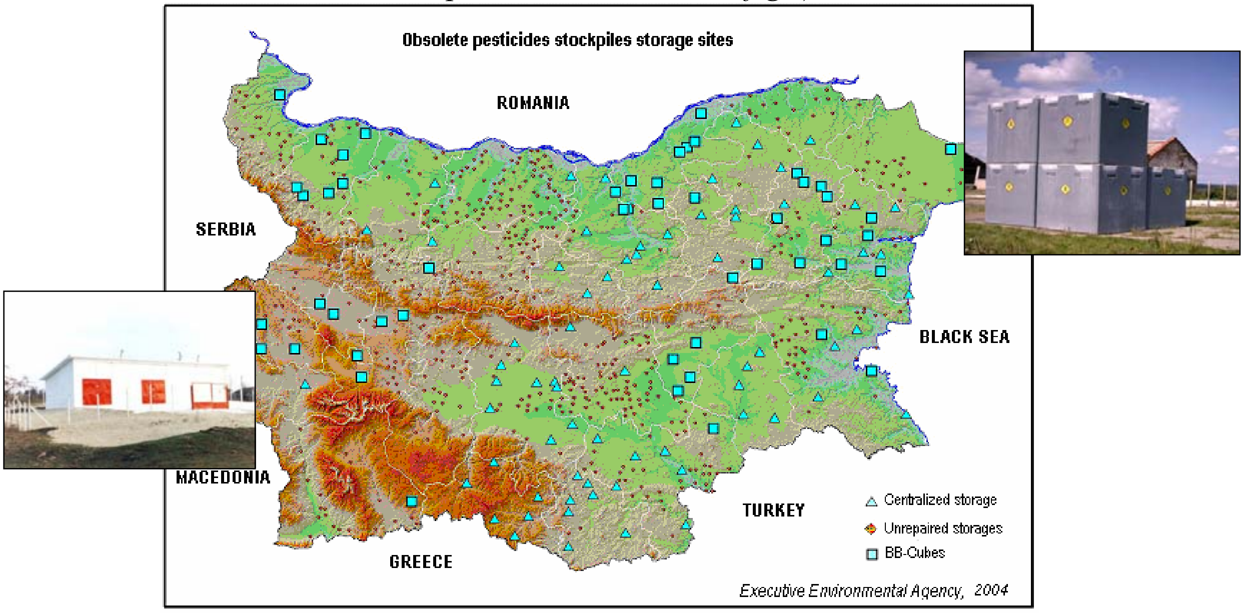


Figure 4 Distribution of warehouses and BB-cubes for storage of obsolete and useless pesticides on the territory of Bulgaria for 2004.

At the end of 2004 the total number of storage facilities is 561, out of which being 84 centralized and 477 operating unrepaired storehouses.The 477 unrepaired storage facilities for obsolete pesticides are located on 460 lands of 130 municipalities. In 19 districts are located 1255 BB cubes. The number of centralized storages in 2004 compared with 2003 has increased with 12, and that of BB cubes – with 298. At the same time the number of unrepaired warehouses has been reduced with 102. In 2004 113 storages out of 579 unrepared ones in 2003 has been demolished and 24 new obsolete pesticides warehouses has been discovered.

In 2004 the total stockpiles of obsolete pesticides are 11222 t, as 37,2% of them are permanently disposed in 1255 BB-cubes, and 41,9% arestored safely in 84 centralized storage facilities.Compared to 2003, the total OP stockpiles has been reduced with 1172 t, the repacked and moved to centralized storehouses OP has increased with 47 t, and that in BB cubes – with 652 t. (*Fig.5*).

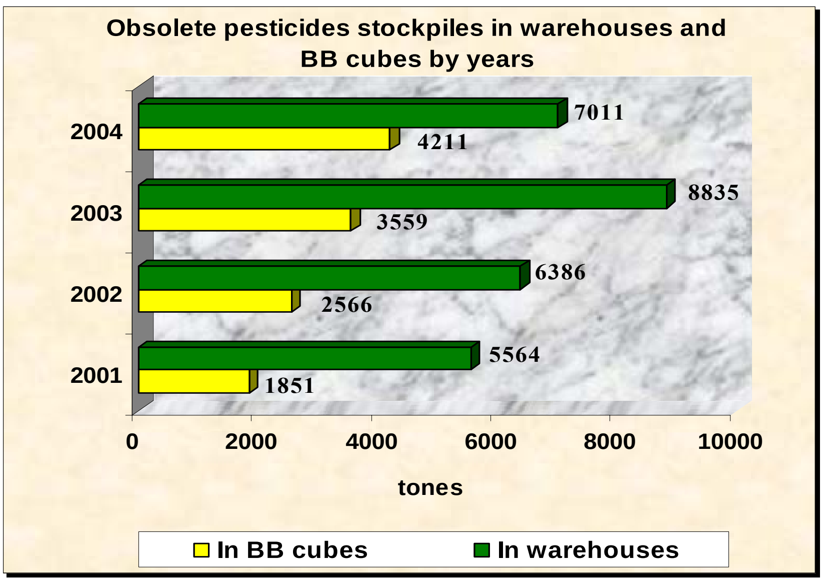


Figure 5 Obsolete pesticides stockpiles for 2001-2004.

The ownership of warehouses is state, municipal, cooperative and private.
In 2004 the largest share in was held by the cooperative property – 58,17%, followed by municipal – 24,4%, private – 14,6%, and state – 2,8%. In comparison with 2003, it is observed an increase of storage facilities cooperative ownership and decrease of those municipal and state ownership. (*fig.6*).

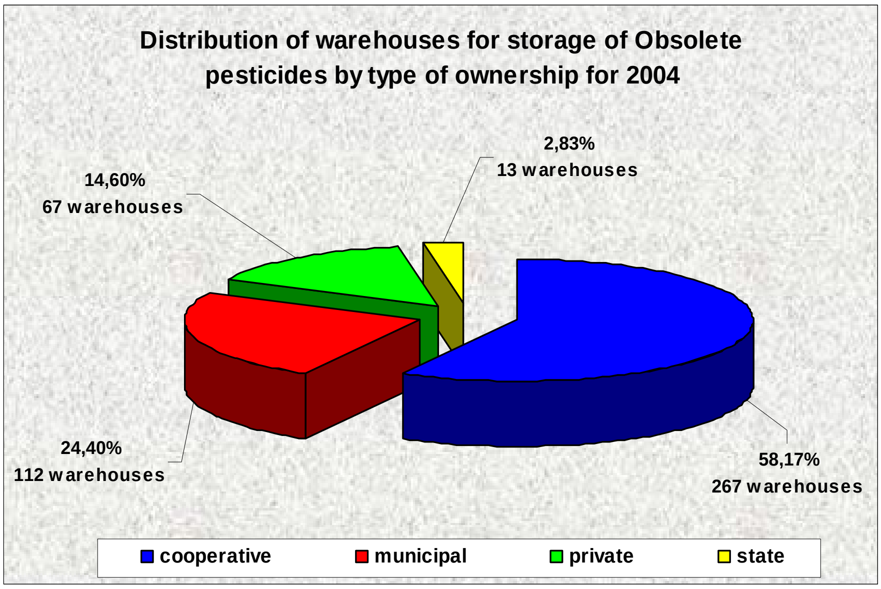


Figure 6 Distribution of warehouses for storage of Obsolete pesticides by type of ownership for 2004.

In 2004 the safe-guarded storages has decreased from 46% in 2003 to 38% in 2004, probably because of limited financial resourses of the municipalities, responsible for safe-guarding of warehouses. The total obsolete pesticides stockpiles, stored safely in centralised storages and in BB cubes has increased – from 66% in 2003 to 79% in 2004. The obsolete pesticides stockpiles , stored in operating unrepaired warehouses decreases from 37% in 2003 to 21% in 2004 (*fig.7).*

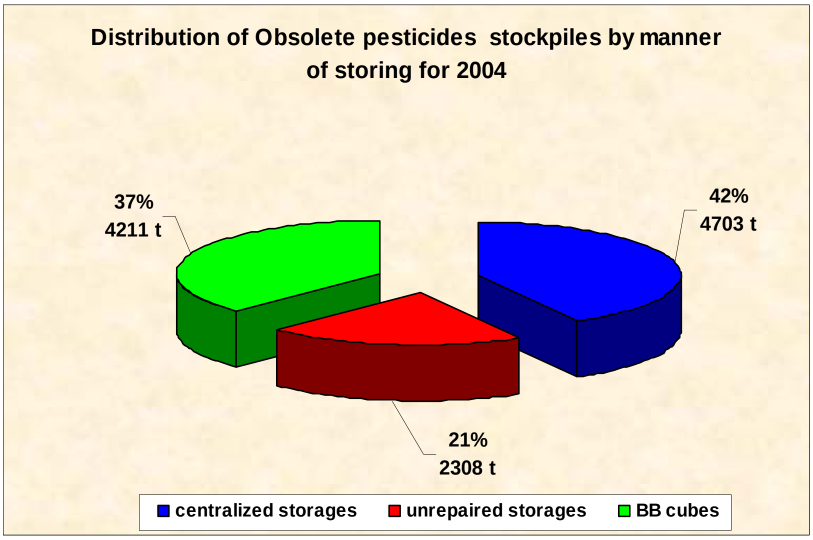


Figure 7 Distribution of Obsolete pesticides stockpiles by manner of storing for 2004.

In 2004 are concluded 7 contracts for repairing of warehouse in municipalities: Saedinenie, Rakovski, Radnevo, Vetrino, Kaloyanovo, Maritza and Asenovgrad. In BB cubes obsolete pesticides are stored in 23 municipalities. The number of centralized storages in 2004 compared with 2003 has increased with 12, and that of BB cubes – with 298. At the same time the number of unrepaired warehouses has been reduced with 102. In 2004,113 storages out of 579 unrepared ones in 2003 has been demolished and 24 new obsolete pesticides warehouses has been discovered.

The obsolete pesticides in 100 municipalities have been collected safely, treated with inert materials, re-packed, transported and stored in reinforced concrete containers – BB cubes – or in repaired warehouses .

The increased activity towards permanent and environmental sound disposal of obsolete and useless pesticides in newly built or repaired centralized warehouses and BB cubes for the period 2001 ÷ 2004 is shown in comparative *Table 27.*

In 2004 , 298 new BB cubes with approx. 652 t of obsolete pesticides capsulated had been established. At the same time the number of centralized newly built or totally repaired warehouses for obsolete pesticides, complying with the requirements for safe storage increases from 72 in 2003 to 84 in 2004. The number of unrepaired warehouse in bad status decrease respectively from 579 to 477, representing 18% decline versus 2003. (*Fig 8).*

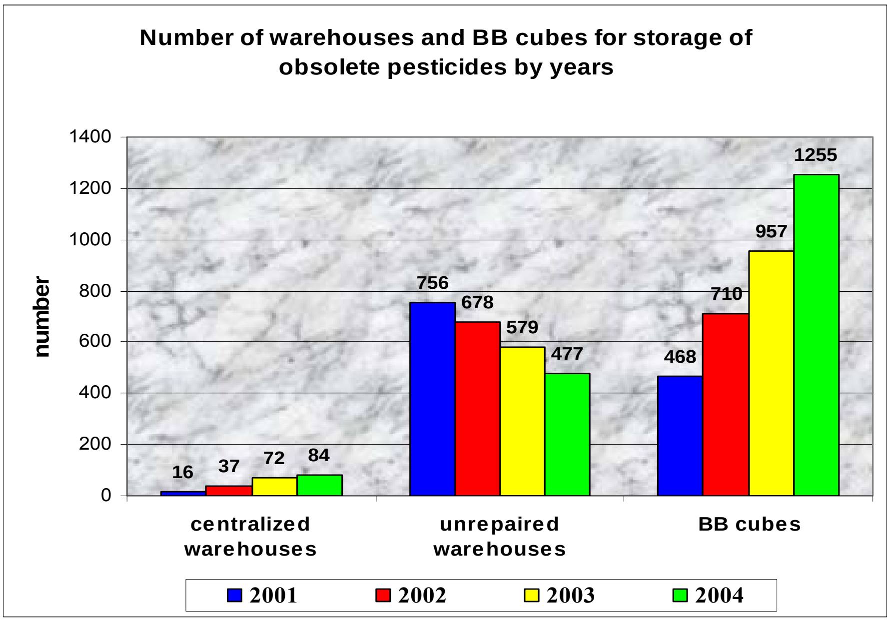


Figure 8 Number of warehouses and BB cubes for storage of obsolete pesticides by years

In 2004 a decline of OP stockpiles have been observed from 12382 t to 11222 t. The distribution of “unknown” obsolete pesticides stockpiles (in kgs), stored in centralized and operating unrepaired warehouses and capsulated in BB cubes for 2004 by administrative districts is shown on *Table 28.*

Table 27 Total obsolete pesticides stockpiles in storages facilities by types of warehouse and BB cubes for the period 2001-2004 in Bulgaria

Year	Storage facilities for obsolete pesticides			"known" Obsolete pesticides in warehouses	"unknown" Obsolete pesticides in warehouses	Obsolete pesticides in warehouses	BB cubes sites	BB cubes	"unknown" Obsolete pesticides in BB cubes	"unknown" Obsolete pesticides in warehouses & BB cubes	Obsolete pesticides in warehouses & BB cubes
	TOTAL	Centralized	Unrepaired operating	Q/ty	Q/ty	Total			Total	TOTAL	TOTAL
	numbe r	*number*	*number*	*tones*	*tones*	*tones*	*number*	*number*	*tones*	*tones*	*tones*
2001	**772**	16	*756*	2138	*3427*	**5565**	20	**468**	*1851*	**5278**	**7416**
2002	**715**	37	*678*	1955	*4431*	**6386**	40	**710**	*2566*	**6997**	**8952**
2003	**651**	72	*579*	12	*8823*	**8835**	55	**957**	*3559*	**12382**	**12394**
2004	**561**	84	*477*	2,8	*7008,2*	**7011**	60	**1255**	*4210,5*	**11218,7**	**11221,5**

Table 28"unknown" obsolete pesticides stockpiles, stored in centralized and unrepaired operating warehouses and BB cubes by districts for 2004.

District	In centralized storehouses		In unrepaired operating warehouses		Total	Общо	Liquidated	In BB cubes		TOTAL kg
	Warehouses nr	Q/ty kg	Warehouses nr	Q/ty kg	Warehouses nr	Q/ty kg	Warehouses nr	Cubes nr	Q/ty kg	
Blagoevgrad			17	66340	17	66340	4	11	42300	108640
Burgas	3	152100	27	113033	30	265133	20	123	511240	776373
Varna	6	213330	3	62600	9	275930	8	70	161150	437080
V.Tarnovo	9	1046675	8	41368	17	1088043	0	11	30000	1118043
Vidin			14	66940	14	66940	6	45	174000	240940
Vratza	1	291185	23	176100	24	467285	0			467285
Gabrovo	3	82979			3	82979				82979
Dobrich			23	102760	23	102760	8	131	506600	609360
Kardjali	8	316849	4	11335	12	328184	0			328184
Kyustendil	3	129102			3	129102				129102
Lovech	1	66400	42	174350	43	240750	3			240750
Montana			17	63640	17	63640	10	177	596000	659640
Pazardjik			19	45521	19	45521	4	1	1370	46891
Pernik			12	56636	12	56636	0	49	196000	252636
Pleven	3	105951	89	340712	92	446663	4			446663
Plovdiv	13	585342	3	38600	16	623942	14	6	36600	660542
Razgrad	5	116655	1	6250	6	122905	1			122905
Ruse	4	84187			4	84187		111	235197	319384
Silistra	1	39225	21	85485	22	124710	2			124710
Sliven			4	3455	4	3455	1	176	864400	867855
Smoljan	5	94170			5	94170		1	5000	99170
Sofia			40	367414	40	367414	0	64	256000	623414
Stara Zagora	4	188745	57	229651	61	418396	27	69	341000	759396
Targovishte	4	184145	3	7600	7	191745	1	14	18300	210045
Haskovo	5	571340	35	94766	40	666106	0	50	103000	769106
Shumen	1	8050	15	153624	16	161674	0	100	281300	442974
Yambol	5	426700			5	426700		46	235000	661700
TOTAL	84	4703130	477	2308180	561	7011310	113	1255	4210487	11221797

In 2004, the obsolete pesticides stockpiles in the centralized 84 warehouses is 4703 t and that, capsulated in 1255 BB cubes – 4211 t, located on the territory of 19 districts. Total obsolete pesticides stockpiles stored in safe and in conformity to all requirements warehouses and in BB cubes comprises to 8914 t. *(table 28).*

The amount of "unknown" obsolete pesticides stored in 477 unrepaired and unsafe warehouses is 2308 t.These stockpiles pose risk to the environment. The insufficient information about the assumed available approx. 52.3 t ÷ 55.9 t obsolete POPs pesticides and mixtures, consisting of or contaminated with POPs, due to torn packages, lack of labels and impossibility to identify their composition requires the implementation of detailed inventory of "unknown" OP stockpiles of 2308 t, stored in 477 unrepaired warehouses. The poor status of 53% of unrepaired operating storages requires measures for safe storage of the available there 1223 t obsolete pesticides – repacking and moving in repaired warehouses or export for disposal abroad.

Conclusions:

Obsolete pesticides stockpiles in 2004

- **At the end of 2004 the total amount of obsolete pesticides stockpiles is 11222 t, stored in 561 warehouses and 1255 BB-cubes.**
- **The "unknown" obsolete pesticides comprise of 11219 t, out of which 4703 t are stored in 84 centralized warehouses, 2308t – in 477 unrepaired storages and 4211t – in 1255 BB-cubes.**
- **Total obsolete pesticides stockpiles stored in safe warehouses, conforming to all European requirements for safe and environmentally sound storage of hazardous waste and in BB cubes is 8914 t.**
- **The amount of "unknown" obsolete pesticides stored in 477 unrepaired and unsafe warehouses is 2308 t.**
- **The insufficient information about the assumed available approx. 52.3 t ÷ 55.9 t obsolete POPs pesticides and mixtures, consisting of or contaminated with POPs, contained exactly in these 2308t obsolete pesticides requires the implementation of detailed inventory of the "unknown" obsolete pesticides, stored in 477 unrepaired warehouses.**

4.4. Summary and conclusions

In 2001 were repaired 124 warehouse in municipalities: Smolyan, Veliko Tarnovo, Kirkovo, Ardino, Burgas, Kubrat, Bobov dol, Tryavna, Yambol, Mizia, Svishtov and Targovishte.

In 2002 were repaired warehouses in municipalities:Sredets, Kameno, Provadia, Avren, Aksakovo, Krivodol, Yakimovo, Brusartsi, Valche Dram, Chiprovtsi, Georgi Damyanovo, Kneja, Samokov, Krumovgrad, Harmanli and Kardjali.

In 2003 were repaired warehouses in municipalities: Hisar, Brezovo, Saedinenie, Loznitza, Kardjali, Rodopi, Samoil, Belene, Haskovo, Dimitrovgrad, Svishtov, Lukovit, Antonovo, Kneja, Zavet, Kozloduy and Pleven. Obsolete pesticides encapsulated in BB cubes in municipalities: Aksakovo, Sliven, Avren, Krichim, Opaka, Suvorovo, Gorna Malina, Sungurlare, Samokov, Shumen, Veliki Preslav, Nikola Kozlevo, Vidin, Kaspichan and Novi Pazar and Ruse district. More than 80 warehouses have been eliminated and cleaned up in 2003, and due to improved control and better identification more than 90 new storages have been discovered. The problem for safe storage of obsolete pesticides has been completely solved in the following administrative areas: Yambol, Smolyan, Russe, Gabrovo. Almost completely it is solved in Veliko Tarnovo, Kardzhali, Razgrad, Sliven, Targovishte.

In 2004 are concluded 7 contracts for repairing of warehouse in municipalities: Saedinenie, Rakovski, Radnevo, Vetrino, Kaloyanovo, Maritza and Asenovgrad. In BB cubes obsolete pesticides are stored in 23 municipalities. The number of centralized storages in 2004 compared with 2003 has increased with 12, and that of BB cubes – with 298. At the same time the number of unrepaired warehouses has been reduced with 102. In 2004,113 storages out of 579 unrepared ones in 2003 has been demolished and 24 new obsolete pesticides warehouses has been discovered.

The obsolete pesticides in 100 municipalities have been collected safely, treated with inert materials, re-packed, transported and stored in reinforced concrete containers – BB cubes – or in repaired warehouses .

Obsolete pesticides stockpiles in 2003

- **At the end of 2003 the total amount of obsolete pesticides stockpiles is 12394 t, stored in 651 warehouses and 957 BB-cubes.**
- **The "unknown" obsolete pesticides comprise of 12382 t, out of which 4656 t are stored in 72 centralized warehouses, 4167 t – in 579 unrepaired storages and 3559 t – in BB-cubes.**
- **Total obsolete pesticides stockpiles stored in safe warehouses, conforming to all European requirements for safe and environmentally sound storage of hazardous waste and in BB cubes is 8215 t.**
- **The amount of "unknown" obsolete pesticides stored in 579 unrepaired and unsafe warehouses is 4167 t.**

Obsolete pesticides stockpiles in 2004

- **At the end of 2004 the total amount of obsolete pesticides stockpiles is 11222 t, stored in 561 warehouses and 1255 BB-cubes.**
- **The "unknown" obsolete pesticides comprise of 11219 t, out of which 4703 t are stored in 84 centralized warehouses, 2308t – in 477 unrepaired storages and 4211t – in 1255 BB-cubes.**
- **Total obsolete pesticides stockpiles stored in safe warehouses, conforming to all European requirements for safe and environmentally sound storage of hazardous waste and in BB cubes is 8914 t.**
- **The amount of "unknown" obsolete pesticides stored in 477 unrepaired and unsafe warehouses is 2308 t.**
- **The insufficient information about the assumed available approx. 52.3 t ÷ 55.9 t obsolete POPs pesticides and mixtures, consisting of or contaminated with POPs, contained exactly in these 2308t obsolete pesticides requires the implementation of detailed inventory of the "unknown" obsolete pesticides, stored in 477 unrepaired warehouses.**

5. POLLUTION OF THE ENVIRONMENT WITH POP PESTICIDES

5.1. POPs PESTICIDES MONITORING

5.1.1. POPs pesticides Level in the environment

5.1.1.1.POPs pesticides levels in water

A National System for Environmental Monitoring operates on national level. The National Water Monitoring System shall be a complex of specific control, measurement, analytical and information activities which make it possible to assess and forecast water quantity and quality.

The National Water Monitoring System shall comprehend:

1. the national network for precipitation and surface waters, including firm water yield;
2. the national network for ground waters;
3. the coastal reference network for the Black Sea;
4. a control and information system on the state of waste waters;
5. the operation, maintenance, communication support and laboratory information services under the foregoing items.

The networks include monitoring posts and/or stations. The Ministry of Environment and Water and the Ministry of Transport shall establish and maintain the part of the National Water Monitoring System relating to the River Danube.

Any data obtained from observations and assessments as a result of the activity of the National Water Monitoring System, as well as any such data obtained from self-monitoring, shall provide a basis for the exercise of control and for the imposition of sanctions upon violation of regulatory requirements.

Surface water

The main purposes of the national surface water monitoring network are to:

– obtain quantitative and qualitative data on the state of surface waters and assess trends with respect to their past, present and future development;
– oversee compliance with national surface water quality standards;
– assess the impacts of point sources on the receiving water body;
– identify heavily polluted water areas (hot spots) where immediate action is needed;
– provide public and private decision makers, academics and the general public with relevant information on the state of surface waters.

Surface waters are divided into three categories, according to their use: water supply; leisure, fishing and industrial; irrigation. The national network for monitoring surface water quality comprises 253 stations covering all major river basins. Three of these stations, located on the rivers Struma, Mesta and Maritza, are automatic. Of the surface water stations, 185 are in rivers (ten in the Danube), eight in lakes, 26 in reservoirs and 24 in the Black Sea. Fresh water measurements are made for some 30 parameters, including quantity, temperature, DO, BOD, COD, NH_4, NO_2, NO_3, total N, PO_4, total P, heavy metals, detergents and hydrocarbons. Measurements are taken once a month in rivers and lakes and seven times a year in the Black Sea.[5]

Within the period 1992-1993 an investigation of Danube river waters had been implemented in the region of town Silistra. From 2 riverside pointя and 6 thalweg points, it had been analyzed samples

[5] National automated system for environmental Monitoring /NASEM/, Dimitar Vergiev,Executive Environment Agency, Ministry of Environment and Water, Bulgaria

with broad spectrum of parameters – microbiological and chemical, including POPs pesticides. In 2 of the analyzed samples was found Heptachlor and p,p'- DDE residues respectively 0,004 µg/l and 0,003 µg/l, considerably lower than the ALVs (0,01 µg/l). Residues of p,p'-DDT, o,p'-DDT and Dieldrin had not been detected.[6]

During the period of 1995-1997, the " Danube Pesticide Regional Study", a project supported by PHARE was completed. The data on the presence of pesticides residues in the water were collected from 10 Danube countries, including Bulgaria. The data indicated that the levels of DDT in Bulgarian section of the Danube dropped considerably between the 70-ties and 90-ies from 0,098 µg/l to 0,001 µg/l.[7]It was not found presence of other POPs pesticides.

NCHMEN had carried out investigations on pesticides residues in underground and surface water from 68 water bodies (rivers, wells, irrigation waters, dam lake of drinking water). One to four samples were examined for each water body or totally 176 samples for the period 1993÷1999. Twenty drinking water sources were examined including 3 dams lake for drinking water supply and 17 underground water sources. Forty eight non-drinking water bodies were investigated including 6 of the biggest Bulgarian rivers – Iskar, Ogosta, Yantra, Vit, Maritza and Struma rivers as well as lakes, irrigation dams, drilling wells, etc. One hundred and fifty six samples were examined for POPs pesticides. *Table 29* shows the concentrations of POPs pesticides in the analyzed water.

Table 29 Concentrations of POPs pesticides found in Bulgarian waters [8]

POPs pesticides	**POPs pesticides concentrations found**		**POPs pesticides concentrations found in case of accidents**		**Limit of Detection (LOD), µg/l**	**Method**
	No of samples analyzed/No of positive samples	Conc.range/Mean value, µg/l	No of samples	Conc.range, µg/l		
DDT	156/0	-	7	0,06 – 1,63	0,001 0,01	GC/ECD GC - MS
DDE	156/2	0,001 – 0,003	7	0,13 – 0,53	0,001 0,01	GC/ECD GC - MS
Heptachlor	156/2	0,001 – 0,004	7		0,001 0,01	GC/ECD GC - MS
HCB	156/4	0,01 – 0,04/0,02	7		0,001 0,01	GC/ECD GC - MS

No positive samples of POPs pesticides in surface water sources, used for drinking water supply (dam lakes) were found. The classic representative of persistent organochlorine insecticide – DDT and its methabolites showed clear trend for decrease of DDT and its methabolites in hydrosphere of Bulgaria. In 70-ies of past century this POP chemical was found in amount range 0,023÷0,410 µg/l, in 80-ies respectively - 0,013÷0,150 µg/l, while at present DDT is found only at incidental point pollution and DDE – in rare cases (176/2) in non-drinking waters.

No positive samples of POPs pesticides in surface water sources, used for drinking water supply (dam lakes) were found.

Ground water

[6] Gopina G.et al., Health-Hygiene Characteristics of the Danube River in the district of Silistra with basic receiver the Black Sea, 1996, Hygiene and Public Health, vol. XXXIX, pp 25-27.

[7] Bratanova Z. et al., A review of Existing data on occurance of Pesticides in water of the River Danube and its tributaries, 1998, Fresenius Envir.Bull.,7:495-501.

[8] Bratanova Z, K.Vassilev, Pesticides residues in ground and surface water in Bulgaria, 2000, Hygiene and Public Health, vol. XLIII,1, pp16-18.

The main purposes of the national ground water monitoring network are to:
– obtain quantitative and qualitative data, as well as assess trends in the state of ground water;
– control compliance with national standards for ambient ground water;
– provide decision makers and interest groups with up to date information on the state of ground water.

The national network for monitoring ground water quality is made up of 225 stations. They are sampled two or four times a year for about 30 parameters. Bulgaria reports monitoring results from 74 ground water stations to the EUROWATERNET system. Groundwater is assessed on the ground of information, collected by Executive Environmental Agency. The samples are analyzed by the parameter, indicated in article 33 of Regulation 5 on the Procedure and Manner for Establishment of Networks and on the Operation of the National Water Monitoring System (SG 95/21.11.2000). Once per year in some points pesticides are analyzed.

The results are compared with the recommended parameters for groundwater pollution protection - ecological threshold (ET) and pollution threshold(PT) fro Annex 3 of of Regulation 1 on the Exploration, Use and Protection of Groundwater (SG 57/14.07.2000). According to the Regulation 1 , the groundwater condition is defined as follows:

1.Groundwater in excellent condition - the values of the indicators (POPs pesticides) are below the ecological threshold (ET);
2.Groundwater in good condition - the values of the indicators(POPs pesticides) are between the ecological threshold (ET) and the pollution threshold(PT);
3.Groundwater in bad condition - the values of the indicators(POPs pesticides) are above the pollution threshold(PT);
4.Groundwater in very bad condition - groundwater which is damaged.

In the period 1998-2002 two groups of samples have been taken for analysis of pesticides in ground water – at high ground water level in spring time, and low level by the later summer and early autumn. The sampling points in the spring were selected after analysis of the data from previous years – these are points where at least one pesticide exceeded the drinking water level of 0.1 μg/l.

The following POPs pesticides had been analyzed - aldrin, dieldrin, endrin, chlordane, heptachlor, hexachlorbenzene and 6 DDT isomers and metabolites (o,p-DDT, p,p’-DDT, o,p-DDD, p,p’-DDD, o,p-DDE, p,p’-DDE). The samples taken for POP pesticides in ground water were 287, and in the year 2002 they were 70. Table 30 presents data about POP pesticides in ground water for 1998-2002, and Table 31 presents data about DDT content above the pollution threshold (PT).

The analysis of data shows that no ground water in the Republic of Bulgaria is polluted with aldrin, dieldrin, endrin, chlordane, heptachlor and hexachlorobenzene. Although HCB had not been imported and used as pesticide in R Bulgaria , HCB residues had been found in single points samples being below ET, probably due to unintentional emission releases. The investigation results of DDT and its metabolites(o,p-DDT; p,p’-DDT; o,p-DDD; p,p’-DDD; o,p-DDE; pp’-DDE) indicate that in 1998 from totally 49 samples, in 8 samples the values exceed the pollution threshold (PT) - 0,1 μg/l and in 26 samples – above ecological threshold (ET) - 0,01 μg/l. The highest levels have been registered in Byala slatina(area of Vratza) - 1,037 μg/l; village of Yakimovo – 0,306 μg/l and village of Septemvriitsi - 0,178 μg/ (area of Montana); the town of Kozloduy(area of Vratsa) – 0,180 μg/l. For 1999 samples exceeding pollution threshold (PT) are registered in the village of Brushlen(area of Russe) - 0,523 μg/l and the town of Petrich (area of Blagoevgrad.)– 0,263 μg/l. The levels measured in the same points in 2002 were already below the minimum detection level (MDL).

The analysis and data assessment shows that no groundwater polluted with DDT in the R Bulgaria ehist in 2002. All values were below the minimum detection level (MDL) in 2002 and this classifies the groundwater as ground water in excellent condition.

Table 30 Analyzed samples for POPs pesticides residues in Groundwater in the RBulgaria for the period 1998 ÷ 2002.

POP pesticide	1998					1999					2000					2001					2002				
	No of samples	No of samples <MDL	No of samples <ET	No of samples >ET	No of samples >PT	No of samples	No of samples <MDL	No of samples <ET	No of samples >ET	No of samples >PT	No of samples	No of samples <MDL	No of samples <ET	No of samples >ET	No of samples >PT	No of samples	No of samples <MDL	No of samples <ET	No of samples >ET	No of samples >PT	No of samples	No of samples <MDL	No of samples <ET	No of samples >ET	No of samples >PT
Aldrin	49	40	1	8	0	52	46	6	0	0	51	50	1	0	0	65	65	0	0	0	70	70	0	0	0
Dieldrin	49	42	2	5	0	52	50	2	0	0	51	47	4	0	0	65	65	0	0	0	70	70	0	0	0
Endrin	49	46	1	2	0	52	49	3	0	0	51	48	3	0	0	65	65	0	0	0	70	68	2	0	0
Chlordane	49	47	0	2	0	52	52	0	0	0	51	51	0	0	0	65	65	0	0	0	70	70	0	0	0
Heptachlor	49	35	4	10	0	52	40	10	2	0	51	46	5	0	0	65	65	0	0	0	70	66	4	0	0
Hexachlorobenzene	49	35	14	0	0	52	48	4	0	0	51	50	1	0	0	65	62	3	0	0	70	68	2	0	0
DDT Total	49	7	7	26	9	52	5	38	7	2	51	10	37	4	0	65	58	6	1	0	70	64	6	0	0

Table 31 DDT content in groundwater above the pollution threshold

DDT content in ground water above the pollution threshold						
Area	**Urban cetntre**	**1998**	**1999**	**2000**	**2001**	**2002**
		level in µg/l				
Blagoevgrad	Petrich		0,263	> ET	< MDL	< MDL
	Byala Slatina	1,037		< ET	< ET	< MDL
Vratsa	Kozloduy	0,180	> ET	> ET	< ET	< MDL
Dobrich	Tyanevo	0,144			< ET	< MDL
	Septemvritsi	0,178			< MDL	
Montana	Yakimovo	0,306			< MDL	
	Goyam chardak	0,125				
	Graf Ignatievo	0,158				< MDL
Plovdiv	Ioakim Gruevo	0,154			< MDL	< MDL
Russe	Brushlen		0,525			< MDL

ET – Ecological threshold(0,01 µg/l) ; PT – Pollution threshold(0,1 µg/l); MDL – Minimum Detection Level(0,001 µg/l)

In 2003 for the territory of Danube, Black Sea, East Medetiranian and West Medetiranian Basin Regions were analyzed samples for POPs residues in groundwater – aldrin, dieldrin, endrin, HCB, Heptachlor, isomers and metabolites of DDT(o,p-DDT, p,p'-DDT, o,p-DDD, p,p'-DDD, o,p-DDE, p,p'-DDE) . All values are below minimum detection level - MDL (*Table 32).*

Table 32 Analyzed samples for POPs pesticides residues in Groundwater in the RBulgaria for 2003

BASIN REGIONS	No of samples	ALDRIN	DIELDRIN	ENDRIN	HCB	HEPTACHLOR	DDT
DANUBE	23	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
BLACK SEA	15	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
EAST MEDETIRANIAN	23	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
WEST MEDETIRANIAN	1	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL

In 2004 an investigation study for the groundwater pollution with POPs pesticides (aldrin, endrin, heptachlor, p,p'-DDT, p,p'-DDE and p,p'-DDD) has been carried out in selected regions with intensive agriculture.It has been tested 103 groundwater sources from 16 regions in Bulgaria, according to available information about past pollution accidents. The analysis of pesticides were implemented by liquid-liquid extraction with n-hexane and GC/ECD. It was not found POPs pesticides content in any sample (LOD of method 0,001µg/l).[9]

POPs pesticide monitoring indicates excellent condition of groundwater on the whole territory of the country. The analysis and data assessment show that during 2003 in R Bulgaria there are no groundwater, polluted with POPs pesticides, listed in Annex A, Part I & II of Stockholm Convention.

5.1.1.2. POPs pesticides level in Soil

Land and soil quality monitoring, managed by the EEA as part of the NASEM, includes the control and protection of soil from pollution with persistent organic pollutants (20 monitoring stations for PAH, PCB and pesticides, and 48 stations for pesticide monitoring).

Data on polluted soils are collected by EEA, together with the Institute of Soil Science and Agroecology. Soil contamination of industrial sites is also monitored using EIA procedures and an environmental auditing system.

In 1997, the EEPA at the MOEW initiated a systematic study of soils for residues of POP pesticides – DDT, hexachlorbenzene, aldrin, chlordane, dieldrin, endrin, heptachlor, mirex – that are prohibited for use in the Republic of Bulgaria. Within the MoEW's **4 years soil**

9 Bratanova Zl. At al., "Groundwater pollution with pesticides in selected regions in Bulgaria", 2005, Hygiene and health care, XLVIII**.**

monitoring programme 277 soil samples had been collected and analyzed , 124 of which were in the year **2000**.

In 1997, the soil sampling points had been located in sites of expected pollution. The point selection methodology was changed during the **period 1998-2000**, and the soil samples were equally distributed along the country's agricultural land. For evaluation of the results the established 3 levels of reference values - Precautionary Levels (PL), Admissible Limit Values (ALV) and Intervention Value (IV) for the Content of Prohibited Chloroorganic Pesticides in Soils.

Table 33 present the results from the soil monitoing carried out during the period 1997-2000.

Table 33 Reference values for the Content of Prohibited for use DDT and HCB

LEVELS	**DDT Total** mg/kg dry soil	**DDE** mg/kg dry soil	**DDT** mg/kg dry soil	**HCB** mg/kg dry soil
Precautionary Levels (PL)	*0,3 ÷ 1,5*	< 0,5	< 0,5	*0,025 ÷0,25*
Admissible Limit Values (ALV)	*1,5*	0,5	0,5	*0,25*
Intervention Value (IV)	> 4	-	-	> 10

Tables 34 & 36 present the results from the soil monitoing carried out during the period 1997-2000.

Table 34 Analyzed samples for POPs pesticides residues in Soil in the RBulgaria for the period 1997-2000

POP pesticide	**1997**				**1998**				**1999**				**2000**			
	No of samples	No of samples <MDL	No of samples <ALV	No of samples >AVL	No of samples	No of samples <MDL	No of samples <ALV	No of samples >AVL	No of samples	No of samples <MDL	No of samples <ALV	No of samples >AVL	No of samples	No of samples <MDL	No of samples <ALV	No of samples >AVL
Aldrin	12	11	1	0	52	47	5	0	89	82	7	0	124	120	4	0
Dieldrin	12	10	2	0	52	52	0	0	89	84	5	0	124	109	15	0
Endrin	12	11	1	0	52	46	6	0	89	83	6	0	124	114	10	0
Heptachlor	12	12	0	0	52	48	4	0	89	80	9	0	124	110	14	0
HCB	12	9	3	0	52	19	33	0	89	67	22	0	124	98	26	0
Total DDT	12	0	8	4	52	0	46	6	89	4	82	3	124	6	118	0

Table 35 Summary of the monitoring data for POPs pesticides levels in soil for the period 1997 - 2000

POPs pesticide	**Total samples/ Positive samples**	**% Positive samples**	**Min/Max Value mg/kg dry soil**	**AVL mg/kg dry soil**
Aldrin	277/17	6,13	0,000012 ÷ 0,00514	
Dieldrin	277/22	7,94	0,000013 ÷ 0,0513	
Endrin	277/23	8,30	0,000015 ÷ 0,0102	
Heptachlor	277/27	9,74	0,000003 ÷ 0,00237	
Hexachlorobenzene	277/84	30,32	0,00002 ÷ 0,00401	0,25
Total DDT	277/263	94,94	0,00007 ÷ 8,994	1,5

The analysis of data about redisual POP pesticides in soils showed that the registered positive samples of aldrin, dieldrin, endrin and heptachlor towards the total number of tested samples are relatively few, respectively 6.13%, 7.94%, 8.30% and 9.74%. Relatively low maximal values were detected for the 4th POPs pesticides. Although not imported and used as pesticide in Bulgaria, probably as a result of emissions, Hexachlorobenzene (HCB) residues are found in 30.32% of tested soil samples, which are significantly lower than the ALV (0,25 mg/kg in dry soil).

On the basis of the analysis and the data about redisual POP pesticides in soils the following conclusions could be made:

DDT and metabolites

In Bulgaria DDT was banned for import and agriculture and public health use 32 years ago.Out of total 277 tested soil samples, in 14 (5.1%) the DDT total residue level is below the minimum detected level MDL.The data demonstrate that DDT still exists in in the environment of almost all regions of the country (94,94% positive samples – table 55). Most of the positive values (212/76,5%) the level of DDT total was below the precautionary levels (PL 0.3 mg/kg). The DDT total residue level in 38 samples was in the range of 0.3 ÷ 1.5 mg/kg dry soil (13.7%). Residues concentrations of DDT total higher than ALV were registered in 10 soil sampling points (3,6%) and only 3 samples (1.1%) were exceeding the intervention value (IV) of 4 mg/kg dry soil *(Table 36).*

Table 36 Analyzed samples for DDT total and metabolites residues in Soil in Bulgaria for 1997-2000

Pesticide/ Metabolite	Total number of samples n	< MDL		<PL < 0.3 – DDT Total < 0.1 – DDE/DDT mg/kg dry soil		PL 0.3-1.5 – DDT Total 0.5 – DDE/DDT mg/kg dry soil		>ALV >1.5- DDT Total >0.5- DDE/DDT mg/kg dry soil		>IV >4 - DDT Total mg/kg dry soil	
		n	%	n	%	n	%	n	%	n	%
DDT Total	277	14	5.1	212	76.5	38	13.7	10	3.6	3	1.1
DDE	277	40	14.4	182	65.7	28	10.1	27	9.8		
DDT	277	33	11.9	202	72.9	28	10.1	14	5.1		

The distribution of DDT total residues in tested soil samples by reference values are shown on *Figure 9.*

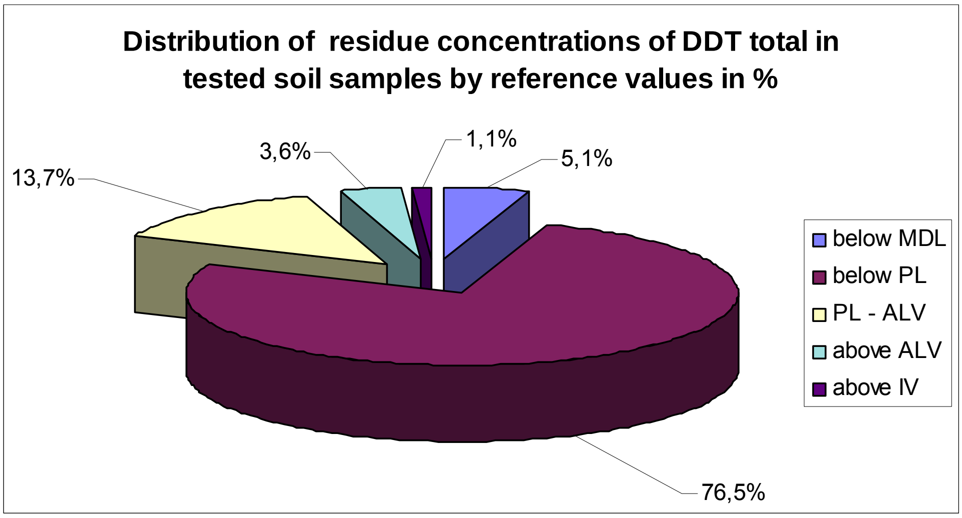


Figure 9 Distribution of DDT total residues in tested soil samples by reference values

The data about excessive DDT and metabolite content in soils by urban centres are presented in *Tables 37 & 38.*

Table 37 Data about measured excessive content of DDT total in soils by urban centres

Year	Area	Urban cetntre	o,pDDE	p,pDDE	o,pDDD	p,pDDD	o,pDDT	p,pDDT	DDE	DDD	DDT	DDT Total
			µg/kg									
1997	V. Tarnovo	Dzulyunitsa	10,000	817,000	10,000	91,000	65,000	1225,000	827,000	101,000	1290,000	2218,000
1999	Vidin	Kiriaevo	23,800	1530,000	17,000	177,000	230,000	1445,000	1553,800	194,000	1675,000	3422,800
1999		Novo selo	10,800	671,000	24,692	128,000	163,000	830,000	681,800	152,692	993,000	1827,492
1997	Vratsa	Hairedin	26,000	3756,000	23,000	112,000	117,000	556,000	3782,000	135,000	673,000	4590,000
1997		Mizia	40,000	7423,000	39,000	205,000	192,000	1095,000	7463,000	244,000	1287,000	8994,000
1997	Montana	Azadzhiski dol		66,000		221,000	31,000	2312,000	66,000	221,000	2343,000	2630,000
1998	Pazardzhik	Malo Konare	194,310	1013,250	69,110	376,470	105,610	913,500	1207,560	445,580	1019,110	2672,250
1998		Zvanitchevo	7,010	804,170	56,480	136,530	91,010	527,750	811,180	193,010	618,760	1622,950
1998		Septemvri	91,990	1010,760	73,570	229,150	64,880	971,050	1102,750	302,720	1035,930	2441,400
1999		Ognianovo	18,140	2062,200	3,350	11,190	100,500	377,600	2080,340	14,540	478,100	2572,980
1998	St.Zagora	Kirilovo	10,430	767,320	6,450	32,940	101,470	1351,770	777,750	39,390	1453,240	2270,380
1998		Bratia Daskalovi	28,100	1056,450	12,550	42,930	208,250	1558,000	1084,550	55,480	1766,250	2906,280
1998		Gorno Belevo	402,710	1191,860	74,240	195,720	1494,260	1920,370	1594,570	269,960	3414,630	5279,160
ELV									**500,000**	**500,000**	**500,000**	**1500,000**

Table 38 Data about measured excessive content of some DDT metabolites in soils by urban centres

Year	Area	Urban cetntre	o,pDDE	p,pDDE	o,pDDD	p,pDDD	o,pDDT	p,pDDT	DDE	DDD	DDT	DDT Total
			µg/kg									
	Blagoevgrad	Gotse Delchev	4,900	1197,000	12,000			196,000	1201,900	12,000	196,000	1409,900
2000	Burgas	Vetren	9,383	607,500	6,478	44,889	78,638	739,690	616,883	51,367	818,328	1486,578
1999	Vidin	Rakovitsa	9,660	496,000	4,510	27,500	45,700	204,000	505,660	32,010	249,700	787,370
2000	Kyustendil	Dupnitsa	5,480	500,000	9,100			117,000	505,480	9,100	117,000	631,580
1998	Pazardzhik	Pazardzhik	4,360	1038,220	12,130	18,480	8,250	7,650	1042,580	30,610	15,900	1089,090
1998	Plovdiv	Dolna Mahala	20,010	880,200	8,960	24,850	7,620	12,270	900,210	33,810	19,890	953,910
1998		Parvomai	7,350	911,690	6,160	10,170	8,040		919,040	16,330	8,040	943,410
1998		Tsalapitsa	10,660	882,580	16,540	50,780	1,830	24,030	893,240	67,320	25,860	986,420
1998		Perushtitsa	9,760	1321,100	12,430	35,470		10,270	1330,860	47,900	10,270	1389,030
1999	Sofia-city	Chelopechene	9,050	625,000	9,610			839,000	634,050	9,610	839,000	1482,660
1999	Sofia-district	Stolnik	7,775	573,000	6,530			203,000	580,775	6,530	203,000	790,305
2000		Elin Pelin	5,500	1139,000	8,100			54,600	1144,500	8,100	54,600	1207,200
1998	Stara Zagora	Malka vereia	3,830	573,680	1,650	10,440	19,100	205,160	577,510	12,090	224,260	813,860
1998	Haskovo	Brod	18,900	710,730	42,120	47,450	2,090		729,630	89,570	2,090	821,290
1998	Yambol	Veselinovo	2,640	808,490	0,940	5,560	2,820	42,210	811,130	6,500	45,030	862,660
ELV									**500,000**	**500,000**	**500,000**	**1500,000**

Out of all tested 277 soil samples 10 samples (3.6%) contain DDT total>ALV up to 4 mg/kg dry soil, as for 9 samples the level of p,p'-DDE and p,p'-DDT was exceeding ALV (0.5 mg/kg). Higher concentrations were detected in 5 districts as follows – Veliko Tarnovo, Vidin, Montana, Pazardjik and Stara Zagora. The ratio of p,p'-DDE to p,p'-DDT was in the range of 0.53 ÷ 4.35, indicating for increased value of the main metabolite p,p'-DDE, a cerain trend of breakdown and old contamination of soil with DDT. In the soil sample taken from Azadzhiski dol, Montana the ratio of p,p'-DDE to p,p'-DDT was 0.3, indicating a recent soil pollution due to illegal use of DDT after its ban for import and use in 1969.

In 3 soil samples taken from 2 points in Vratza district and in 1 point in Stara Zagora district were registered residue content of DDT total above 4 mg/kg dry soil, amounting 1.1% of total analyzed samples. The ratio of p,p'-DDE to p,p'-DDT was in the range of 0.46 ÷ 5.79 and is an evidence of old soil contamination.

Conclusions:

- **No soils polluted with the following POPs - aldrin, dieldrin, endrin, heptachlor and hexachlorbenzene exist in all of the studied regions of R Bulgaria.**

- **DDT and its metabolites still exists in in the environment of almost all regions of the country.**
- **Most of the positive values (76,5%) of DDT total are below the precautionary levels of 0.3 mg/kg and 13.7% - within the range of 0.3 ÷ 1.5 mg/kg .**
- **Despite the ban on DDT use since 1969, residues of DDT total higher than admissible limit value of 1.5 mg/kg are registered in 3,6% of soil samples within the period 1997-1999.**
- **Only 1.1% of samples are exceeding the intervention value of 4 mg/kg. Nevertheless the ratio of p,p'-DDE to p,p'-DDT is an evidence of old soil contamination, new sampling at the same points is required and if necessary remediation measures and clean up sites should be taken.**
- **The summarized analytical data show that about 95% of soils in the country are not polluted with DDT.**

Local soil pollution in the vicinity of old pesticides storages[10]

The Plant Protection Institute, Kostinbrod had carried out a two years (1994 - 1996) investigation on pesticides soil pollution in the neighborhood of obsolete pesticides storages in Sofia district: The selected sites included 7 storehouses of obsolete pesticide in Kostinbrod, Aldomirovtsi, Vakarel, Bojurishte, Ichtiman and Slivnitsa. Samples were collected from plots in front of the depots and at 50 m distance. Soil drill was used for sampling until 1 m depth at 20 cm layer interval.

[10] Balinova A.,"The Obsolete pesticides stocks in Bulgaria – a source of long-term contamination of the environment", 7th International HCH and pesticides forum, Kiev, Ukraine, 2003, pp 187-190.

Individual samples were collected from 10 points at each plot of the selected layers. 27 target pesticides including also the following POPs – heptachlor and DDT metabolites (p, p'DDT, o, p-DDT, p, p'-DDE, o, p'-DDE) were analyzed by GC method.

In all cases, soils in the neighborhood of the observed point sources were heavily polluted with complex of different pesticides. 3 of DDT metabolites were determined in the surface soil samples with different maximum concentrations (*Table 39).*

Table 39Maximal Concentrations of DDT metabolites in the Surface Soil

DDT metabolite	Frequency %	Maximum concentrations (mg/kg)
p,p'-DDE	85.7	29.4
p,p'-DDT	71.5	700
o,p-DDT	71.5	200

Extremely high concentrations were determined for some metabolites such as p, p'-DDT , o,p-DDT and p,p'-DDE in the surface soil that were hundreds times exceeding the concentrations resulting after normal agricultural practice. The data corresponds to the great quantities of DDT used in agriculture in the past.

Characteristic examples of distribution patterns of the DDT metabolites in soil profiles are shown in *Figures 10 and 11.*

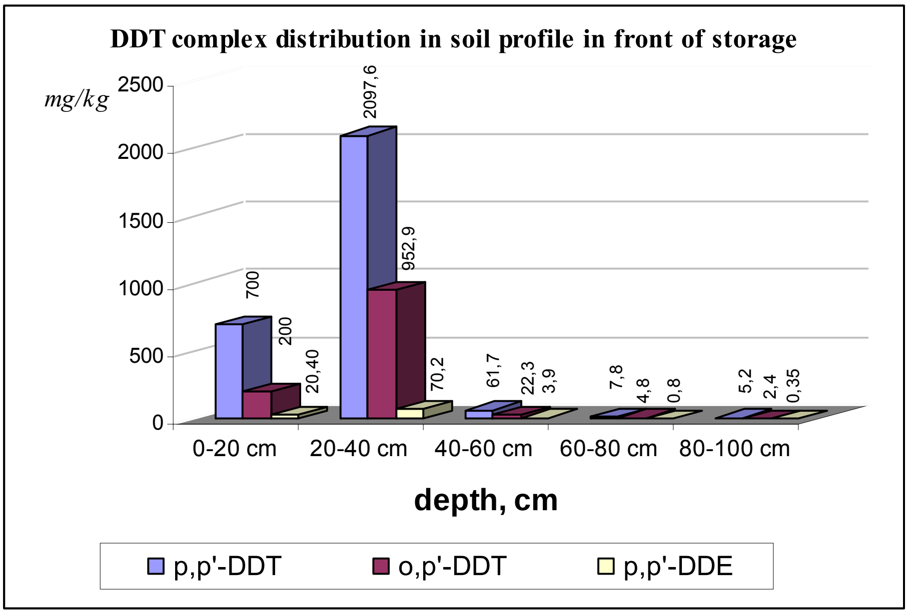


Figure 10 DDT complex distribution in soil profile in front of storage

Results confirmed that the rate of the vertical migration of the investigated DDT metabolites into soil profile is strongly influenced by their concentrations. Compounds characterized as nearly immobile in soil, such as DDT showed remarkable leachability under conditions of permanent extreme concentrations. Residues within a range of about 0.35 ÷5.2 mg/kg were determined at 80-100 cm depth. .

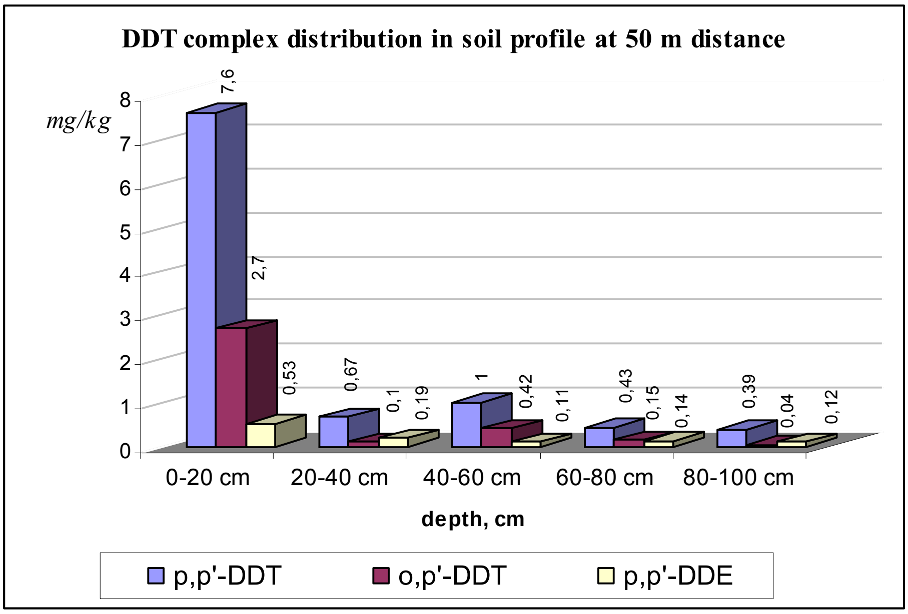


Figure 11. DDT complex distribution in soil profile at 50 m distance from storage

Contamination at 50 m distance was detected in most cases at similar rates as in vicinity of the depots, although hundreds time decreased in comparison . For example p,p'-DDT in front of storage in the 0-20 cm soil layer depth is 700 mg/kg, while at 50 m distance – 7.6 mg/kg. The results indicate that in vicinity and at 50 m distance of the depots a real hazard exists for the surface waters, agricultural land, crops etc. The distribution of DDT complex in depth 80-100 cm poses no hazardous risk for groundwater.

The contamination of the investigated sites was mostly a result of accidental events such as spilling of formulations,working solutions etc. The ratio p,p'-DDE/p,p'-DDT is 0.042, and is an evidence of direct soil contamination. The occurrence of high residues many years after the last practices was due to the improper handling and non-compliance with the requirements for save work. Pesticides detected outside the storehouses represent high potential risk of environmental pollution.

Opsolete pesticides impact on rural environment by small-scale incidents[11,12]

For a period of 8 years (1993 – 2000) eleven cases of fire incidents associates with obsolete pesticides stocks were registered in Bulgaria. All of them occurred in rural areas. As point sources of environmental pollution with POPs were considered storage sites and related accidental events – fires, releases to the environment, illegal entering in storehouses.The study was addressed mainly to POPs pesticides. DDT total, DDT-isomers and metabolites by GC/ECD were analised.[5]

To assess the pollution impact on the environment, samples were taken after extreme weather accident in the village of Rani list. The roof of the storage was destroyed because of storm and part of the pesticides mainly DDT was spread. The land around the storage place was used as a pasture and capped water spring (40 m away) with a pool for animals' watering. After the event 2 soil samples were taken in the vicinity (№ 1 , № 2) and 1 (№3) at 60 m distance from the sorage as well as 1 water sample (№4) from the watering pool. The results of DDT and metabolites are presented in *Table 40.*

[11] Kamburova V.,"Impact of obsolete pesticides on rural environment",J.Balkan Ecology, 2004,Vol.7, No 4, pp 422-427.

[12] Kamburova V., J.Christova, Zl.Bratanova, "Environmental pollution with organochlorine pesticides by small-scale incidents", Fresenius Environmental Bulletin, 2005, Vol. 14, No 3,pp 1-4.

Table 40. DDT and metabolites content in soil and water after the incident in v.Rani list

DDT & metabolites	Soil samples, mg/kg			Water, μg/l
	№1	№2	№3	№4
p,p'- DDT	6.20	6.00	0.60	0.030
o,p'- DDT	0.50	0.40	0.09	0.009
p,p'- DDE	2.70	5.10	0.06	< 0.005
p,p'- DDD	0.90	2.50	0.60	< 0.005
DDT total	10.30	14.00	1.35	0.039

The DDT content in the soil shows high pollution levels in the vicinity of the storehouse (№ 1, № 2) exceeding IL of 4 mg/kg. Considering the DDE/DDT ratio, it might be assumed that it was a result of past contamination. The DDT total in soil collected at the remote site (№3) was close to the admissible limit value ALV (1.5 mg/kg) and above the precautiona level PL (0.3 mg/kg). The DDE/DDT ratio indicates recent contamination and spreading the contamination towards the watering place. This was confirmed by the analysis detecting traces of DDT total (0.039 μg/l) in the water sample (№4). Immediate measures for safe making and repair of the storage were taken.

The level of pollution was assessed at representative points around 9 storage places being in bad condition. Soil samples were taken from 15 points close to store houses. The results are presented in *Table 41.*

Table 41. DDT & metabolites contents in soil near storage house of obsolete pesticides

Number of points	Storage location	POPs content in soil, mg/kg				
		p,p'-DDT	o,p'-DDT	p,p'-DDE	p,p'-DDD	DDT total
1	Iskrets	2.10	0.03	0.60	0.12	2.85
2	Iskrets	0.80	0.11	0.09	0.09	1.09
3	Iskrets	0.02	< 0.02	0.02	0.03	0.07
4	Iskrets	0.03	0.02	0.03	0.02	0.10
5	Iskrets	0.66	0.06	0.24	0.09	1.05
6	Chepintsi	1.80	0.10	0.50	< 0.02	2.40
7	Chepintsi	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
8	Chepintsi	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
9	Elin Pelin	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
10	Chelopech	0.18	< 0.02	0.30	< 0.02	0.48
11	Pirdop South	1.30	0.09	1.00	0.06	2.45
12	Anton	0.18	< 0.02	0.09	< 0.02	0.27
13	Piperovo	0.03	< 0.02	0.03	0.02	0.08
14	Pancharevo	0.21	0.02	0.21	0.24	0.68
15	Dragovishtitsa	0.80	0.10	0.40	1.00	2.30

The data indicated that the area close to the storages was mostly contaminated one. In the cases where the storehouses were in bad status due to improper handling and non-observance of sanitary standars in location №№1, 6, 11 and 15 the levels of DDT total in the soil exceeded the ALV of 1,5 mg/kg. The values were in the range of 2.30 ÷ 2.85 mg/kg . In the region of village Iskrets (№ 2) the pollution is spread even over the closely situated corn field. The detected content of DDT total – 1.09 mg/kg exceeded the PL of 0.3 mg/kg. It is well understood that the presence of DDT in soil is generally a result from contamination due past use.

Two follow-up studies related to incidents with obsolete pesticides stocks registered 1997 in Bulgaria had been carried out. The contamination of local environment (water and soil) had been assessed immediately after the events and several years later. DDT total and metabolites, heptachlor, heptachlor epoxide were analysed by GC/ECD.[13] Two rural places were in the focus of the study.

The first incident was registered yearly in spring of 1997 near the village Zvunartsi.By excavation storehouse ruins and sacks labeled as DDT were found out. The sacks wre repacked and transported to safeguarded storage place. An area of 25 m^2 was excavated to a depth of 2 m and the contaminated soil was tracked away for disposal. In spite the remedial measures, there were complains from the inhabitants for smell and death of poultry. Samples were taken from the capped spring, located 200 m far from the place of the incident and from 2 microreservoirs, situated 500 m away. Soil was sampled from the place of the store ruins. The second set of sample from the same places was collected in 2000.
The analytical results of spring, microreservoirs and soil samples are presented in *Table 42.*

Table 42. DDT levels in water and soil samples from the region of Zvunartsi

DDT & metabolites	Year 1997					Year 2000
	Groundwater samples,µg/l	Surfacewater samples,µg/l		Soil samples, mg/kg		
	No 1	No 2	No 3	No 4	No 5	No 6
p,p'- DDT	0.09	0.37	0.27	875	1750	1030
p,p'- DDE	0.02	0.15	0.06	625	1000	20
o,p'- DDT	0.01	0.05	0.14	105	192	140
o,p'- DDE	< 0.02	< 0.02	< 0.02	10	28	15
DDT total	0.13	0.57	0.48	1615	2970	1205

The concentration of total DDT in groundwater sample No 1 was comparable with the pollution threshold level (0.10 µg/l), but higher the ecological threshold (0.01 µg/l). Higher levels of DDT residues were detected in the local surfacewater samples 2 and 3, respectively 0.57 and 0.48 µg/l.

The low ratio DDE/DDT (between 0.22 and 0.41) indicated recent pollution events. Total DDT up to 2970 mg/kg were detected in soil semples 4 and 5.The values determined in both soil samples exceeded the intervention value of 4 mg/kg. In the water samples, collected in 2000 no DDT total, isomers and metabolites were found. The total concentration of DDT (1205 mg/kg), taken almost 4 years after the incident (sample 6) was several orders of magnitude above the the intervention value.

The second incident occurred at the outskirts of the town Koinare in May 1997. The investigation was initiated due to a fish perish in a breeding pond, fed up by a small river and located 300 m away from an old storehouse for obsolete pesticides.Throwing away of pesticides into the river was supposed. The drinking water source of the town was located about 1 km from the stockpile. Water samples were taken immediately after the incident and a month later from the river, the breeding pond and the drinking water source. In 1999 the pesticides sorage was liquidated. The rests were barried in concrete reservoirs and covered with soil without any waterproof material. A follow-up sampling was performed in January 2001 and soil samples were taken from the surface layer on embankment. Water samples were collected from the pond and the nearest consumer's tap.
The results of the investigation are presented in *Table 43.*

Table 43. POPs pesticides levels in water and soil samples from the region of Koinare

Pesticide	Year 1997[1]						Year 2001[2]
	Water samples ,μg/l						Soil samples, mg/kg
	River		Breeding pond		Drinking water		Embankment
	1	2	3	4	5	6	7
p,p'- DDT	0.19	< 0.02	0.17	< 0.02	0.83	0.08	1.2
p,p'- DDE	0.06	< 0.02	0.04	< 0.02	0.30	0.19	0.8
o,p'- DDT	0.06	< 0.02	0.08	< 0.02	0.46	0.09	< 0.1
o,p'- DDE	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.1
DDT total	0.31		0.29		1.59	0.36	2.0
Heptachlor	-[3]	-	-	-	-	-	6.9
Heptachlor epoxide	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.45

(1) soil samples were not collected in 1997;
(2) no residues were found in the water samples collected in 2001.
(3) "-" the compound was not analyzed.

DDT andits main metabolite DDE had been detected in all water sampes in 1997. In the river (No 1), in breeding point (No 3), and in drinking water (NoNo 5,6) the values exceeded the pollution threshold of 0.1μg/l.These values affect adversely the aquatic species. Environmental exposure concentration of 0.1μg/l could cause inhibition of growth and photosynthesis in green algae. DDT is considered to be highly toxic to aquatic invertebrates at concentration as low as 0.3 μg/l. The concentration of DDT total in drinking water was 1.59 μg/l exceeding 3 times the limit (0.5μg/l) laid down from the preventive point of view for human consumption water (Council Directive 98/83 EC), but approaches the WHO guideline value of 2 μg/l for DDT and its metabolites relevant for lifetime exposure via drinking water (WHO, 1993). The low ratio DDE/DDT in all samples point at continuing release of DDT into the water. DDT residues in the drinking water (No 6) were confirmed a month later, but a lower level of 0.36 μg/l. The water analysis carried out two years after the liquidation of the storehouse evidenced no residue of DDT and its metabolites, heptachlor and heptachlor epoxide.

DDT total (2,0 mg/kg); p,p'- DDT(1.2 mg/kg) and p,p'-DDE(0.8 mg/kg) were found in soil sample No 7 in 2001. It is evident that the embankment remains as a local hot spot and potential source for additional environmental pollution. Further clean-up activities are necessary in order to eliminate this problem.

Conclusions:

Obsolete pesticides storehouses are an important point source of pollution, representing a risk for soil and water contamination. The percentage contribution to local soil contamination, caused by 715 storage sites for obsolete pesticides, estimates to 10.5% from all main types of local pollution sources.[13]

The local environmental consequences after incidents are often neglected, but their contribution to the problem is important because of the improper extent of the actions undertaken. The data obtained from the places of incidents stress the necessity of continuous pollution monitoring and control of the effectiveness of the performed remedial measures on a long-term and broader scale in order to minimize the ecological threat and to avoid the risk for human health.

13 Progress in the management of local soil contamination, Soil Contamination 2003 Delivery Report of EEA/MoEW, Bulgaria to EIONET

5.1.1.3. POPs pesticides levels in food

The control over the foods is implemented by Ministry of Agriculture and Ferestry and Ministry of Health.It is carried out by the State Control Authorities under the Health Act, the Law on veterinary and medical activity and the Law on storage and marketing of grains.

The Authorities of State Sanitary Control (SSC) exercise control over all foods , excluding the foods from animal origin.

From the numerous control analysis of different food stuff from vegetable and animal origin (average 2200 food products for the Year 2003) made by accredited laboratories of Ministry of Health (MoH) in Bulgaria, it was not found food samples, exceeding the maximum admissible residual concentration (MARC) for POPs pesticides residues in foods.

The Authorities of State Veterinary Control (SVC) exercise control on foods from animal origin, including their import, transit and export.

The National Veterinary Medical Service (NVMS) at the Ministry of Agriculture and Forestry (MoAF) is the national competent authority responsible for the National Monitoring Program for Control on Residues (NMPCR), including POPs in live animals and animal products intendet for human consumption. It is authorised to organize, manage, control and carry out the NMPCR trough the Regional Veterinary Services. The Central Laboratory of Veterinary Control and Ecology (CLVCE) perform the laboratory tests.

All animal species, types and products which are subject to control, are specified in the relevant annual plans for control on residues. The National Monitoring Program for Control on Residues (NMPCR) in live animals and animal product includes:

- live animals and fresh meat – cattle, horses, sheep, lambs, goats, kids and pigs;
- poultry – ducks, goose and hens;
- eggs - hen eggs and quail eggs;
- fish - carp, silver carp, hausen, trout, pike and perch;
- milk - sheep and cow milk;
- game - deer and pheasants;
- farmed game – pheasants and rabbits;
- bee honey.

Individual samples are tested for Residues of antibacterial substances, phosphorus organic or organochlorine compounds - organic substances, including such as PCBs, chemical elements, mycotoxines or radionuclides in Life animals and animal products - red meat; poultry; hen eggs; raw milk; fish; bee honey; farmed and wild game. NVMS publishes annual report on residues detected.

The analysis of the results from the NMPCR for 2003 in regard with POPs pesticides and PCBs are given in Table 45.[14]

[14] National Monitoring Programme for Control on Residues from Medicinal products and Environmental pollutions in Live animals and Foodstuffs of animal origin, MoAF, NVMS, 2004, pp 40-63.

Table 44 POPs Residues in live animals and animal products in Bulgaria for 2003

Animals and animal products	B (3) (a) Group of substances: Organochlore compounds including PCBs	Matrix	Laboratory Method	Number of Samples	Number of samples above Action Level
FRESH MEAT	Aldrin DDT tot Heptachlor epoxide PCBs	Fat	GC	18 cattle /< 2 years/ (S); 35 f.p. (S); 8 sheep (S); 34 lambs (S); 3 goats(S); 9 kids (S)	None
POULTRY	Aldrin DDT tot Heptachlor epoxide PCBs	Fat	GC	8 ducks 4 geese 27 hens	None
FISH	Aldrin DDT Heptahlor epoxide PCBs	Fat	GC	25 fish carp 21 fish silver carp 14 fish trout 8 sturgeon 4 hausen fish	None
ROW MILK	Aldrin DDT Heptahlor epoxide PCBs	Milk	GC	12 cows milk 6 sheep milk	None
HEN EGGS	Aldrin DDT Heptahlor epoxide	Eggs	GC	18 hen eggs	None
FARMED GAME	Aldrin DDT Heptahlor epoxide PCBs	Fat	GC	9 pheasant 2 rabbits	None
WILD GAME	Aldrin DDT Heptahlor epoxide PCBs	Fat	GC	3 partridges 2 rabbits	None
BEE HONEY	Aldrin DDT Heptahlor epoxide	Bee honey	GC	53	None

Explanatory Notes:
GC - Gas Chromatography
(S) – slaughter animals/ slaughtered cattle / < 2 years /
(f.p.) – fattening pigs

The analysis of the results from the National Monitoring Programme for control on residues (NMPCR) of POPs in food and foodstuff from animal origin intended for human consumption for 2003, indicated in Table 36, shows the following:

Red meat - Out of the total 1231 analyzed individual samples of live or slaughtered animals, 107 samples of slaughtered cattle (18), pigs (35), sheep (8), lambs (34), goats (3) and kids (9) have been tested for POPs residues. There have not been any presence of residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT,Heptahlor epoxide and PCBs in the tested samples of Bovine, Swine , Ovine, Lamb, Caprine and Kid fresh meat.

Poultry - There were totally 388 samples of liver, muscle and fat of poultry (ducks, goose and hens) tested. For POPs residues 71 fat saples had been analyzed in 8 ducks, 36 goose and 27 hens. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT,Heptahlor epoxide and PCBs in all tested samples of ducks', goose' and hens' fat has been detected.

Hen eggs - Out of 58 samples of hen eggs, 18 were sampled and tested for POPs pesticides residues. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT and Heptahlor epoxide in the tested samples of hen eggs has been detected.

Fish - Out of the totally 107 analyzed individual samples of fish , 72 samples of trout (14), carp(25), silver carp(21), sturgeon (8) and hausen (4) have been tested for POPs residues. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT,Heptahlor epoxide and PCBs in the tested samples of trout, carp, silver carp, sturgeon and hausen fish has been detected.

Row Milk - There were totally 63 samples from row milk tested and analysed, out of which 18 samples of cow milk (12) and sheep milk (6) had been tested for POPs residues. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT,Heptahlor epoxide and PCBs in the tested samples of row milk has been detected.

Bee Honey - Out of totally 129 samples from bee honey, 53 samples were tested for POPs residues. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT and Heptahlor epoxide in the tested samples of bee honey has been detected.

Farmed Game - Out of the totally 54 samples of farmed game analyzed, 11 fat samples of pheasants (9) and rabbits (2) have been tested for POPs residues. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT,Heptahlor epoxide and PCBs in the tested samples of farmed pheasants and rabbits has been detected.

Wild Game - There were 16 samples of wild game tested , out of which 5 fat samples of rock partridge (3) and wild rabbits (2) had been analysed for POPs residues. No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT,Heptahlor epoxide and PCBs in the tested samples of Rock partridge and wild rabbits has been detected.

Conclusions:

- **No presence of any residues of POPs pesticides exceeding the maximum admissible residual concentration (MARC) in the tested 2200 foodstuffs from vegetable and animal origin for the Year 2003 has been detected.**
- **No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT, Heptahlor epoxide and PCBs in the tested samples of Live Animals, Fresh Meat, Poultry, Fish, Farmed & Wild Game, Raw Milk, Hen Eggs and Bee Honey in Bulgaria for the Year 2003 has been detected.**

5.1.2.POPs pesticides levels in human body

Under the international project developed by 19 European countries, "WHO-coordinated Exposure Study on the Levels of PCBs, PCDDs and PCDFs in Human Milk, Organohalogen Compounds, 2003"[15], a study was conducted in Bulgaria of the content of persistent and chlororganic pesticides in mothers' milk from 30 healthy women, in groups of 10 from three regions (Bankya – ecologically clean area and two others – Sofia and Blagoevgrad – polluted in varying degrees).

- The preliminary results show no presence of endrin, toxaphene and mirex in the mothers' breast milk in the ecologically clean region of Bankya.
- The following POPs pesticides were present in breast milk of Bankya region – hexachlorbenzene (0.012 mg/kg lipids), chlordane (0.018 mg/kg lipids), heptachlor (0.013 mg/kg lipids), dieldrin/aldrin (0.004 mg/kg lipids) and $\sum$ DDT (0.499 mg/kg lipids), presented by pp'-DDE (0.452 mg/kg lipids), op′-DDT (0.003 mg/kg lipids) and pp′-DDT (0.044 mg/kg lipids). The large predominance of pp' – DDE in samples suggests the general absence of recent DDT sources.
- The results for POPs pesticides residues in mothers' breast milk from Sofia and Blagoevgrad region are still in the process of finalizing.

5.2. Human health impacts

POP pesticides may enter human body by respiratory, dermal and oral pathway, and they accumulate mainly in breast-milk, blood and fat tissue of human organisms. They are eliminated by mothers' milk and could be dangerous for breast-fed children.

The chronic exposure to POP pesticides may lead to negative impacts on central and peripheral nervous system, gastro-intestinal tract, the liver (toxic hepatitis with different extent of functional disturbances), skin irritations and allergic reactions. Representatives of POP pesticides in contact (respiratory, dermal and oral) with living organisms

[15] WHO-coordinated Exposure Study on the Levels of PCBs, PCDDs and PCDFs in Human Milk, Submitted to Dioxin 2002. Organohalogen Compounds, 2003.

may cause cancer or increase carcinogen sick rate, male and female reproductive functions and hereditary genetic defects.

The connection between hazard classification and health risk of POP pesticides has been a subject of lot of research work *(Table 45 and Fig.12).*

Table 45 Hazard Classification and health risks of POP pesticides

Pesticides	**LD_{50} (mg/kg b.m.) WHO***	**Class of Hazard WHO***	**Category of carcinogenicity JARC****	**Harmful effects to human health**
Aldrin	98	I b	3	Immunotoxicity, chronic liver effect, male reproductive system and central nervous system impact
Dieldrin	37	I b	3	Immunotoxicity, chronic liver effect, male reproductive system and central nervous system impact
DDT and metabolites	113	II	2B	Immunotoxicity, interference with estrogenic system, possible endocrine disruption , thyroid, adrenal and retinol effects
Endrin	7	Ib	3	Allergic reactions, toxic hepatitis , central and peripheral nervous system damage
Heptachlor	100	II	2B	Possible endocrine disruption, reproductive disorders
Hexachlorobenzene	> 10 000	Ia	2B	Effects on nervous, thyroid, immune, reproductive and endocrine systems , porphyria at humans
Toxaphene	80	II	2B	Central and peripheral nervous system damage, possible endocrine disruption
Chlordane	460	II	2B	Endocrine system impact, reproductive disorders and immunotoxicity
Mirex	306		2B	Teratogen, possible endocrine disruption, immunotoxicity, reproductive and development system impact.

* **WHO – Hazard Classification of WHO of POP pesticides**

(**Class of Hazard:**

Ia – extremely hazardous;

Ib – highly hazardous;

II - moderately hazardous;

III – slightly hazardous.

** **IARC – Classification of agents, mixtures and exposures according to their carcinogenic risk to humans in accordance with the procedures adopted as standard IARC practice:**

Group 1 - carcinogenic to humans;

Group 2A - probably carcinogenic to humans;

Group 2B - possibly carcinogenic to humans;

Group 3 - not classifiable as to carcinogenicity to humans;

Group 4 - probably not carcinogenic to humans.

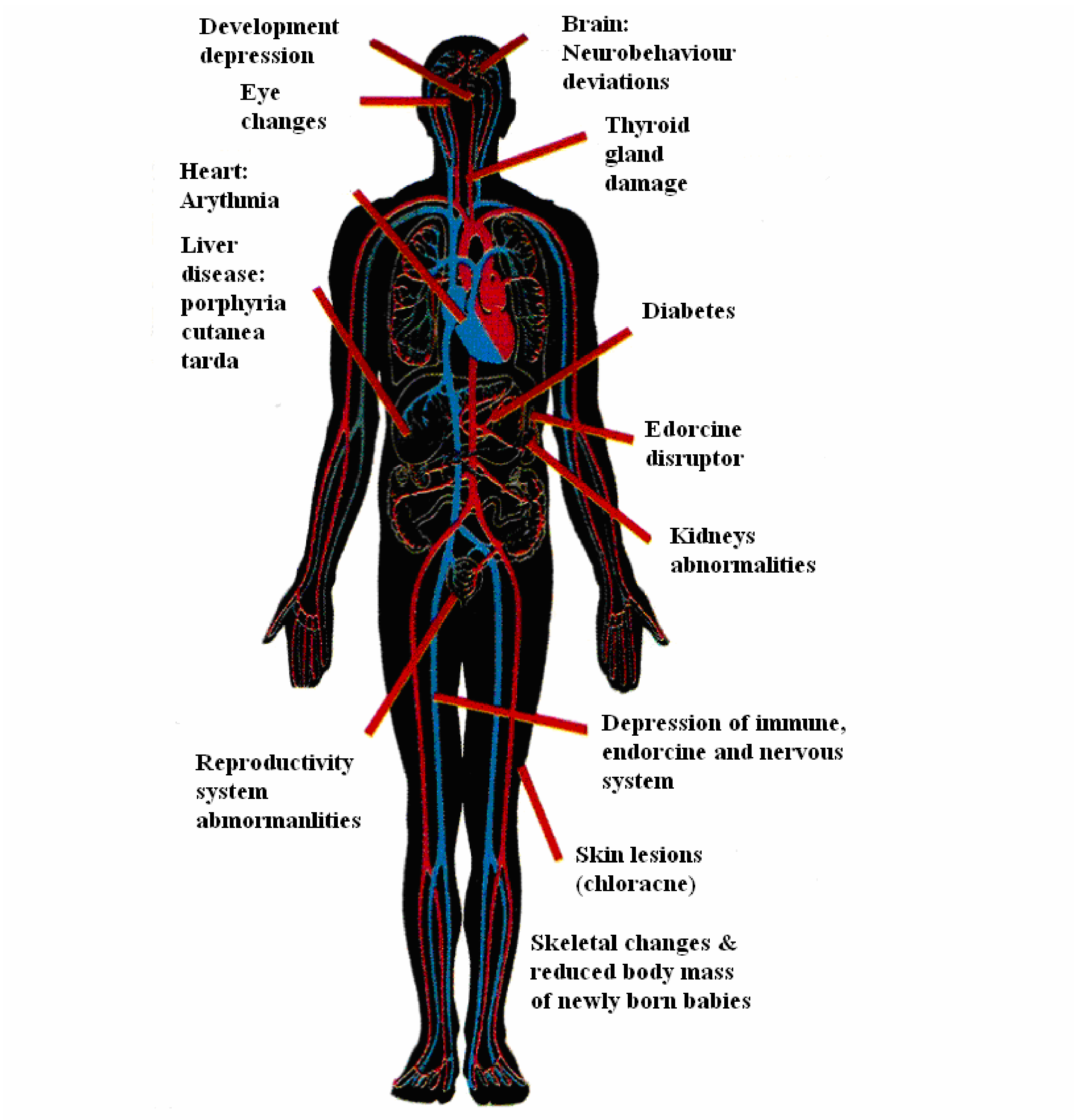


Figure 12 Potential effects on human health of POPs

Conclusion:

- **No cases of acute and chronic intoxication with persistent chlororganic pesticides have been registered in the Republic of Bulgaria**

Risk assessment by modeling of exposure and effects

Although risk assessment is not an exact science, it continues to be the milestone for decision making in regard with environmental and human health protection. Competent Authorities examine human and animal studies to determine the health effects of a particular contaminant. Both carcinogenic and non-carcinogenic health effects were examined. The investigations about the relation between the DDT and aldrin exposures of humans and cancer occurance continue, nevertheless, the human data are controversial. The allowable level of a contaminant in soil and the health-based clean-up criterion were determined, using combined toxicity, exposure data and risk management factor. Of 14 case control studies published in 2000, there is a positive correlation between breast cancer occurance and the levels of DDT or dieldrin in blood or adipose tissues (Simeonov, 2001[16]) only in 5. Estimation of risk for adults and children in 4 diffrenet scenarios (agricultural, industrial, recreational and urban) was performed in 2001 using Human Exposure to Soil Pollutants (HESP) Model. In the monitoring study 15 districts were included. Soil monitoring data (maximum and average concentrations) were used. The HESP model is directed towards assessment of human exposue to chemicals, which are present in the environment as soil pollutant. The main exposure routes are: ingestion, inhalation and dermal absorption. These main exposure routes have been devided according to environmental media involved:

- **a.** Direct ingestion of small quantities of soil or dust as well as indirect exposure via consumption of drinking water, ingestion of vegetables, fruits, meat and dairy products, poultry, eggs and fish;
- **b.** inhalation of vapours, particulates as inhalation of vapours during bathing or showering;
- **c.** dermal exposure to soil or dust, as dermal exposure during bathing.

The magnitude of exposure is relevant to the particular situation, which can be selected and included in the calculation depending on the use of the land or characteristics of the agricultural land. The model calculates cumulative and maximum intakes for adults and children living at the contaminated site. The calculated total exposure indicates an annual average. Therefore, the calculated results of daily intake (DI) can be compared with tolerable/acceptable daily intake levels (ADI).

For example: In the Netherlands, the tolerable daily intake (TDI) of DDT equals 0.0200 mg/kg.day. The USA EA Reference dose (RfD of DDT) equals 0.0005 mg/kg.day. The Risk Quotient represents the ratio of maximum or average DI/TDI or D/RfD. Its levels: > 1 – large(L); 0.1÷1 – moderate(M); 0.01÷0.1 – small(S); and < 1-negligible(N). The input parameter used were:

(1) Physical-chemical properties;
(2) Polluted areas (length and width of site): 1 hectare;
(3) Concentration of the contaminant (in upper, medium and deep layers) assessed according to the quantity of application per hectare;
(4) Type and properties of soil: standard soil with 100% organic content;
(5) Land use: agricultural;
(6) Exposure conditions: (inter alia) time spent on the land in various activities.

Fixed values (climate, human food consumption parameters) were also taken from the Netherlands default scenario.

The risk is negligible in all regions if the risk quotient DI/Netherlands TDI is used for the calculation.

[16] Simeonov, J.(2001),"Analysis of studies relating pesticides to breast cancer risk in exposed persons and their offspring."In:Euroworkshop Proceedings Current Epidemiological Evidence versus Experimental Data on Reproductive and Development Toxicity of pesticides (T.Vergieva and F.Kaloyanova-Simeonova), Sofia, pp 193-216.

In *Tables 46 & 47* risk indicating data are given ,calculated using the quotient DI/RfD(US EPA). The data are part of the Case Study on persistent organic pesticides implemented in Bulgaria in 2001[17].

Table 46 Risk for children and adults from DDT soil contamination, based on modeling estimation (HESP model)

District	Adult				Children			
	1	2	3	4	1	2	3	4
Montana								
Max.Conc.	S	S	S	-	M	-	S	S
Av. Conc.	S	-	-	-	-	-	-	S
Pleven								
Max.Conc.	-	-	-	-	S	-	-	-
Vratza								
Max.Conc.	-	-	-	-	S	-	-	-
Burgas								
Max.Conc.	-	-	-	-	S	-	S	-
Stara Zagora								
Max.Conc.	-	-	-	-	S	-	-	S
Pazardjik								
Max.Conc.	S	-	S	-	M	-	S	S
Av. Conc.	S	-	-	S	S	-	S	S
Plovdiv								
Max.Conc.	S	-	S	-	M	-	S	S
Av. Conc.	-	-	-	-	S	-	-	S
Haskovo								
Max.Conc.	S	-	-	-	S	-	S	-
Sofia								
Max.Conc.	M	S	S	S	L	-	M	M
Av. Conc.	S	-	-	-	-	-	S	S
Blagoevgrad								
Max.Conc.	-	-	-	-	S	-	-	S
Av. Conc.	-	-	-	-	S	-	-	-
Smoljan								
Max.Conc.	S	S	S	-	S	-	S	S
Av. Conc.	S	-	-	-	S	-	S	S

1 – Agricultural/Rural; **2** - Industrial; **3** -Recreational; **4** - Urban. **Risk: S** (small) ; **M** (medium) ; **L** (large);

The average annual concentrations of DDT in all monitored regions represent no risk for the general population .Only maximum concentrations of DDT represent more than small rick for the rural general population in the polluted sites. For children it is considerable in the Sofia rural (1) district and moderate in Montana, Pazardjik and Plovdiv rural districts (1) and Sofia Recreational district (3). For adults moderat risk exists only in Sofia ruaral district (1).

[17] Kaloyanova-Simeonova F., et all, Human exposure and Risk assessment of soil pollution with Persistent Organochlorine Compounds in Bulgaria, 2001, 7(3-4): 263-275.

Table 47 Risk for children and adults from Dieldrin soil contamination, based on modeling estimation (HESP model)

District	Adult				Children			
	1	2	3	4	1	2	3	4
Plovdiv	M	-	S	M	-	-	S	M
Veliko Tarnovo	S	-	-	S	M	-	S	M

1 – Agricultural/Rural; **2** - Industrial; **3** -Recreational; **4** - Urban.

Risk: **S** (small) ; **M** (medium) ;

The average annual concentrations of Dieldrin in all monitored regions represent no risk for the general population Only maximum concentrations of Dieldrin in Plovdiv and Veliko Tarnovo districts represent more than negligible risk according to HESP calculations. For children moderate risk exist in urban Plovdiv district (4) and rural and urban Veliko Tarnovo district (1,4) . For adults the risk is moderate in rural and urban Plovdiv district (1,4).

Conclusion:

The health risk is negligible in all regions if the risk quotient DI/Netherlands TDI is used for the calculation.

The annual average concentration of DDT and Dieldrin in all monitored districts present no health risk for the general population.

6. EXISTING DISPOSAL METHODS FOR POPS PESTICIDES WASTES

6.1. RELEVANT POPS – RELATED PROVISIONS OF THE STOCKHOLM CONVENTIONS

Article 6 ("Measures to reduce or eliminate releases from stockpiles and wastes") sets out waste related provisions as follows:

"1. In order to ensure that stockpiles consisting of or containing chemicals listed either in Annex A or Annex B and wastes, including products and articles upon becoming wastes, consisting of, containing or contaminated with a chemical listed in Annex A, B or C, are managed in a manner protective of human health and the environment, each Party shall:

(a) Develop appropriate strategies for identifying:

(i) Stockpiles consisting of or containing chemicals listed either in Annex A or Annex B; and

(ii) Products and articles in use and wastes consisting of, containing or contaminated with a chemical listed in Annex A, B or C;

(b) Identify, to the extent practicable, stockpiles consisting of or containing chemicals listed either in Annex A or Annex B on the basis of the strategies referred to in subparagraph (a);

(c) Manage stockpiles, as appropriate, in a safe, efficient and environmentally sound manner. Stockpiles of chemicals listed either in Annex A or Annex B, after they are no longer allowed to be used according to any specific exemption specified in Annex A or any specific exemption or acceptable purpose specified in Annex B, except stockpiles which are allowed to be exported according to paragraph 2 of Article 3, shall be deemed to be waste and shall be managed in accordance with subparagraph (d);

Take appropriate measures so that such wastes, including products and articles upon becoming wastes, are:

(i) Handled, collected, transported and stored in an environmentally sound manner;

(ii) Disposed of in such a way that the persistent organic pollutant content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of persistent organic pollutants or otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option or the persistent organic pollutant content is low, taking into account international rules, standards, and guidelines, including those that may be developed pursuant to paragraph 2, and relevant global and regional regimes governing the management of hazardous wastes;

(iii) Not permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants; and

(iv) Not transported across international boundaries without taking into account relevant international rules, standards and guidelines;

(e) Endeavour to develop appropriate strategies for identifying sites contaminated by chemicals listed in Annex A, B or C; if remediation of those sites is undertaken it shall be performed in an environmentally sound manner.

2. The Conference of the Parties shall cooperate closely with the appropriate bodies of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal to, *inter alia*:

(a) Establish levels of destruction and irreversible transformation necessary to ensure that the characteristics of persistent organic pollutants as specified in paragraph 1 of Annex D are not exhibited;

(b) Determine what they consider to be the methods that constitute environmentally sound disposal referred to above; and

(c) Work to establish, as appropriate, the concentration levels of the chemicals listed in Annexes A, B and C in order to define the low persistent organic pollutant content referred to in paragraph 1 (d) (ii)."

Article 3, paragraph 2 (a) (i), pertaining to imports, stipulates: "Each Party shall take measures to ensure that a chemical listed in Annex A or Annex B is imported only for the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6." Similarly, article 3, paragraph 2 (b) (i), requires that: "Each Party take measures to ensure that a chemical listed in Annex A for which any production or use specific exemption is in effect or a chemical listed in Annex B for which any production or use specific exemption or acceptable purpose is in effect, taking into account any relevant provisions in existing international prior informed consent instruments, is exported only for the purpose of environmentally sound disposal as set forth in paragraph 1 (d) of Article 6."

Annex C, Part II, outlines industrial source categories that have the potential for comparatively high formation and release to the environment of POPs listed in Annex C. Part III outlines source categories from which POPs listed in Annex C may be unintentionally formed and released. Part V outlines general guidance on BAT and BEP.

6.2. POPs Pesticides Waste

Wastes consisting of, containing or contaminated with pesticide POPs, except HCB as an industrial chemical, are found in a number of physical forms including:

(a) Obsolete stockpiles of pesticides in original packages, which are no longer usable because of their exceeded shelf life and/or because of deteriorated packages;

(b) Liquid technical grade pesticide POPs diluted with specific solvents such as gas oil and others;

(c) Solid technical grade pesticide POPs diluted with inert materials;

(d) Demolition wastes such as storage walls and slabs, foundations, beams;

(e) Equipment such as shelves, spray pumps, hoses, personal protective materials, vehicles, storage tanks.;

(f) Packaging materials such as drums, bags, bottles, gas cylinders;

(g) Soil, sediment, sewage sludge, water.

(h) Spent treatment media such as activated carbon;

(i) Foodstuffs and animal feeds.

6.3. POPs Waste prevention and minimization

Both the Stockholm and Basel Conventions advocate waste prevention and minimization, while POPs pesticide are targeted in the Stockholm Convention for complete elimination. POPs pesticide should be taken out of service and disposed of in an environmentally sound manner. Pesticides producers, formulators and users of products and articles containing POPs pesticide may be required to develop waste management plans, which cover all hazardous wastes, including wastes consisting of, containing or contaminated with POPs pesticide.

Quantities of waste containing these compounds should be minimized through isolation and source separation in order to prevent mixing and contamination of other waste streams or environmental resources (air, water, soil). For example, at those locations where obsolete pesticides are directly leaking from unstable and deteriorated containers, the risks for further damage to environment and population should be minimized as soon as possible and following options should be considered:

(a) Stabilisation of the concerned site: leaking pesticides should be segregated and repacked;

(b) Reduction of number of storage sites and repackaging of obsolete pesticides and safe storage in a limited number of centralized storage sites.

POPs pesticide are typically found in:

(a) Residues from pesticide POPs' formulation sites;

(b) Government storage from environment and agriculture ministries;

(c) Storage facilities within farms and stables;

(d) Houses (domestic storage);

(e) Contaminated materials like: application equipment and accessories, empty packaging materials, containers, floors, walls, windows and others;

(f) Dumpsites and landfills

(g) Soils, sediment, sewage sludge and water (contaminated by spills);

(h) Commercial products containing POPs pesticide (e.g. household insect spray).

6.4. DISPOSAL OPTIONS OF OBSOLETE & POPS PESTICIDES

Depending from a country obsolete pesticide wastes profile, different disposal options may be selected for final POPs pesticides elimination. From the review of the scientific and patent literature and Internet sources, it had become clear that not all materials requiring disposal will need a high technology solution, such as high temperature incineration at a licensed and monitored commercial hazardous waste facility. No single technology is suitable to deal with the wide range wastes usually found during inventory of obsolete pesticides. The waste streams considered including obsolete, banned and unwanted pesticides, any POPs pesticide too, require standards in terms of health, safety and environment. Above typically require collection, transportation, storage and final treatment and/or disposal in an environmentally sound manner. Any disposal option considered must utilize Best Available Techniques (BAT) and Best Environmental Practices (BEP). In all instances the impact of any treatment disposal option proposed has to be assessed in terms of real and potential impact on general population and the environment.

In most cases, **the recommended method** will be **high-temperature incineration**. Developing countries do not generally have appropriate high-temperature incineration facilities for hazardous waste. This means that obsolete products may have to be shipped to special hazardous waste incineration plants in countries that are willing to accept the waste. The costs of repackaging, shipment and incineration are high and the administrative procedures to comply with international conventions concerning the shipment of hazardous waste may be complicated and timeconsuming.

Alternative high-temperature incineration methods such as the use of a mobile incinerator or a local cement kiln have their limitations and are often not applicable in a safe and/or cost-effective manner. Such practices are generally unsafe and inappropriate and in most cases are not permitted in developed countries for health or environmental reasons.

Methods such as **chemical treatment or landfilling after solidification** may sometimes offer solutions for relatively small quantities of specific groups of pesticides. Other methods are not recommended. **Pesticides should never be disposed of by burying or open burning.**

The new disposal technology has also been suggested as an alternative to transportation and incineration. Evolving techniques such as Gas Phase Hydrogenation, Molten Metal Technology, Plasma Arc and Electrochemical Oxidation appear to be at advanced stages of development or in early commercial use.

Safe and environmentally sound disposal of pesticides can be very expensive. Costs depend on the disposal method, the total quantity of obsolete pesticides to be disposed of, the type and variety of products, the number of locations from where pesticides are to be removed, the distance to a port of exit, the degree of contamination, and so on.

In the cases of Bulgaria due to the absence of sutable high-temperature incineration facilities for hazardous waste, disposal of obsolete pesticides entails repackaging, transportation to some European country and incineration in dedicated high temperature toxic waste incinerators. This is difficult and administratively complex operation which requires expert knowledge and equipment. It is also expensive-current costs are US$ 3,500 - US$ 4,500 per tonne of waste.That’s why Bulgaria needs to be financially supported by Grand Funding from International Donor Programmes and EU funds.

6.5. TECHNICAL SOLUTIONS

Current disposal methods

Current disposal methods for obsolete and POPs pesticides include:

- At present the most commonly used disposal method is repackaging and transportation to a European country for high temperature incineration;
- The possibility of using new disposal technology such as Gas Phase Hydrogenation, Molten Metal Technology, Plasma Arc and Electrochemical Oxidation, appearing to be at advanced stages of development or in early commercial use.

Permanent solutions:

- High temperature incineration:
  - High temperature incineration
  - Installations with rotary furnaces
  - Burners with liquids injection
  - Burners with circulating layer
  - Burners with pseudo-burning layer
  - Cement kilns
  - Lime-burning kilns
  - Light mass-burning kilns
  - Blast furnaces

Temporary solutions

The temporary solutions for disposal of Obsolete pesticides stocks include:

- Container Encapsulating Disposal;
- Repackaging and transferring to new storage centralized facilities for temporary storage until a better destruction method is put in place(the case in Bulgaria);

Photo 16 Centralized state storages for obsolete pesticides in Bulgaria

- Encupsulating in hermetized steel – concrete containers “BB cubes” for long-term storage up to 300 years (the case in Bulgaria);

Photo 17 BB cubes for storages of obsolete pesticides in Bulgaria

- Permanent storage in facilities located in geohydrologically isolated underground salt mines and hard rock formations (caverns or tunnels) is an option to separate hazardous wastes from the biosphere for geological periods of time.

Photo 18 Storage facility for obsolete pesticides in isolated underground salt mines and hard rock formation in Germany

6.6. Destruction and Irreversible Transformation Technologies for POPs

6.6.1. Alkali metal reduction

Process description: Alkali metal reduction involves the treatment of wastes with dispersed alkali metal. Alkali metals react with chlorine in halogenated waste to produce salt and non-halogenated waste. Typically, the process operates at atmospheric pressure and temperatures between 60 ˚C and 180 ˚C. Treatment can take place either in situ (i.e., PCB-contaminated transformers) or ex situ in a reaction vessel. There are several variations of this process. Although potassium or potassium sodium alloy has been used, metallic sodium is the most commonly used reducing agent. The remaining information is based on experiences with the metallic sodium variation. The sodium reduction process has also been demonstrated to meet regulatory criteria - less than 2 ppm in solid and liquid residues.

Efficiency: Destruction efficiency (DE) values of greater than 99.999 per cent and destruction removal efficiency (DRE) values of 99.9999 per cent have been reported for aldrin, chlordane and PCBs *(Ministry of Environment of Japan, 2004).*

Waste types: Sodium reduction has been demonstrated with PCB-contaminated oils containing concentrations up to 10,000 ppm.

Vendors include:

- Dr. Bilger Umweltconsulting GmbH – www.bilgergmbh.de;
- Decoman Srl, Italy – www.decoman.it;
- Envio Germany GmbH & Co. KG – www.envio-group.com
- Kinectrics Inc. – www.kinectrics.com
- Nippon Soda Co. Ltd. – www.nippon-soda.co.jp
- Orion BV, Netherlands – www.orionun2315.nl/en/index.php
- Powertech Labs Inc. – www.powertechlabs.com
- Sanexen Environmental Services Inc. – www.sanexen.com

6.6.2. Base catalysed decomposition (BCD)

Process description: The BCD process involves treatment of wastes in the presence of a reagent mixture consisting of hydrogen donor oil, alkali metal hydroxide and a proprietary catalyst. When the mixture is heated to above 300°C, the reagent produces highly reactive atomic hydrogen. The atomic hydrogen reacts with the waste to remove constituents that confer the toxicity to compounds.

Efficiency: DEs of 99.99–99.9999 per cent have been reported for DDT, PCBs, PCDDs and PCDFs. DEs of greater than 99.999 per cent and DREs of greater than 99.9999 per cent have also been reported for chlordane (Ministry of the Environment of Japan, 2004). It has also been reported that reduction of chlorinated organics to less than 2 mg/kg is achievable.

Waste types: BCD should be applicable to other POPs in addition to the waste types listed above. BCD should be capable of treating wastes with a high POP concentration, with demonstrated applicability to wastes with a PCB content of above 30 %.

Vendors: The patent for this technology is held by BCD Group, Inc., USA (www.bcdinternational.com). BCD Group, Inc. sells licences to operate the technology. Currently, licences are held by companies based in Australia, Czech Republic, Japan, Mexico and the United States of America.

6.6.3. Catalytic hydro-dechlorination (CHD)

Process description: CHD involves the treatment of wastes with hydrogen gas and palladium on carbon (Pd/C) catalyst dispersed in the paraffin oil. Hydrogen reacts with chlorine in halogenated waste to produce hydrogen chloride (HCl) and non-halogenated waste. In the case of PCBs, biphenyl is the main product. Process operates at atmospheric pressure and temperatures between 180 ˚C and 260 ˚C (Sakai, Peter and Oono, 2001; Noma, Sakai and Oono, 2002; and Noma, Sakai and Oono, 2003a and 2003b).

Efficiency. DEs of 99.98–99.9999 per cent have been reported for PCBs. It has also been reported that a reduction of the PCB content to less than 0.5 mg/kg is achievable.

Waste types. CHD has been demonstrated with PCBs removed from used capacitors. PCDDs/PCDFs contained in PCBs as impurities have also been dechlorinated.

Vendor(s). The patent for this technology is held by Kansai Electric Power Co and Kanden-Engineering Co. (www.kanden-eng.co.jp).

6.6.4. Cement kiln co-incineration

Process description: Cement kilns typically consist of a long cylinder of 50–150 metres, inclined slightly from the horizontal (3 per cent to 4 per cent gradient), which is rotated at about 1–4 revolutions per minute. Raw materials, such as limestone, silica, alumina and iron oxides are fed into the upper or so-called “cold” end of the rotary kiln. The slope and rotation cause the materials to move toward the lower or “hot” end of the kiln. The kiln is fired at the lower end of the kiln where temperatures reach 1400°C–1500°C. As the materials move through the kiln, they undergo drying and pyroprocessing reactions to form the clinker.

Efficiency: DREs of greater than 99.99998 per cent have been reported for PCBs in several countries (Ahling, 1979; Benestad, 1989; Lauber, 1987; Mantus, 1992. US EPA, 1986; Lauber, 1982; von Krogbeumker, 1994; Black, 1983).

Waste types: As mentioned above cement kilns have been demonstrated with PCBs, but should be applicable to other POPs. Cement kilns are capable of treating both liquid and solid wastes.

Vendors: A number of existing cement kiln co-incineration operations are identified in the inventory of worldwide PCB destruction capacity.

6.6.5. Gas phase chemical reduction (GPCR)

Process description: The GPCR process involves the thermo-chemical reduction of organic compounds. At temperatures greater than 850°C and low pressures, hydrogen reacts with chlorinated organic compounds to yield primarily methane and hydrogen chloride.

Efficiency: DEs of 99.9999 per cent have been reported for DDT, HCB, PCBs, PCDDs and PCDFs.

Waste types: In addition to the substances listed above, GPCR should also be capable of treating wastes consisting of, containing or contaminated with all other POPs. GPCR is capable of treating wastes with a high POP concentration. This includes aqueous and oily liquids, soils, sediments, transformers and capacitors.

Vendors: The patent for this technology is held by the sole supplier ELI Eco Logic International Inc. (www.ecologic.ca). ELI Eco Logic International Inc. sells licences to operate the technology.

6.6.6. Hazardous waste incineration

Process description: Hazardous waste incineration uses controlled flame combustion to treat organic contaminants mainly in rotary kilns. Typically a process for treatment involves heating to a temperature greater than 850 °C or, if the chlorine content is above 1 per cent, greater than 1,100 °C, with a residence time greater than 2 seconds, under conditions that assure appropriate mixing. Dedicated hazardous waste incinerators are available in a number of configurations including rotary kiln incinerators, static ovens (for liquids only). High-efficiency boilers and lightweight aggregate kilns are also used for the co-incineration of hazardous wastes. (See Brunner, 2004, for additional information regarding the application of these technologies.)

Efficiency: DREs of greater than 99.9999 per cent have been reported for treatment of wastes consisting of, containing or contaminated with POPs. DEs of greater than 99.999 and DREs of greater than 99.9999 per cent have been reported for aldrin, chlordane and DDT (Ministry of the Environment of Japan, 2004), while DEs between 83.15 and 99.88 per cent have been reported for PCBs *(United States Environmental Protection Agency, 1990).*

Waste types: As noted above, hazardous waste incinerators are capable of treating wastes consisting of, containing or contaminated with any POPs. Incinerators can be designed to accept wastes in any concentration or any physical form, i.e., gases, liquids, solids, sludges and slurries.

6.6.7. Photo-chemical dechlorination (PCD) and catalytic dechlorination (CD) reaction

Process description: PCD and CD is a technology using the combined methods of both photo-chemical dechlorination (PCD) reaction and catalytic dechlorination (CD) reaction (Watanabe, Ohara and Tajima, 2002 and Watanabe, Ohara, Tarima, Yoneki and Hosya, 2003). In the destruction process, PCBs are mixed with NaOH and isopropyl alcohol (IPA) so that the PCB concentration in IPA should reach several per cent by weight. Subsequently, PCBs are dechlorinated by two independent processes, i.e., PCD and CD processes. Each process is operated at moderate temperature (<75 °C) and atmospheric pressure. After the PCBs are dechlorinated, biphenyl, NaCl, acetone, and water are generated, but no gases such as hydrogen or hydrochloric gas are produced.

Efficiency: DEs of 99.99-99.9999 per cent have been achieved for PCBs and 99.9999-99.999999 per cent for PCDDs and PCDFs (Tajima et al., 2003; and Watanabe et al., 2003).

Waste types: PCD and CD has been demonstrated to treat oil from transformers and capacitors containing PCBs with a high concentration and contaminated with PCDDs and PCDFs, and should be applicable to other POPs as well. Soils and sludge are not treatable with this technology. PCB in clothing, packaging, wood and other multi-porous materials should be extracted by solvent.

Vendor(s): The patent and all rights for this technology are held and reserved by Toshiba corporation (www.toshiba.co.jp/efort/market/pcb/index_j.htm). Toshiba Corporation sells licensees for operation of the technology.

6.6.8. Plasma arc

Process description: The Plascon™ process uses a plasma arc with temperatures in excess of 3000˚C to pyrolyse wastes. Together with argon, wastes are injected directly into the plasma arc. The high temperature causes compounds to dissociate into their elemental ions and atoms. Recombination occurs in a cooler area of the reaction chamber, followed by a quench resulting in the formation of simple molecules.

Efficiency: Bench scale tests with oils containing 60 per cent PCBs have achieved DREs ranging from 99.9999 to 99.999999 per cent.

Waste types: In addition to PCB oils, a Plascon™ plant in Australia has recently been configured to treat pesticide wastes. Waste types to be treated must be liquid, gas or solids if in the form of a fine slurry, which can be pumped. Very viscous liquids or sludges thicker than 30 to 40 weight motor oil cannot be processed without pre-treatment. Other solid wastes cannot be treated unless some form of pre-treatment is undertaken.

Vendors: The vendor for the Plascon process is SRL Plasma Pty Ltd Narangba Australia (www.srlplasma.com.au) and Commonwealth Scientific Industrial Research Organization (CSIRO). The three patents for Plascon are jointly owned by SRL Plasma PTY Ltd and CSIRO.

6.6.9. Potassium tert-Butoxide (t-BuOK) method

Process description: PCBs in insulating oils are dechlorinated by the reaction with potassium tert-butoxide (t-BuOK). t-BuOK reacts with chlorine in PCBs to produce salt and non-chlorinated waste. Typically, the process operates at atmospheric pressure and temperatures between 200˚C and 240˚C (Oono, Kaneda and Kirata, 1997 and Oono and Kaneda, 1997).

Efficiency: DEs of 99.98-99.9999 per cent have been reported for PCBs. It has also been reported that a reduction of the PCB content to less than 0.5 mg/kg is achievable.

Waste types: The t-BuOK method has been demonstrated with low contaminated mineral oils. A vendor has also claimed that the chlorinated wastes in liquid state or dissolved in solvents can be treated by the t-BuOK method.

Vendor(s): The patent for this technology is held by Kansai Electric Power Co and Kanden-Engineering Co. (www.kanden-eng.co.jp).

6.6.10. Supper-critical water oxidation (SCWO) and subcritical water oxidation

Process description: SCWO and subcritical water oxidation treat wastes in an enclosed system, using an oxidant (such as oxygen, hydrogen peroxide, nitrite, nitrate, etc.) in water at temperatures and pressures above the critical point of water (374°C and 218 atmospheres) and under subcritical conditions (370 °C and 262 atmospheres). Under these conditions, organic materials become highly soluble in water and are oxidized to produce carbon dioxide, water and inorganic acids or salts.

Efficiency: DEs of greater than 99.999 per cent and DREs of greater than 99.9999 per cent have been reported for aldrin, chlordane and PCBs for SCWO (Ministry of the Environment of Japan, 2004). DEs of greater than 99.999999 and DREs of greater than 99.9999999 per cent have been reported for subcritical water oxidation (Ministry of the Environment of Japan, 2004). DREs as high as 99.9999 per cent have also been demonstrated for PCDDs in bench-scale tests.

Waste types: SCWO and subcritical water oxidation are thought to be applicable to all POPs. (Japan Industrial Waste Management Foundation, 1999). Applicable waste types include aqueous wastes, oils, solvents and solids with a diameter less than 200 µm. The organic content of the waste is limited to less than 20 per cent.

Vendors: Firms providing this service include:

- Foster Wheeler Development Corporation (www.fosterwheeler.com);
- General Atomics (www.ga.com);
- Mitsubishi Heavy Industries, Ltd. (www.mhi.co.jp).

6.7. RECOMMENDED DISPOSAL METHODS FOR POPs PESTICIDES

6.7.1. Aldrin/Dieldrin

Aldrin and dieldrin are classified as hazardous wastes. The Chemical Manufacturers Association recommends disposing of aldrin and dieldrin by incineration. Incineration by rotary kiln (at 820–1,600 °C), liquid injection (at 877–1,038 °C), and fluidized bed (at 450–980 °C), with residence times of seconds for gases and liquids and hours for solids, is recommended too. Aldrin and dieldrin are often mixed with vermiculite, sodium bicarbonate, or a sand-soda ash mixture prior to incineration. The incineration of these chemicals emits highly toxic fumes of hydrogen chloride and chlorinated breakdown products. Thus, incinerators used for disposal of aldrin and dieldrin must have an acid scrubber and an after-burner. Also, prior to incineration, local air and fire authorities must be contacted.

Another recommended disposal method for aldrin and dieldrin is burying the chemicals in landfills. Contaminated material should be buried 8–12 feet underground in an isolated area away from water supplies, with a layer of clay, a layer of lye, and a second layer of clay beneath the wastes. Gravity filtration of solids, followed by dual-media filtration of the liquids, followed by activated carbon adsorption (100–300 pounds of carbon per pound of soluble material) is also an approved disposal method. Finally, disposal of small amounts of aldrin and dieldrin can be accomplished through degradation by active metals (sodium or lithium) in liquid ammonia.

6.7.2. Endrine

Because endrin is as classified as hazardous waste. Land disposal restrictions apply to wastes containing endrin. Chemical treatment (reductive dechlorination) or incineration are possible disposal methods.

Past disposal methods included land disposal. In general, disposal methods for endrin residues or endrin-containing wastes are similar to those for wastes containing aldrin/dieldrin.

6.7.3. Chlordane

Chlordane may be disposed of by dissolving it in a flammable solvent and incinerating it under controlled conditions. The incinerator should be equipped with an afterburner and an acid scrubber to remove halo acids from the effluent gas, and adequate ash disposal procedures should be followed. Before disposing waste residue containing chlordane (including waste sludge) on land,
environmental competent authority should be consulted for guidance on acceptable disposal practices.

In situ vitrification is a thermal treatment technology in which substantial quantities of energy are introduced into contaminated soil, thereby destroying organic compounds and immobilizing inorganic compounds. This technology has been applied to chlordane-contaminated soils.

6.7.4. Heptachlor

Heptachlor is hazardous waste; as such, it must be disposed of in secure landfills in compliance with all state, and local regulations. They may also be incinerated at 865°C for 0.5 second for primary combustion and at 1800°C for 1 second for secondary combustion, with adequate scrubbing of incinerator exhaust and disposal of ash.

6.7.5. DDTs

DDT and DDD are potential candidates for incineration in a rotary kiln at 820–1,600 °C. Disposal of DDT formulated in 5% oil solution or other solutions is mainly by using liquid injection incineration at 878–1,260 °C, with a residence time of 0.16–1.30 seconds and 26–70% excess air. Destruction efficiency with this method is reported to be >99.99%. Multiple-chamber incineration is also used for 10% DDT dust and 90% inert ingredients at a temperature range of 930–1,210 °C, a residence time of 1.2–2.5 seconds, and 58–164% excess air. DDT powder may be disposed of by molten salt combustion at 900 °C (no residence time or excess air conditions specified). A low temperature destruction method involving milling DDT with Mg, Ca, or CaO is under development on a laboratory scale. Landfill disposal methods are rarely used at the present time.

6.7.6. Toxaphene

Toxaphene is classified as hazardous waste. It must be treated by biodegradation or incineration (waste waters only).

6.7.7. Mirex

Since mirex is not flammable and is very stable in the environment, many disposal methods investigated for these chemical have proven unsuccessful.

Mirex is unaffected by hydrochloric, sulfuric, and nitric acids, and would be expected to be extremely resistant to oxidation except at the high temperatures of an efficient incinerator.

A recommended method of disposal for mirex is incineration or long-term storage. Polyethylene glycol or tetraethylene glycol and potassium hydroxide when used in combination with sodium borohydride or alkoxyborohydrides, produce a powerful reducing media which quantitatively destroys mirex at 70 ºC. The reduction rate is further increased by using tetrahydrofuran and catalysts which produce 100% destruction of mirex to hexahydromirex within 1 hour at 58 ºC .

6.7.8. Hexachlorobenzene

Hexachlorobenzene is listed as a toxic substance. Incineration at high temperatures is a proposed disposal method, but incineration can lead to chlorinated products as toxic as hexachlorobenzene. Past disposal methods for industrial wastes containing hexachlorobenzene included incineration, disposal in landfills, discharge to municipal sewage treatment plants, and emission to the atmosphere.

High temperature incineration (around 1,300 ^{o}C) with a retention time of approximately 0.25 seconds is the recommended disposal technique because it is reported to destroy more than 99% of the chemical. It is reported that organic waste compounds including hexachlorobenzene are used to co-fire cement kilns. The destruction efficiency of hexachlorobenzene fed to a rotary kiln/afterburner incinerator was greater than 99.9999%.

Landfill disposal of hexachlorobenzene can lead to migration of the compound via water and sublimation of the compound into the air. Calaminus et al. (1993) conducted pyrolysis experiments with hexachlorobenzene in an inert atmosphere of argon. These authors reported hexachlorobenzene was substantially pyrolyzed (70%) at temperatures of 1,100 ^{o}C for 20 seconds into elemental carbon (soot) and chlorine (Cl2), but that other polychlorinated compounds were also produced. Deep well injection of HCB is also not recommended.

The waste water treatment technology that most closely resembles incineration is wet air oxidation. It is specifically designed to destroy organics in waste waters and efficiently oxidizes organics in aqueous media by operating at relatively high temperatures and pressures.

7. SUMMARY CONCLUSIONS

7.1. CURRENT SITUATION WITH POPS ISSUE IN THE COUNTRY

The Stockholm Convention includes the following persistent chloroorganic pesticides, listed in Annexes A & B - **aldrin, dieldrin, endrin, mirex, toxaphene, hexachlorbenzene, heptachlor, chlordane and DDT.**

Manufacturing: POPs pesticides subject to the Stockholm Convention have never been manufactured in the Republic of Bulgaria.

Use : In R Bulgaria most POPs pesticides have been applied mainly as pest control preparations to treat termites and soil insects. The use of POP pesticides has been largest in the 60s in quantities 100-200 t annually. Aldrin, dieldrin, endrine and DDT have been banned for import and use in 1969, toxaphene – in 1985 and heptachlor – in 1991. **Mirex, hexachlorobenzene and hlordane have not been imported and used in the country.**

Import : In R Bulgaria POPs pesticides had been imported within the period 1960 ÷1990, most intensively in early 60s of past century. **All POPs pesticides are banned for import and use in agriculture.**

Export : **No data exist for POPs pesticides exports.**

POPs pesticides stockpiles :

- The assumed POPs pesticides stockpiles at the end of 2003 in Bulgaria are in the range of 22.25 t ÷ 25.82 t.
- The obsolete pesticides mixtures, consisting of or contaminated with POPs comprise of approx. 30.06 t.
- The assumed POPs pesticides stockpiles are totaling between 52.3 t ÷ 55.9 t
- To identify the specific POPs pesticides, a detailed POPs Inventory is required to be carried out in Bulgaria.

Obsolete pesticides stockpiles :

The “unknown” obsolete pesticides stockpiles in warehouses and in BB cubes have been increasing constantly in the period 2001-2003, due to better control and annual discoveries of new quantities of obsolete pesticides. The obsolete pesticides preliminary inventory data for 2004 indicates the following:

- **At the end of 2004** the total obsolete stockpiles equals to 11222 t, stored in 561 warehouses and 1255 BB cubes;
- **The “unknown” obsolete pesticides stockpiles** have increased to 11219 tonnes. 4703 t are stored in 84 centralized warehouses, 2308 t – in 477 non-repaired and 4211 t – in 1255 concrete-steel sealed BB-cubes;
- **The total obsolete pesticides stockpiles** stored in safe centralized warehouses, conforming to all requirements and in BB cubes are 8914 tonnes;
- **The “unknown” obsolete pesticides stockpiles,** stored in 477 non-repaired and unsafe municipal warehouses is 2308 tonnes. The poor status of 53% of the unrepaired operating storages requires immediate measures – repairing and cleaning up. It is necessary urgent measures to be taken for safe storage of the sored in them 1223 t obsolete pesticides- repacking and moving into repaired warehouses or export abroad for disposal .
- **The insufficient information about the assumed available approx. 52.3 t ÷ 55.9 t obsolete POPs pesticides and mixtures, consisting of or contaminated with POPs, contained exactly in these 2308 t obsolete pesticides requires the implementation of detailed inventory of the “unknown” obsolete pesticides, stored in 477 unrepaired warehouses.**

Existing policy : The storage facilities for obsolete and POPs pesticides are one of the sources for local environmental pollution and may pose health risk The construction of centralized municipal warehouses and BB cubes conforming to the legislative requirements for safe disposal, liable storage of available obsolete pesticides stockpiles and cleaning up of emptied warehouses are activities that illustrate consistency in environmental protection policy and sustainable management of obsolete pesticides. The funds allocated by the Enterprise for Management of Environmental Protection Activities (EMEPA) and National Plant Protection Service (NPPS) have been increasing constantly during the period 1998-2004 for safe storage of obsolete & unusable pesticides, repairing of warehouses, cleaning up of premises and sites, collection, re-packing, and shifting of chemicals from warehouses in the small urban centres to municipal and centralised warehouses, or disposal in BB cubes. **The totally allocated funds by EMEPA for safe storage of obsolete pesticides for the period 1998-2005 equals to approx. 7,5 million BGN as only for 2004 the funds are almost 2**

millions BGN. The decreasing of old warehouses and the environmentally sound storage of obsolete pesticides has reduced the threat of environmental pollution and human health risk.

Nevertheless the steady positive trends observed during recent years and constantly increased funds allocated by Bulgarian state for the management of POPs and obsolete pesticides , the Republic of Bulgaria can not cope alone with final solving of POPs and Obsolete pesticides stockpiles without international financial support, due to limited national funding available and the fact that Bulgaria is in Currency Board. To reduce the risk of POPs pesticides impacts on human health and the environment measures should be taken for safe storage and/or environmentally sound disposal abroad, due to absence of appropriate disposal facility in the country. For this purpose the Republic of Bulgaria needs to be supported by providing financial resources from GEF and other international, bilateral, regional and multilateral twinning programmes.

Existing regulatory framework : The observation of existing national legislation in regard with POPs pesticides management guarantee the reducing of POPs negative impacts on environment and human health. The country has transposed the main provisions under Stockholm convention in the Environment Protection Act, the Law on protection from harmful impact of dangerous substances and preparations, Water Act, the Law on preservation of agricultural lands, the Law on the protection of soil against pollution, the Law of Health,the Law on Fodders, the Law on Foods, Waste Management Act and their sub-legislative acts.

7.2. POPs pesticides Monitoring

POPs levels in Surface water : No positive samples of POPs pesticides in surface water sources, used for drinking water supply (dam lakes) were found. The classic representative of persistent organochlorine insecticide – DDT and its metabolites showed clear trend for decrease of DDT and its metabolites in hydrosphere of Bulgaria. At present DDT is found only at incidental point pollution and DDE – in rare cases in non-drinking waters.

POPs levels in Groundwater : POPs pesticide monitoring indicates excellent condition of groundwater on the whole territory of the country. The analysis and data assessment show that during 2003 **in R Bulgaria there are no groundwater, polluted with POPs pesticides,** listed in Annex A, Part I & II of Stockholm Convention.

POPs pesticides level in Soil : No soils polluted with the following POPs - aldrin, dieldrin, endrin, heptachlor and hexachlorbenzene exist in all of the studied regions of R Bulgaria.**DDT and metabolite residues** in soils are still registered in the environment of almost all regions of the country:

- Most of the positive values (76,5%) of DDT total are below the precautionary levels of 0.3 mg/kg and 13.7% - within the range of 0.3 ÷ 1.5 mg/kg .
- Despite the ban on DDT use since 1969, residues of DDT total higher than admissible limit value of 1.5 mg/kg are registered in 3,6% of soil samples within the period 1997-1999.
- Only 1.1% of samples are exceeding the intervention value of 4 mg/kg. Nevertheless the ratio of p,p'-DDE to p,p'-DDT is an evidence of old soil contamination, new sampling at the same points is required and if necessary remediation measures and clean up sites should be taken.
- The summarized analytical data show that about 95% of soils in the country are not polluted with DDT.

POPs pesticides levels in food

- No presence of any residues of POPs pesticides exceeding the maximum admissible residual concentration (MARC) in the tested 2200 foodstuffs from vegetable and animal origin for the Year 2003 has been detected.
- No presence of any residues from B (3)(a) group organochlorine compounds – organic substances, including such as Aldrin, DDT, Heptahlor epoxide and PCBs in the tested samples of Live Animals, Fresh Meat, Poultry, Fish, Farmed & Wild Game, Raw Milk, Hen Eggs and Bee Honey in Bulgaria for the Year 2003 has been detected.

POPs pesticides levels in human body :

Within the frame of a study, conducted in Bulgaria of the content of POPs pesticides in mothers' milk from 30 healthy women from three regions (Bankya – ecologically clean area and two others – Sofia and Blagoevgrad – polluted in varying degrees), it was found out that **no presence of endrin, toxaphene and mirex in the mothers' breast milk** in the ecologically clean region of Bankya exists, but the following POPs pesticides – hexachlorbenzene (0.012 mg/kg lipids), chlordane (0.018 mg/kg lipids), heptachlor (0.013 mg/kg lipids), dieldrin/aldrin (0.004 mg/kg lipids) and DDT total (0.499 mg/kg lipids) were present. The results for POPs pesticides residues in mothers' breast milk from Sofia and Blagoevgrad region are still in the process of finalizing.

Human health impacts:

No cases of acute and chronic intoxication with persistent chlororganic pesticides have been registered in the Republic of Bulgaria

Risk assessment by modeling of exposure and effects:

- The health risk is negligible in all regions if the risk quotient DI/Netherlands TDI is used for the calculation.
- The annual average concentration of DDT and Dieldrin in all monitored districts present no health risk for the general population.

Annex I : Synonyms and trade names for POPs pesticides

Chemical	Some Synonyms and Trade Names
ALDRIN (CAS No.: 309-00-2)	1,4:5,8-dimethano-naphtalin; GGDN; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4-exo-5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-5,8-exo-dimethano-naphthalene; 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a hexahydro (1.alpha.,4.alpha.,4a.beta.,5.alpha.,8.alpha.,8; 1,2,3,4,10,10-Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8- dimethanonaphthalin 1R,4S,4aS,5S,8R,8aR-; 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene; 1.2.3.4.10.10-Hexachlor-(4arH.8acH)-1.4.4a.5.8.8a-hexahydro-1c.4c:5t.8t-dimethano-naphth; 1.2.3.4.10.10-hexachloro-(4arH.8acH)-1.4.4a.5.8.8a-hexahydro-1c.4c:5t.8t-dimethano-napht; 1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4 a,5,8,8a-hexahydro-, (1alpha,4alpha,4abe 1,4:5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, endo,exo-; 1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abet), (1R,4S,4aS,5S,8R,8aR)-1,2,3,4,10,10-Hexachlor-1,4,4a,5,8,8a-hexahydro-1, 4:5,8-dimethanonaphthalin; Aglyucon*, Agronex TA; Aldocit; Aldrec; Aldrex; Aldrex 30; Aldrex 30 E.C.; Aldrex 40; Aldrin cast solid; Aldrin mixture, dry (with 65 % or less aldrin); Aldrin mixture, dry (with more then 65 % aldrin); Aldrin mixture, liquid (with 65 % or less aldrin); Aldrin mixture, liquid (with 65 % or less aldrin); Aldrin 2.5; Aldrin 5; Aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-(1.alpha.,4.alpha.,4a.beta.,5.alpha.,8.al]; Aldrite; Aldrosol; Altox; Alvit 55; Compound 118; 4:5,8-Dimethanonaphthalene; 22DN; Drinox; Eldrin; ENT-15949; Eruzin*; exo-Hexachlorodimethanonaphthalene; Hexachlorhexahydro-dimethano-naphtaline; Hexachlorohexahydro-endo, exo-dimethanonaphthalene; Hexachloro-1,2,3,4,10,10 hexahydro-1,4,4a,5,8,8a exodimethano-1,4,5,8 naphtalene; Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalin; Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethano-naphtalin, (1R,4S,4aS,5S,8R,8aR)-1,2,3,4,10,10-; Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4-endo-5,8-exodimethanonaphtalin, 1,2,3,4,10,10-; HHDM; HHDN; HHPN; Kartofin*; Kortofin; Latka 118; NA 2761; NA 2762; NCI-C00044; OMS-194; Octalene; Octalin*;Seedrin; SD 2794; Sojedinenie (= compound) 118*; Tatuzinho; Tipula; Veratox*

CHLORDANE (CAS No.: 57-74-9)	1-exo,2-endo,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7methanoindene; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetra-hydro-4,7-methan-; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro- ; 1,2,4,5,6,7,8,8-Octachloro-4,7-Methano-3a,4,7,7a-Tetrahydroindane Oindane; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-endo-methano-indene; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1H-indene; 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-1H-4,7-methano-indene; 1,2,4,5,6,7,8,8-Octachloro-4-7-methano-3.alpha.,4,7,7,.alpha.-tetrahydroindane; 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro- 1-exo,2-endo,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene); AG Chlordane; Aspon; Aspon-Chlordane; Belt; CD 68; Chloordaan, Zuiver; Chlordan, Kemisk rent; Chlordan, rein; Chlordane; Chlordane (gamma); chlordane, pur; Chlordane technical; Chlordane [4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-]; Chloriandin; Chlorindan; Chlorkil; Chlorodane; gamma.-Chlordan; Clordan; Clordano, puro; Corodan(e); Chlordane HCS 3260; Chlordasol; Cortilan-Neu; Dichlorochlordene: Dowchlor; Dow-Klor; Ent 9932; Ent 25552-X; HCS 3260; Kilex lindane;Kypchlor; M140; M 410; Latka 1068;4,7-Methanoindan; 4,7-Methano-1H-indene; NCI-C00099; 4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-; 4,7-methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-; Niran; Octachlor; Octachloro-4,7-methanotetrahydroindane; Octachlorodihydrodicyclopentadiene; Octachlorohexahydromethanoindene; Octachlor-2,3,3a,4,7,7a-hexahydro-4,7-methano-(1H)-inden, 1,2,4,5,6,7,8,8-; Octachlor-3a,4,7,7a-tetrahydro-4,7-endomethanoindan, 1,2,4,5,6,7,8,8-; Octa-Klor; Oktaterr; Ortho-Klor; SD 5532; Shell SD-5532; Starchlor; Synklor; Tat chlor 4; t-chlordan;Topichlor; Topichlor 20; Toxichlor; Unexan-koeder;Veliscol-1068
DDT CAS-No: 50-29-3	Aerosol DDT, Aerosol DL, Agritan, Anofex, Antrix, Arkotine, Azotox, benzene,1,1'-(2,2,2-trichloroethylidene)bis(4-chloro-alpha, alpha-bis(p-chlorophenyl)-beta,beta,beta-trichlorethane, Bercema-Aero-Super, Bercema-Spritz-Aktiv, Bercema-Bekusal, Bosan Supra, Bovidermol, chlorophenothan, chlorophenothanes, chloro phenothan, chlorophenothane, chlorophenotoxum, Citox, Clofenotane, Cyklodyn, p,p'-DDT, Dedelo, Deoval, Detox, Detoxan, Dibovan, Dibovin, dichlorodiphenyltrichloroethane, p,p'- dichlorodiphenyltrichloroethane, 4,4'-dichlorodiphenyltrichloroethane, Dicophane, Didigam, Didimac, Diphenyltrichloroethane, Dodat, Duaryl, Dykol, Dynocid, Dynol, Estonate, Gamadyn, Genitox, Gesafid, Gesapon, Gesarex, Gesarol, Guesapon, Guesarol, Gyron, Havero-extra, Hildit, Holus, Hylotox 59, Ipsotox, Ipsotox Special, Ivoran, Ixodex, Kopsol, Lidykol, Meryl N, Micro DDT 75, Mutoxin, Nera-emulze, Neocid,Nerafum, Neracaine (Nerakain), Neratidine (Neratidin), Neocid, OMS 16, Parachlorocidum, Pararyl, Pentachlorin, Pentalidol, Pentech, Pilusan, Ppzeidan, p,p´-dichlordiphenyltrichlormethylmethane, R50, Rukseam, Santobane, Solomitol, Tech DDT, Trichlorobis(4-chlorophenyl)ethane, 1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane, 1,1,1-trichloro-2,2-di(4-chlorophenyl) ethane, 1,1'-(2,2,2-trichloroethylidene)bis(4-chlorobenzene), 1,1-bis-(p-chlorophenyl)-2,2,2-trichloroethane, 2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane, 4,4'-dicholorodiphenyltrichloroethane, Tridynol Zeidane, Zerdane,Rothane; Dilene, TDE

DIELDRIN (CAS No.: 60-57-1)	(1alpha,2beta,2alpha,3beta,6beta,6alpha,7beta,7alpha- 2,7:3,6-Dimethano-3,4,5,6,9,9-hexachlor-1a,2,2; (1R,4S,4aS,5R,6R,7S,8S,8aR)-1,2,3,4,10,10-Hexachlor-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-di; (1R,4S,4aS,5R,6R,7S,8S,8aR)-1,2,3,4,10,10-Hexachlor-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-di; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro,endo,exo-1,4:5,8-dimethanonaphthalene 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-exo-dimethano-naphthalene 1,2,3,4,10,10-Hexachloro-6,7-Epoxy-1,4,4a,5,6,7,8,8a-Octahydro-exo-1,4 -endo-5,8-Dimethanonaphthalene 1,4:5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-, endo,; 2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,(1aalph; 2,7:3,6-Dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro- ; 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a7,7a-Octahydro-2,7:3,6-Dimethanonapht[2,3-b]oxirene; 5,6,7,8,9,9-Hexachlor-2t,3t-epoxy-(4ar,8ac)-1,2,3,4,4a,5,8,8a-octahydro-1t,4t;5c8c-d; Aldrin epoxide; Alvit; Alvit 55; Compound 497; D-31; Diel'drin*; Dieldrin; Dieldrin, dry weight; Dieldrin (hexachloroepoxyoctahydro-endo,exo-dimethanonaphthalene 85 % and related compounds 15 %); Dil'drin*; Dieldrina; Dieldrine; Dieldrite; Dieldrex; Dieldrix; Dieldrex B, Dielmoth; D-31; DD ;Dimethanonaphth[2,3-b]-Oxirene; DLD; Dorytox ; ENT-16225; ENT 16,225;Exo-Dieldrin ; GEOD*; HEOD; Hexachloroepoxyoctahydro-endo,exo-Dimethanonaphthalene; Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-;"Deutsch" Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethano-naphthalene, (1R,4S,4aS,5R,6R,7S,8S; Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-;"Deutsch" Hexachloro-epoxyoctahydro-dimethanonaphthalene; HOED; Illoxol; Insektalox*; Insecticide No. 497; Insectlack; Kombi-Albertan; Lakta 497; Moth Snub D; NCI C00124; Octalox; OMS18; Oxralox; Panoram D-31; Quintox; Red Shield; SD 3417; Sojedinenie (=compound) 497; Termitox
ENDRIN (CAS No.: 72-20-8)	1a.alpha.,2.beta.,3.alpha.,6.alpha; (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha)-2,7;3,6-Dimethano-3,4,5,6,9,9-hexachlor-1a; (1Aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7Aalpha)3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-; (1R,4S,4aS,5S,7R,8R,8aR)-1,2,3,4,10,10-hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-dime; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a- octahydro-1,4-endo-,8-endo-dimethano-naphthalen; 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethanonaphthalen; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-endodimethanonaphthalen; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8- dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-endo-5,8-dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-5,8-dimethanonaphthalen; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-§octahydro-1,4-endo, endo-5,8-dimethanonaphthali; 1,2,3,4,10,10-hexachloro-6,7-oxido-1,4-endo-5,8-endo-dimethano-1,4,4a,5,6,7,8-octahydronaphthalen; 1,2,3,4,10,10-hexachloro-1r,4s,4as,5s,6,7r,8r,8ar-octahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,endo-5,8-dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-exo-1,4-exo-5,8-dimethanonaph; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-exo-5,8-dimethanonaphthalene; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-§1,4-endo-5,8-endo-dimethanonaphthali; 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-§octahydro-1,4-endo-endo-5,8-dimethanonaphthale;

	2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachoro-1a,2,2a,3,6a,7,7a-octahydro-,(1aalpha,2; 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6- dimethanonaphth(2,3-B)oxirene; 3,4,5,6,9,9-hexachloro-1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha-octahydro-2,7:3,6-dim; Compound 269; 1,4:5,8-Dimethanonaphthalene; endo,endo-1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen; Endrex; Endrin; Endrin 20; Endrin mixture; endrin,endo-endo-isomeres; Endrina; Endrine; ENT-17251; Experimental Insecticide No. 269; Hexachlor; Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-endodimethanonaphthalene, 1,2,3,4,10,10-Hexachloro-oxido-dimethano-octahydronaphthalene; hexachloroepoxyoctahydro-endo-endo-dimethanonaphthalene; Hexachlorooctahydro-endo, endo-dimethanonaphthalene; hexachloroxido-endo-endo-dimethanooctahydronaphthalin; Hexachloroxido-endo-endo-dimethanooctahydronaphthalene; hexachloroxidotetracyclododecen; hexachloräpoxyoctahydro-bis(endo-methylen)naphthalin; Hexachloroepoxyoctahydro-endo,endo-dimethanonaphthalene; Hexadrin; Isodrin Epoxide; Lakta 269; Mendrin; NCI C00157; Nendrin; OMS 197.
HEPTACHLOR (CAS No.: 76-44-8)	1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-Tetrahydro-4,7-Methano-1H-Indene; 1,4,5,6,7,8,8-Heptachlorotetrahydro-4,7-methanoindene ; 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7,7a-tetrahydro-4,7-endo-methanoindene; 1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7- methanoindene; 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-1H-4,7-methano-indene; 2,4-bis-(Thylamino)-6-chlor-1,3,5-triazin; 2-Chlor-4,6-bis(Ethylamino)-1-triazin; 3,4,5,6,7,8,8-Heptachlorodicyclopentadiene; 3-Chlorochlordene; 4,7-Methano-1,4,5,6,7,8,8-heptachlor-3a,4,7,7a-tetrahydro-1H-inden; 4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-; 4,7-Methanoindene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-; Aahepta; Arbinex 30TN; Agronex Hepta; Agronex Hepta T 30; Agroceres; Basaklor; Bis(ethylamino)-chlortriazin; Chlor-bis(ethylamino)-triazin; Chlordiethyltriazindiamin; Drinox; Drinox H-34; E 3314; ENT-15152; Eptacloro; Geptachlor*; Geptazol*; Gesatop; Gold Crest H-60; GPKh; H-34; H-60; Hepta; Heptachloor; Heptachlorane; Heptachlor; [1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methano-1H-indene]; Heptacloro; Heptachlorotetrahydro-4,7-methanoindene; Heptagran; Heptagranox; Heptamak; Heptamul; Heptasol; Heptox; Latka 104; NCI-C00180; Soleptax; Rhodiachlor; Termide; Tetrahydro; Veliscol 104; Veliscol heptachlor
HEXACHLORO-BENZENE (CAS No.: 118-74-1)	Agronal H; Amaticin; Amatin; AntiCarie; Benzene, hexachloro-; benzol, Hexachlor; Bunt-cure; Bunt-no-more; Chlorbenzol, hexa; Co-op Hexa; Ceku C.B.; ENT-1719; esaclorobenzene; GChB*; Gexachlorbenzol*; Granox; Granox nm; HCB; HCBz; hexachloorbenzeen; Hexachlorobenzen; Hexachloro-; Hexa CB; Hexa c.b.; Hexachlorbenzol; Julian's carbon chloride; julin's carbonchloride; julin's chloride; No Bunt; No Bunt 40; No Bunt 80; No Bunt Liquid; Pentachlorophenyl chloride; Perchlorobenzene; Perchlorbenzol; Phenyl perchloryl; Sanocid; Sanocide; Smut-Go; Snieciotox; Snieciotox 40; Zaprawa nasienna sneciotox;

MIREX (CAS No.: 2385-85-5)	1,1a,2,2,3,3a,4,5,5,5a,5b,6-Dodecachloro-octahydro-1,3,4-metheno-1H-cyclobuta[cd]pentalene; 1,2,3,4,5,5-hexachloro-; ,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene dimer; 1,3,4-Metheno-1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachlorooctahydro-1H-cyclobuta<cd>pentalene; 1,3,4-Metheno-1H-cyclobuta(cd)pentalene, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachlorooctahydro-; 1,3,4-Metheno-1H-cyclobuta<cd>pentalene, dodecachlorooctahydro-; 1,3-Cyclopentadiene; 1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-, dimer; Bichlorendo, CG-1283, Dechlorane, Dechlorane 4070, Dechlorane Plus, Dimer; 1,2,3,4,5,5- Dodecachloropentacyclodecane; dodecachloorpentacyclo(5.2.1.O'2,6.O'3,9.O'5,8)decaan; Dodecachloro-decahydro-1,3-cyclo-dicyclobuta<cd,gh>pentalene; Dodecachloroctahydro-1,3,4-metheno-1H-cyclobuta(cd)pentalen, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-; Dodecachlorooctahydro-1,3,4-metheno-2H-cyclobuta<cd>pentalene; Dodecachloropentacyclo(5.2.1.O'2,6.O'3,9.O'5,8)decane; dodecachloropentacyclo<5.2.1.0 %2,6.0 %3,9.0 %5,8>decane; dodecacloropentaciclo(5.2.1.O'2,6.O'3,9.O'5,8)decano; ENT-25719 ;Ferriamicide; GC1283; Hexachloropentadiene Dimer, Hexachloro-1,3-cyclopentadiene Dimer; Hrs 1276, NCI-C06428; Paramex; Perchlordecone, Perchloropentacyclodecane; Perchloropentacyclo(5.2.1.02,6.03,9.05,8)decane; Perchlorodihomocubane
TOXAPHENE (CAS No.: 8001-35-2)	2,2-Dimethyl-3-methylennorbornanchlorid; Agricide; Maggot Killer (f); Alltex; Alltox; attac; Attac 4-2; Attac 4-4; Attac 6; Attac 6-3; Attac 8; Camphechlor; Camphechlor,polychloriert;Camphechlore; Camphene, chlorinated; Camfechlor*; Camphochlor; Campheclor; Chem-Phene; Chemphene M5055; Camphofene Huileux; Chlorinated Camphene; chloriertes 2,2-Dimethyl-3-methylennorbornan; Chloriertes Camphen; Chlorinated camphene, chlorinated camphene,67 %<conc chlorine<69 %; technical; Chloro-Camphene; Clor Chem T-590; Compound 3956; Coopertox; Crestoxo; Cristoxo; Cristoxo 90; Delicia Fribal; Dimethyl-3-methylennorbornanchlorid, 2,2-; Estonox; ENT-9735; Fasco-Terpene; Geniphene; Gy-Phene; Hercules 3956; Hercules toxaphene; Huilex; Kamfochlor; Liro Toxaphen 10; M 5055; maggot killer (f); Melipax; Melipax 60 EC; Melipax do zamglawiania; Melipax plynny; Melipax pylisty; Melipex; Motox; NCI-C00259; Octachlorocamphene; PCC; Penphene; Phenacide; Phenatox; Phenphane; Polichlorcamfen*; Polychlorocamphene; Polychloriertes Camphechlor; Polychlorinated camphene; Strobane-T; Strobane T-90; Taxaphene; Terpentol plynny 60; Toxadust; Toxafen*; Toxakil; Toxaphene (Campechlor); Toxaphene (Polychlorinated camphenes); Toxaphene (Technical chlorinated camphene (67-69 % chlorine);Toxon 63; Toxaphen 10; Toxaphen 50; Toxyphene; Vertac Agricide; Vertac 90 %.

This **WEB Publication** is **edited by**

Ministry of Environment and Water

with financial support of

United Nation Environmental Programme (UNEP)
and Global Environment Facility (GEF)