Department
for Environment
Food & Rural Affairs

National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants

United Kingdom of Great Britain and Northern Ireland

February 2017

This publication is available at https://consult.defra.gov.uk/eu-environment/uk-nip-for-stockholm-convention-on-pops-2017

Any enquiries regarding this publication should be sent to us at

Chemical.Management@defra.gsi.gov.uk

www.gov.uk/defra

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Executive summary

The Stockholm Convention is a global treaty to protect human health and the environment from Persistent Organic Pollutants (POPs). These chemicals persist in the environment, can bioaccumulate and biomagnify in food chain organisms including humans and are toxic. They also have the potential to be transported long distances and are deposited far from their place of manufacture/release. The Convention requires that Parties adopt and introduce measures to reduce releases of POPs into the environment with the aim of minimising human and wildlife exposure.

There are currently 26 POPs listed in the Convention. These fall into three broad categories: pesticides (such as aldrin, chlordecone and lindane), industrial chemicals (e.g. polychlorinated biphenyls (PCBs), and certain homologue groups of poly-brominated diphenyl ethers (PBDEs)) and unintentional by-products (such as dioxins and furans) of combustion and some industrial and non-industrial processes. Many of the pesticides and industrial chemicals listed in the Convention have already been banned in the United Kingdom (UK) for many years. However, continued use is permitted for certain applications based on limited exemptions, which are detailed in Annexes A and B of the Convention.

As a Party to the Stockholm Convention, the United Kingdom (UK) developed a National Implementation Plan (NIP) in 2007 and an update was published in 2013[1]. This has now been revised to describe how the Convention is being implemented in the UK and to outline next steps for the management of POPs, particularly those which have been more recently listed. Evidence for the more recently included POPs has been obtained through a review of existing emission inventories for releases to the following vectors: air, land, water, residue and product; a periodical review of scientific journals for emission factor data; and communication with industry and national and international experts.

Since 2007, a UK POPs multi-vector inventory has been developed, maintained and reviewed annually to evaluate those POPs which are released unintentionally from anthropogenic sources (listed in Annex C of the Convention). This has been built on the existing UK National Atmospheric Emissions Inventory[2] (NAEI) and now reflects better knowledge of emissions from non-air vector emission sources. These include PCB concentrations in sewage sludge, waste incineration residues, non-ferrous metal smelting

[1] http://chm.pops.int/Implementation/NIPs/NIPTransmission/tabid/253/Default.aspx

[2] http://naei.defra.gov.uk/data/data-selector?view=air-pollutants

residues, and hexachlorobenzene (HCB) emissions from the use of the pesticide Chlorothalonil (which is emitted to air, land and water). Additional research has also been conducted to look at household burning of garden waste, to better typify activity within the UK population

The multi-vector inventory provides detailed information on sources of POPs and is a key part of the UK's assessment capability for further emissions and emission minimisation. It shows that estimates of emissions to air, land and water for all Stockholm Convention Annex C substances (including the recently listed pentachlorobenzene) have declined significantly in the UK between the period 1990 to 2014. This is largely due to policy actions targeting major UK point sources. The magnitude of diffuse sources such as accidental house fires, use of solid fuels in domestic properties and backyard burning have also declined since 1990, but represent a more challenging set of sources to control and further minimise.

In particular for dioxins and furans, there is evidence that annual release totals are reaching a plateau with the remaining annual emission levels being maintained by contributions from domestic combustion activities. In 2014, most dioxins/furans emissions came from diffuse sources such as the small scale combustion of waste or accidental fires. The heat and power generation sector is the main source of industrial emissions. Emissions to land/landfill are products of open burning processes and waste disposal. However for two of the vectors (water and product), there is an increase to that of the 2010 figure. For the water vector the increase (17%) is due to emissions from waste entering landfill, and from the heat and power generation sector. For the product vector the increase (7%) is due to the increase in recycled ashes and residues for use largely in aggregates.

For polychlorinated biphenyls (PCBs), the major source of emissions to air and land continue to be PCB-based di-electric heat transfer fluids from old electrical equipment (e.g. capacitors, transformers, electrical switching gear). The UK Government recognises that the main source of UK PCB emissions arising from di-electric equipment is still cause for concern. However, total emissions have declined over the last twenty years and in 2014 the UK PCB emissions had reduced by 97% from that of the 1990 emissions. The Government is seeking further ways in how it can address emissions from di-electric equipment that contain PCBs.

The release estimates of HCB to air, land and water in 2014 indicate a continuing decline in emissions since 1990, with the current key sources being the combustion of fuels in the power industry and its presence as a trace contaminant in the pesticide chlorothalonil.

The major route of potential human exposure to POPs is through the food chain. The Food Standards Agency monitors the UK food supply and animal feeds for a selection of the listed POPs. The levels found have raised no concerns for human health.

As the contribution to emissions (and potential human exposure) from larger industrial sources has reduced, a range of smaller, more diffuse sources have come to dominate emissions of unintentionally produced POPs in the UK. Although backyard burning and domestic space heating remains a key diffuse source of some POPs, publicity has helped to raise public awareness about good practice in the disposal practices of household waste. The Government will continue to build on this work.

Emissions of both unintentionally produced and manufactured POPs including PCDD/Fs, PCBs and polybrominated di-phenyl ethers (PBDE) flame retardants will continue to be monitored through the Toxic Organic Micro-Pollutants (TOMPS) air monitoring programme. The UK recognises that it is important to continue to provide long–term data to ensure that existing controls are sufficient to continue reductions in environmental exposure but also believes that there is a need to develop strategies to address the “new” chemicals that are being to the added to the Convention annexes. Hence the UK will be developing work around selecting and monitoring some of the recently listed POPs. Where available, current emission trends data will be compared to data collected in 2020 to review the success of UK policies on reducing emissions as well as input into the next review of the UK National Implementation Plan.

Overall the UK has made good progress against the actions outlined in the 2007 and 2013 NIPs. In terms of future activity, the priority is to gain a better understanding of the potential scale and magnitude of emissions from past (legacy) uses and in items currently in-use and which still contain POPs, particularly when these enter waste streams. The UK emissions inventory has been expanded to provide detail to the five vectors required by the Stockholm Convention. Where relevant, the emission inventory will be expanded to include emission data on the four substances which were added to the Convention in 2013 and 2015 (hexachlorobutadiene, polychlorinated naphthalenes, pentachlorophenol its salts and esters, and hexabromocyclododecane (HBCDD)). The UK Government will also continue to support research on POPs, which will help inform future measures needed to achieve further emission reductions.

Section 1

Introduction

1.1 Purpose of the United Kingdom's (UK) National Implementation Plan

The Stockholm Convention on Persistent Organic Pollutants (POPs, http://www.pops.int/) entered into force on 17 May 2004. It is a global treaty signed by 151 States and regional economic integration organisations. The Convention's objective is to protect human health and the environment from these chemicals.

Parties to the Convention are required to develop and endeavour to put into practice a National Implementation Plan (NIP) setting out how they will implement their obligations under the Convention. This plan was to be submitted within two years of the date on which the Convention entered into force for that Party. The UK ratified the Stockholm Convention on 17 April 2005 and consequently submitted its first NIP in 2007. This was followed up with an update in 2013.

Under the Stockholm Convention there is a requirement that the UK NIP is subject to periodic updating and revision in response to the dynamic nature of the Convention, for example, in its identification and inclusion of additional POPs.

1.2 Development of the UK's 2017 National Implementation Plan

This updated UK NIP has been developed by the Department for Environment, Food and Rural Affairs (Defra) in close collaboration with the Scottish Government, the Welsh Government, the Department of Agriculture, Environment and Rural Affairs (DAERA), Northern Ireland and other relevant Government Departments and Agencies.

1.3 What are Persistent Organic Pollutants?

Persistent Organic Pollutants (POPs) are a group of chemicals that are toxic, persist in the environment, bioaccumulate in fatty tissues and biomagnify through the food chain. In addition, they have the potential to be transported long distances and deposited far from their place of release, including in pristine environments such as the Arctic and Antarctic. Persistent Organic Pollutants have been identified as priority chemicals for many years and the

international community has called for actions to reduce and eliminate their production, use and release.

1.4 Overview of the listed Persistent Organic Pollutants

The Stockholm Convention currently focuses on reducing and eliminating releases of 26 POPs (Table 1). These include those added to annexes A and C of the Convention in 2013 and 2015. Descriptions of each of the 26 POPs are provided at Annex 2.

Table 1 The 26 POPS listed in the Stockholm Convention

Chemical	CAS Number	Pesticide	Industrial chemical	Unintentional by- product
Aldrin	309-00-2	X		
Chlordane	57-74-9	X		
Dieldrin	60-57-1	X		
Endrin	72-20-8	X		
Heptachlor	76-44-8	X		
Hexachlorobenzene (HCB)	118-74-1	X	X	X
Mirex	2385-85-5	X		
Toxaphene (camphechlor)	8001-35-2	X		
Polychlorinated biphenyls (PCBs)	various		X	X
Dichlorodiphenyltrichloroethane DDT	50-29-3	X		
Polychlorinated dibenzo-p-dioxins (PCDD) (dioxins)	various			X
Polychlorinated dibenzofurans (PCDF) (furans)	various			X
Chlordecone	143-50-0	X		
Hexabromobiphenyl	36355-01-8		X	
Hexa- and hepta-bromodiphenyl ether	various		X	
Alpha hexachlorocyclohexane	319-84-6	X		
Beta hexachlorocyclohexane	319-85-7	X		
Lindane (gamma hexachlorocyclohexane)	58-89-9	X		
Pentachlorobenzene (PCBz)	608-93-5	X	X	X
Perfluorooctanesulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F)	various		X	
Tetra- and penta-bromodiphenyl ether	various		X	

Endosulfan	115-29-7 959-98-8 33213-65-9	X		
Hexabromocyclododecane*	25637-99-4 3194-55-6 134237-50-6 134237-51-7 134237-52-8		X	
Hexachlorobutadiene**	87-68-3		X	
Polychlorinated Naphthalenes (PCNs)**	various		X	X
Pentachlorophenol and its salts and esters**	various	X		

* Listed in 2013; **Listed in 2015

1.5 Provisions of the Stockholm Convention

The Stockholm Convention establishes a strong international framework for promoting global action on POPs, which are divided into three groups according to their mechanism of production and level of restriction.

Twenty-two of the intentionally produced chemicals are subject to a ban on production and use except where there are generic or specific exemptions. These are aldrin, polybromodiphenyl ether (PBDEs: tetra- penta- hexa-, and hepta-BDEs), chlordane, chlordecone, dieldrin, endosulfan, endrin, heptachlor, hexabromobiphenyl (HBB), hexabromocyclododecane (HBCDD), hexachlorobenzene (HCB), hexachlorobutadiene, alpha- and beta-hexachlorocyclohexane (HCH), lindane (gamma- HCH), mirex, pentachlorobenzene (PCBz), perfluorooctanesulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F), polychlorinated biphenyls (PCBs), polychlorinated naphthalenes (PCNs), and toxaphene (also known as camphechlor). In addition, the production and use of DDT is severely restricted.

Parties are required to take measures to reduce releases from the unintentional production of dioxins, furans, PCBs, HCB, PCBz and PCNs with the goal of their continuing minimisation and, where feasible, ultimate elimination. The main tool for this is the development of source inventories and release estimates as well as plans for release reductions. The use of Best Available Techniques (BAT) to limit releases of unintentionally produced POPs from the major sources, as categorised in the Convention, is also required.

There are special provisions for those Parties with regulatory assessment schemes to both review existing chemicals for POP characteristics and to take

regulatory measures to prevent the development, production and marketing of new substances with POP characteristics.

The Convention also makes provision for the identification and safe management of stockpiles containing or consisting of POPs. Waste containing, consisting of or contaminated with POPs should be disposed of in such a way that the POP content is destroyed or irreversibly transformed. Where this does not represent the environmentally preferable option or where the POP content is low, waste shall be otherwise disposed of in an environmentally sound manner. Disposal operations that may lead to the recovery or re-use of POPs are forbidden.

The Convention recognises the particular needs of developing countries such as specific provisions on technical assistance and financial resources and mechanisms are included in the general obligations.

Section 2

The UK's legislative and policy framework on Persistent Organic Pollutants (POPs)

In addition to the Stockholm Convention, the UK has the following commitments at the international, European Union (EU) and national level.

2.1 International level

Owing to the long range transportation of POPs, a global approach is necessary to agree the control of these substances.

2.1.1 The 1998 Aarhus Protocol on Persistent Organic Pollutants to the United Nations Economic Cooperation for Europe (UNECE) Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution

The UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP; http://www.unece.org/env/lrtap/pops_h1.html) Executive Body adopted the Protocol on Persistent Organic Pollutants on 24 June 1998 in Aarhus, Denmark. This aims to eliminate discharges, emissions and losses of 16 pesticides, industrial chemicals and by-products/contaminants. The POPs Protocol bans or severely restricts the production and use of specified products and includes provisions for dealing with their wastes. Seven new substances were added to the Protocol in 2009, although these changes have not yet entered into force.

In its Long Term Strategy adopted in December 2010, the UNECE Convention stated that the main focus of global action on POPs should be through the Stockholm Convention, with further changes to the POPs Protocol focusing on unintentionally released POPs and where it is agreed that the implementation of stricter measures in the UNECE region is needed.

2.1.2 The Rotterdam Convention on the Prior Informed Consent for certain hazardous chemicals and pesticides in international trade

The Rotterdam Convention is a global agreement which seeks to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals, in order to protect human health and the environment. It establishes a Prior Informed Consent (PIC, http://www.pic.int/) procedure, which seeks agreement from importing countries to accept shipments of certain hazardous chemicals. Many of the POPs listed in the Stockholm Convention are also listed in the Rotterdam Convention. The UK ratified the Rotterdam Convention in 2004. It is implemented in the European Union (EU) through Regulation (EU) No

649/2012 (the PIC regulation) on the export and import of hazardous chemicals. In the UK, the PIC procedure is operated by the Government's Health and Safety Executive which has been appointed jointly with the Health and Safety Executive for Northern Ireland as the UK PIC Designated National Authorities.

2.1.3 The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

The Basel Convention (http://www.basel.int/) is a global agreement which addresses the problems and challenges posed by the movement and management of hazardous wastes, including those consisting of, containing or contaminated with POPs. The Basel Convention uses a PIC procedure to control transboundary movements of waste whereby hazardous waste cannot be shipped from one country to another without the consent of those countries involved, including countries of transit.

The Basel Convention was amended in 1995. The amendment prohibits the export of all hazardous waste from Parties that are members of the EU, OECD and Liechtenstein to all other Parties to the Convention. While the ban is not yet in force, it is implemented in the EU through the Waste Shipment Regulation. The UK ratified it in 1994.

In recent years the Basel Convention has been developing technical guidelines on the environmentally sound management of wastes containing POPs. Seven guidelines were adopted by the Conference of the Parties in May 2015.

2.1.4 The Sustainable Development Goals

The United Nations Sustainable Development Summit of September 2015 adopted the 2030 Agenda for Sustainable Development. This agenda sets out an international commitment to 17 Sustainable Development Goals and 169 targets, which aim to, *inter alia*, end poverty, combat inequality, protect human rights, and ensure protection of natural resources. Goals 3 (Good Health and Well-Being), 6 (Clean Water and Sanitation), and 12 (Responsible Consumption and Production) all include targets relating to harmful chemicals.

The Department for International Development (DFID) leads on coordinating the UK's implementation of the Goals, with support from Cabinet Office. Other Government Departments have overall responsibility for implementing the Goals related to their area of work to ensure the UK fulfils its obligations.

The Well-being of Future Generations (Wales) Act 2015 gives public bodies in Wales a statutory duty to carry out sustainable development, and puts

national goals, linked to the UN Sustainable Development Goals, on a legislative footing for the first time.

2.1.5 The Strategic Approach to International Chemicals Management

The International Conference on Chemicals Management February 2006 finalised and adopted the Strategic Approach to International Chemicals Management (SAICM, http://www.saicm.org/).

This is a global framework to improve chemicals management. It is a voluntary agreement supported by a high-level declaration and contains a toolkit of policies and activities aimed at raising the standards of chemicals management, particularly in developing countries. SAICM coordinates international bodies with responsibilities for chemicals management and supports and enhances the global treaties that cover chemicals and hazardous waste.

The 4th ICCM held in 2015 addressed issues on the continued implementation of SAICM as a policy framework to foster the sound management of chemicals globally. Resolutions were negotiated on:

- The endorsement of “overall orientation and guidance” (OOG) to assist further implementation of SAICM towards its 2020 goal;
- Work on emerging policy issues within SAICM, including the adoption of a new one on environmental persistent pharmaceutical pollutants;
- The establishment of a process for consideration of what international arrangements should follow in respect of sound management of chemicals and waste after 2020; and
- Budgetary and administrative arrangements for SAICM.

An “open group” of countries is addressing the future of SAICM through an inter-sessional process. The overall result should enable ICCM5 – to take place in March 2020 – to reach a decision on further work.

2.2 European Union

As a Member State of the European Union (EU), there is close co-operation between the EU and the UK on policy and legislation on chemicals. Most UK legislation concerning the control of chemicals arises from European Community legislation.

2.2.2 European Union legislation on Persistent Organic Pollutants

The Union Implementation Plan includes a full list of relevant European Legislation. Further details can be found at:

http://ec.europa.eu/environment/chemicals/international_conventions/index_en.htm

The key instruments are outlined below.

Regulation (EC) 850/2004 on POPs is directly applicable in UK law and implements the most important obligations of both the Stockholm Convention and the UNECE POPs Protocol. It prohibits the production, use and marketing of the POPs listed in the Annexes of both instruments and contains provisions on stockpiles and wastes.

In 2012 and 2016 a number of amendments of (EC) 850/2004 entered into force to implement the international agreement reached at the 5th, 6th and 7th Conference of the Parties (COP) to the Stockholm Convention in 2011, 2013 and 2015, respectively. The new chemicals added to the EU Regulation on POPs have already been subject to prohibition or severe restrictions in the EU. However, certain restrictions go further than previously was the case in order to comply with the new international commitments.

The new chemicals were: Endosulfan, Hexachlorobutadiene (HCBD), Polychlorinated Naphthalenes (PCNs), Short Chain Chlorinated Paraffins (SCCPs) and Hexabromocyclododecane (HBCDD). Endosulfan is a new pesticide and the other new substances have been widely used in consumer and industrial products.

Council Directive 96/59/EC on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCTs) aims at disposing PCBs and equipment containing PCBs[3] as soon as possible. This Directive included a target to remove and safely dispose of all larger equipment (heat transfer fluid reservoirs of greater than 5 litres) containing PCBs before the end of 2010. Furthermore this Directive also sets requirements for the environmentally sound use and disposal of PCBs.

With regard to unintentionally produced POPs, there are several instruments that have an impact, either directly or indirectly, on the reduction of releases of these substances. The main release control measures are set out in the Industrial Emissions Directive (IED) (2010/75/EU). Agreed in 2010, the IED brought together and updated, seven existing European Directives covering industrial emissions.

Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) *inter alia* provides

[3] Transformers can be used until the end of their useful life provided their PCB level is less than 500ppm.

provisions to ensure that industrial chemicals fulfilling POP criteria[4] can be identified and may be prevented from being produced or imported in the EU. Criteria for the identification of these substances are set out in REACH Annex XIII.

Under REACH, the standard information requirements for substance registration depend upon the amount of the substance which is manufactured in or imported into the EU. The most basic level of information (physico-chemical data) applies to substances manufactured in quantities of one tonne or more per year. The information requirements become progressively more detailed including data on human toxicology and ecotoxicology, at manufacture or import levels of 10, 100 and 1,000 tonnes or more per year. The data requirements for higher tonnage brackets will have a potential overlap with the POP criteria set out in the Stockholm Convention. However the critical thresholds do not specifically match and some criteria, such as long range transport, are not included within REACH data requirements. The Regulation also has provisions to apply controls to substances of very high concern (SVHC) which fulfil POP criteria. These provisions apply regardless of tonnage. Furthermore, the European Chemicals Agency (ECHA) has a right to request further information from companies if it suspects that a substance might exhibit POP criteria.

Regulation (EU) No 649/2012 concerning the export and import of certain hazardous chemicals (known as the PIC Regulation) prohibits, in accordance with the provisions of the Stockholm Convention, the export from the European Union of POPs listed in Annexes A and B of the Convention.

The Water Framework Directive's daughter directive 2008/105/EC on environmental quality standards in the field of water policy sets out environmental quality standards (EQS) relating to the presence of two groups of priority substances in surface waters. The substances are listed based on the risk they pose to, or via, the aquatic environment. Annex I of this Directive lists 33 substances broken into three groups:

- Priority substances (PS) - required for reduction of discharges and losses;
- Priority hazardous substances (PHS) - required for the cessation or phase out of discharges, emissions and losses; and
- Other pollutants (OP).

[4] These are defined as chemicals which are persistent, bio-accumulative and toxic (PBT) or very persistent and very bio-accumulative (vPvB)

Substances listed in Annex I include some POPs and these are classified as PHS or OP. These are: brominated diphenylethers flame retardants, cyclodiene pesticides (classified as OPs including aldrin, dieldrin and endrin), DDT (OP), HCB, HCBD, HCHs and PCBz. Annex I substances were subsequently reviewed, updated and a further 12 substances were added to Annex II under the Water Framework daughter Directive – 2013/39/EU together with EQS values. The POP chemicals included in the revised list are perfluorooctane sulphonic acid and derivatives (PFOS), and dioxins and furans and dioxin-like PCBs. Member states (MS) are required to report surface water concentrations of these additional 12 substances to the Commission in 2018.

In addition, the 2008/105/EC and 2013/39/EU daughter directives place a requirement on MS to establish, for each River Basin District, an inventory of emissions, discharges and losses for PS and PHS. The aim of these inventories is to provide an evidence base to inform policy decisions, plans and programmes of measures to reduce emissions, discharges and losses and thus help maintain or achieve compliance with EQS.

2.3 National level

The UK has arrangements in place to ensure that independent expert scientific advice is available to inform policy through the Hazardous Substances Advisory Committee. There is also a dedicated body for engagement with stakeholders on chemicals matters, through the UK Chemicals Stakeholder Forum.

2.3.1 UK regulation on Persistent Organic Pollutants

In the UK, the Persistent Organic Pollutants Regulations 2007[5] (UK POP Regulations 2007) supplements the Community Regulation EC 850/2004. Following the addition of five new substances to the Stockholm Convention at the 5th, 6th and 7th Conference of the Parties in 2011, 2013 and 2015 Regulation EC 850/2004 (amended to Regulation (EU) No 757/2010) was amended in 2012 and 2016 to list the additional substances in its annexes. The UK POP Regulations 2007 designates the Environment Agency as the Competent Authority and enforcement agency for Regulation EC 850/2004 in England, Natural Resources Body for Wales in Wales; the Department for Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland; and the Scottish Environment Protection Agency (SEPA) in Scotland.

[5] http://www.legislation.gov.uk/uksi/2007/3106/made

2.3.2 UK roles and responsibilities

The range of UK Government Departments and agencies with an implementation and/or enforcement role for the Stockholm Convention include:

• Department for Environment, Food and Rural Affairs (Defra) - Defra leads for the UK in consultation with the Devolved Administrations, other Government Departments and other stakeholders on the further development and implementation of the Stockholm Convention. Defra aims to promote and protect the quality of life and natural resources, both at home and internationally. The department has published its strategy[6] to 2020 “Creating a great place for living” where it sets out its strategic objective for the environment - a cleaner, healthier environment, benefiting people and the economy. The aims are:

- Increased biodiversity, improved habitat and expanded woodlands;
- Cleaner air;
- Cleaner water and sustainable usage;
- Cleaner and healthier seas;
- Productive land and soils;
- Conserved and enhanced landscapes;
- Maintained protection of designated sites;
- Reduced waste and waste crime; and
- Greater enjoyment of the natural environment.

Defra will publish a 25-year Environment Plan by the end of 2017 to meet these aims.

In the UK environmental responsibilities have been devolved to the following bodies:

• Scottish Government - the Environment and Forestry Directorate (ENFOR) of the Scottish Government aims to improve the sustainable exploitation of land, sea and freshwater resources and rural development, while safeguarding the interests of consumers, and protecting and enhancing the environment. The ENFOR encourages action to reduce pollution and other measures to safeguard the environment. Specifically, it develops and oversees the implementation of policy on, for example, integrated pollution prevention and control, the water environment, waste, resource management

[6] https://www.gov.uk/government/publications/defras-strategy-to-2020-creating-a-great-place-for-living

and air quality. The ENFOR also sponsors the Scottish Environment Protection Agency (SEPA, the regulatory and enforcement authority for environmental protection and pollution control in Scotland, covering discharges to air, land and water);

• Welsh Government– the Welsh Government is committed to sustainable development as its central organising principle. Its responsibilities include: environmental water quality, waste management, contaminated land and land quality, air quality, and industrial pollution controls. The Welsh Government is of the view that the regulation of industrial chemicals and nanotechnologies is best carried out through strong legislation applied consistently across Europe and, where possible, reinforced through global treaties. The Welsh Government supports a consistent UK-wide approach to policy and regulation in this area and sponsors the Natural Resources Body for Wales (NRW); and

• Northern Ireland Department of Agriculture, Environment and Rural Affairs (DAERA NI) –DAERA's objectives include the conservation and enhancement of the environment. The Department takes the lead in advising on and implementing environmental policy and strategy in Northern Ireland. The Northern Ireland Environment Agency (NIEA) as an executive agency of DAERA has a wide range of responsibilities for the environment and supports DAERA's mission to make Northern Ireland a better place to live, work and invest.

One Department with a particular interest in promoting the success of multilateral environmental agreements such as the Stockholm Convention in developing countries is:

• Department for International Development (DFID) – This is responsible for promoting sustainable development and reducing poverty. The UK Aid Strategy[7] sets out the UK's aid priorities, which cover a range of the challenges, set out in the Sustainable Development Goals, including the environment. DFID's assistance is concentrated in the poorest countries of sub-Saharan Africa and Asia. It works in partnership with other Governments, civil society, the private sector and the research community. It also works with multilateral institutions including the World Bank, the Global Environment Facility (GEF), and United Nations agencies.

In England, Wales and Scotland the responsibility for enforcing environmental and chemicals legislation rests with the following bodies:

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[7] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478834/ODA_strategy_final_web_0905.pdf

- The Environment Agency (EA) – the EA is the designated enforcer of the Stockholm Convention in England and is the main environmental regulator in England. It was set up as a non-departmental public body (NDPB) sponsored largely by Defra. The Agency issues various permits, licences, consents and registrations, including permits under Integrated Pollution Prevention and Control to reduce unintentional release of POPs. Before users (e.g. industrial manufacturers) carry out an activity that may need a licence the agency offers advice on ways of reducing that activity's effect on the environment. Part of its role is to regularly inspect and monitor licence-holders to ensure that the standards that have been set are being met. The EA can take legal action against those committing environmental crime;

- The Scottish Environment Protection Agency (SEPA) – the SEPA is the designated enforcer of the Stockholm Convention in Scotland and the main environmental regulator for Scotland. It is sponsored by the Scottish Government, as an NDPB, with the main purpose of protecting and improving the environment, whilst also contributing to improving the health and well-being of people in Scotland and achieving sustainable economic growth. In broad terms it regulates activities that may pollute water, air and land, the storage, transport, management, processing and disposal of waste, and the keeping and disposal of radioactive materials;

- Natural Resource Body for Wales (NRW) – the NRW is the enforcing authority in Wales for the regimes that delivers the UK commitment to the Stockholm Convention and is the main environmental regulator for Wales. Their purpose is to ensure that the environment and natural resources of Wales are sustainably maintained, used and enhanced, now and in the future. It has a broad remit, including land management, conservation, advisor, and is responsible for a wide range of environmental regulation including protecting people and the environment from emissions to air, land and water; and

- The Northern Ireland Environment Agency (NIEA) – the NIEA is the main environmental regulator for Northern Ireland. NIEA aims to protect, conserve and promote the natural environment of Northern Ireland for the benefit of present and future generations. The agency provides education and advice and undertakes the regulation of activities which have the potential to pose a risk to human health or damage the natural environment. It is responsible for implementing a wide range of legislation covering water quality, pollution prevention and control, waste management, and nature conservation and the countryside.

In summary, in relation to matters relevant to the Stockholm Convention, the four environment agency organisations have similar roles and responsibilities. The exception to this is that in England and Wales the industrial processes with less potential to release dioxins and furans (i.e. Industrial Pollution

Prevention and Control (IPPC) Part B and Part A(2)) processes are regulated by local authorities while in Scotland they are regulated by SEPA. In Northern Ireland, those processes corresponding to Part A and Part A(2) of IPPC are regulated by NIEA, while the regulation of those processes corresponding to Part B are split between NIEA and local authorities.

There are also a number of other UK Departments with specific responsibilities for the management of chemicals. These include:

- Health and Safety Executive (HSE) – the HSE's mission is to prevent death, injury and ill health in Great Britain's workplaces. HSE deals with a range of health risks, including noise, vibration, pathogens, radiation and the risks posed by chemicals specifically. HSE is the UK Competent Authority for the regulation of biocides, pesticides, detergents and chemicals as they are regulated by REACH, and duties under the Classification and Labelling regime. Within its enforcement responsibilities HSE enforces a range of chemical related legislation;

- The Chemicals Regulation Division (CRD) – the CRD is a division of HSE. The primary aim of CRD is to ensure the safe use of biocides, industrial chemicals, pesticides and detergents to protect the health of people and the environment;

- Health and Safety Executive Northern Ireland (HSE NI) – the HSE NI is the lead body responsible for the promotion and enforcement of health and safety at work standards in Northern Ireland. Its mission is to ensure that risks to people's health and safety arising from work activities are effectively controlled;

- UK Health Departments – The aim of these departments is to improve the health and well-being of people. The Department of Health for England sets the direction on promoting and protecting people's health, taking the lead on issues such as environmental hazards to health, infectious diseases, health promotion and education and the safety of medicines. The Environmental Hazards Branch, within the Department, plays a role providing policy advice relating to possible impacts on human health of chemicals in the environment. The Department works closely on environmental chemical issues with Other Government Departments and international organisations such as the European Union (EU), World Health Organisation (WHO) and Organisation for Economic Cooperation & Development (OECD). It obtains expert scientific and medical advice from the Public Health England (PHE). PHE is assisted in formulating expert advice by a number of independent advisory committees. PHE also provides a dedicated field service and an integrated approach to protecting the public to chemical hazards, radiation and microbiological hazards;

• Food Standards Agency (FSA) – The FSA is an independent food safety watchdog set up to protect the public's health and consumer interests in relation to food. It's Science and Policy Directorate is responsible for the development of policy and provision of advice on chemical contaminants in food and feed, and represents the UK during negotiations with the European Commission and other Member States regarding regulatory limits for contaminants in food. FSA has devolved offices in Wales and Northern Ireland. Food Standards Scotland (FSS) is a separate department but it works closely with FSA on matters of food safety;

• Local Authorities – in England and Wales local authorities enforce local air pollution controls. Under this, conditions are included in authorisations for prescribed processes to ensure that processes are operated using the best available techniques not entailing excessive cost. They are also responsible for the enforcement of food safety regulations, including contaminant limits;

• Her Majesty's Revenue and Customs (HMRC) - have enforcement responsibility at borders against imports and exports of regulated chemicals under the Stockholm Convention;

• UK Border Force - have law enforcement command within the Home Office. Their role is to secure the UK border by carrying out immigration and customs controls for people and goods entering the UK. In dealing with hazardous chemicals the Border Force will detain shipments that are believed not to comply with the requirements of the legislation for up to two working days pending further enquiries and / or examination by the HSE. The detention of non-compliant shipments for up to two working days is allowed for under the Health and Safety etc Act 1974. In the event that enquiries are likely to take longer than two days then detention powers for up to three working days under Product Safety Regulations[8] can be used; and

• Centre for Environment, Fisheries and Aquaculture Science (Cefas) – Cefas is an Executive Agency of Defra. It is a world leader in marine science and technology, providing innovative solutions for the aquatic environment, biodiversity and food security. Cefas is the designated scientific and technical advisor to the Marine Management Organisation (MMO). The MMO licenses the dredging and disposal of dredged material in England under part 4 of the Marine and Coastal Access Act 2009[9].
When determining an application for a marine licence for disposal to sea, the MMO must have regard to protect the environment and human health and also prevent interference with legitimate uses of the sea hence the suitability

[8] http://www.legislation.gov.uk/uksi/2005/1803/contents/made

[9] http://www.legislation.gov.uk/ukpga/2009/23/contents

of dredged material for disposal to sea must always be assessed. Assessment is undertaken in line with Oslo and Paris Conventions (OSPAR, http://www.ospar.org/convention) guidelines for the management of dredged material (OSPAR 2009). Cefas identifies which contaminants including POPs need to be tested for in sediments proposed for dredging and disposal. The results of chemical analysis are considered against Cefas Action Levels (ALs). The ALs are not statutory contaminant standards but are used as part of a 'weight of evidence' approach to assessing dredged material and its suitability for disposal to sea. It should be noted these ALs are under review. Generally, capital dredged sediments would be tested for POPs whereas maintenance dredged sediments, which have been recently deposited, would only be tested in specific areas where there has been previous a POP contamination issue.

Section 3

Implementation of action on Persistent Organic Pollutants in the UK

This section considers the current situation regarding POPs in the UK, outlining their production, use, release pathways and relevant regulatory controls. Where relevant, details of present stocks and marketing of the substances, and measures undertaken to meet compliance requirements is also provided. Details of POPs emissions are provided in Section 4.

Information regarding the existing POPs identified under the Stockholm Convention was provided in the UK's 2007 and 2013 National Implementation Plans (NIPs). They cover the 12 substances added to the Annexes of the Convention at its creation in 2004, plus the additional substances added to the Convention in 2009, 2011 and 2013 (23 substances in total). A further three substances were also added in 2015, for which the requirements entered into force late in 2016.

The purpose of this 2017 NIP is to provide an update on that information and should be read in conjunction with the 2007 and 2013 NIPs. Those POPs listed in 2013 and 2015 are covered in detail in this NIP. However, more background about the existing POPs and those listed in 2013 and 2015 is provided in the Defra reports, "Cost Benefit analysis of the Addition of Hexabromocyclododecane (HBCDD) to the Stockholm Convention and the 1998 POPs Protocols" and "A Further Update of the UK's Persistent Organic Pollutants Multi-media Emissions Inventory - CB0489 - Annual Report – 2016. These reports are available at http://randd.defra.gov.uk/.

3.1 Overview of regulatory control

The requirements of the Stockholm Convention are implemented in UK principally by the UK's Persistent Organic Pollutants Regulations 2007[10] and these are detailed section 2.3.1 above. Section 2 also details other chemical and environmental legislation that complements the Regulation in implementing the requirements of the Stockholm Convention. In addition there are controls in place to reduce releases of unintentionally produced POPs and human exposure to these. These are outlined at the end of this section.

[10] http://www.legislation.gov.uk/uksi/2007/3106/made

The Environment Agency's (EA) Chemical Compliance Team undertakes proactive, cost-effective monitoring and enforcement of compliance with certain chemical marketing and use regulations, including the requirements relating to POPs. Intelligence-led, risk-based targeting is used to deliver sector-focussed compliance campaigns which employ a combination of advice and guidance to raise awareness across the broader industry audience, and proportionate direct enforcement action where necessary.

3.2 Update for POPs regulated before 2013 (“existing POPs”)

The term “existing POPs” covers those substances listed in the Stockholm Convention before 2013, i.e. all 12 substances added at the Convention’s creation in 2004, nine substances added in 2009 and endosulfan which was added in 2011. The ‘new’ POPs are the substances added to the Convention in 2013 (hexabromocylododecane) and in 2015 (hexachlorobutadiene, polychlorinated naphthalenes, and pentachlorophenol). These substances are chiefly dominated by pesticides and industrial chemicals.

The UNECE POPs Protocol (see section 2.1.1 above), which is independent of the Convention, also includes many of the same substances within its Annexes with some key differences – notably polycyclic aromatic hydrocarbons (PAHs). The EU POPs Regulation (see section 2.2.2 above) acts as the bridging instrument to both the Convention and the Protocol, although the timing of when substances were added to the Regulation may differ for the Convention and Protocol. For the sake of clarity, classification of ‘existing’ POPs is based on the Convention’s chronology, and also extends to include the substances covered under the POPs Regulation. This section provides an update to the more detailed information contained in the UK 2007 and 2013 NIPs.

3.2.1 Pesticides

At its creation the Stockholm Convention listed pesticides within its Annexes (A, B, and/or C). These: were aldrin; chlordane; dichlorodiphenyltrichloroethane (DDT); dieldrin; endrin; heptachlor; hexachlorobenzene; mirex; and toxaphene (also known as camphechlor). Subsequently, in 2009, the chlordecone, lindane, and the principal isomers found in technical hexachlorocyclohexane (HCH) (alpha- and beta- HCH) were added to the Convention, along with pentachlorobenzene (a contaminant found in specific types of pesticide). Then in 2011, endosulfan was included in the list of pesticides.

All the pesticides listed have been banned in the UK for many years, with only lindane (banned in 2002) and endosulfan (banned in the EU as of 2006

EC/777/2006). However, even in these cases the use of lindane and endosulfan has been banned in the UK for over 10 years now.

Only limited monitoring data exists for emissions of these pesticides into air, land and water, but reportable concentrations from point sources covered by the UK Pollutant Release and Transfer Register[11] (PRTR) demonstrate that no emissions above the reporting threshold have been notified from industry. Diffuse emissions of these pesticides, particularly from timber stocks historically treated with lindane, are possible, but are expected to be in trace amounts.

Additional to the Stockholm Convention and EU POPs Regulation, a number of the persistent pesticides (heptachlor, hexachlorobenzene, pentachlorobenzene, lindane, endosulfan and pentachlorophenol are listed as priority substances or priority hazardous substances under the Environmental Quality Standards (EQS) Directive 2008/105/EC (amended by 2013/39/EC). Additionally the industrial chemical HBCDD has also been listed in the EQS. These daughter directives of the Water Framework Directive (2000/60/EC) lists maximum allowable concentrations and annual average (EQSs) in surface waters, and aquatic biota.

The EA carries out water monitoring for some of the pesticides listed in the Stockholm Convention. In 2015, monitoring data collected for compliance with the EQS Directive, for hexachlorocyclohexane (HCH, alpha-, beta- and gamma- (lindane) isomers), the “drins” (cyclodiene pesticides) and para-para DDT showed that the samples exceeded the EQS for these pesticides at a limited number of specific sites. Further analysis of this data will be carried out in order to assess the overall significance of these emissions and to determine if further action is required to eliminate them.

3.2.2 Industrial chemicals

The original 12 substances added to the Stockholm Convention were dominated by pesticide products with the remaining substances covering industrial products, primarily polychlorinated biphenyls (PCBs), and hexachlorobenzene (HCB) which had application both as a pesticide and as an industrial chemical. Amongst the original listed substances were dioxins and furans, which have no commercial use, but can be released unintentionally through a number of pathways typically related to combustion.

In 2009, a further nine substances were added to the Annexes of the Convention, with a number of new industrial use chemicals. In particular, this

[11] https://data.gov.uk/dataset/uk-pollutant-release-and-transfer-register

gave focus to those brominated chemicals chiefly used as flame-retardants, where health and environmental concern warranted action. These included tetra- and penta- brominated diphenyl ether – the primary homologues within the commercial pentabrominated diphenyl ether flame retardant, and hexa and hepta brominated diphenyl ether – homologues found within the commercial octabrominated diphenyl ether flame retardant. Another brominated chemical, hexabromobiphenyl (HBB), used as an industrial chemical, pesticide and flame-retardant was also added at this time. Alongside the brominated chemicals a fluorinated surfactant (perfluorooctanesulfonic acid (PFOS)) used primarily in stain repellents, as a mist suppressant used in the metal plating industry and in firefighting foams was added.

The UK has used all of the above chemicals, with stockpiles and legacy waste aspects a key issue for the named industrial chemical substances. The possible exception being HBB, which has had limited use in the UK and has not been used for many years having been banned in the UK in 1977[12].

3.2.3 Review of specific named "existing POPs"

This section provides an overview of those 'existing POPs' (added to the Convention before 2013) which are the most relevant to the UK for continued emissions and need for emission control.

3.2.3.1 Hexachlorobenzene (HCB)

Hexachlorobenzene is an industrial chemical as well as a seed treatment pesticide. Furthermore, it can be generated unintentionally from certain kinds of combustion process. In 2004, HCB was added to both Annex A (banned) and Annex C (unintentionally released) of the Stockholm Convention reflecting both commercial uses but also its unintentional sources. The ban on commercial use of HCB is upheld in the UK through the UK POPs Regulations, 2007.

The former commercial use of HCB was primarily dominated by the use of hexachloroethane (HCE) as a cover gas in aluminium manufacture. The production process for HCE also generated significant amounts of HCB as part of the same mixture. The cover gas used in this process was subsequently released to air at the end of the production process representing a major point source release for HCB. Environmental concerns over this practice lead to a voluntary cease by industry in 2000[4].

[12] Whiting et al, 2012, 'Further update of the UK source industries for emissions to air, land and water of dioxins, dioxin-like PCBs, and HCB, incorporating multi-media emission inventories for nine new POPs under the Stockholm Convention', Defra Report ref CB0429

The primary direct application of HCB within agriculture was as a seed treatment to prevent fungal diseases in grains, however this application had ceased by the 1970s[13]. Agricultural source emissions of HCB continued to be present after this date with HCB as a contaminant by-product in other pesticides.

This use of pesticides (primarily chlorothalonil) containing HCB as a contaminant, represents the key current emission source for HCB. Emissions to air of HCB from use of chlorothalonil represented 49% (10.5 kg) of total air emissions in 2014, with a range of different combustion sources making up the remaining 51%

Legislative restrictions on levels of contamination and improvements in production processes have seen the level of HCB contamination decline in chlorothalonil. Bailey, 2001[14] quotes working concentrations in the mid-1990s of 26 mg/kg active ingredient. A sampling campaign in 2010 of pesticides on the UK market found working concentrations of 8 mg/kg active[4].

3.2.3.2 Pentachlorobenzene (PCBz)

Pentachlorobenzene) is not produced in the UK and has no current commercial uses. It was, however, present as a contaminant in the pesticide quintozene. The UK set maximum limits for PCBz contamination in quintozene in the early 1990s (10 mg/g active substance). Subsequently, following a review, quintozene was not included as an active substance under Council Directive 91/414/EEC and quintozene-containing products already on the market were withdrawn on 27 June 2001 with existing stocks to be exhausted by 27 June 2002. From 28 June 2002 it has been illegal to market, use or store plant protection products containing quintozene.

Emissions of PCBz from a wide range of sources have been estimated for the period 1990 to 2014. Emissions in 1990 were dominated by industrial sources and from the legacy of earlier industrial processes. The significance of these industrial sources has declined since 1990, leading to more recent emission estimates being dominated by diffuse sources.

In the past PCBz was present as:

- an elastomer in PCB di-electric fluids;
- a contaminant of HCE (hexachloroethane) cover gas agents used in aluminium manufacture;
- a contaminant of the pesticide quintozene;

[13] Barber et al. (2005). 'Hexachlorobenzene, sources, environmental fate, and risk charactisation' *Eurochlor dossier*.

[14] Bailey et al. (2001). 'Global HCB emissions.' *Chemosphere* 43, 167-182

- a contaminant of the pesticide pentachlorophenol (PCP);
- a contaminant of tetrachloroethene (also known as perchloroethylene or PERC) used in dry cleaning; and
- a by-product of the production of carbon tetrachloride.

Pentachlorobenzene is also produced as an unintentional by-product in combustion processes, in the following diffuse activities:

- uncontrolled combustion of waste;
- accidental fires;
- incineration of hazardous and clinical wastes;
- combustion of solid fuels – principally coal in domestic grates; and
- trace residues from emissions at waste water treatment works.

3.2.3.3 Polychlorinated biphenyls (PCBs)

Prior to the mid-1970s, PCBs were used in both ‘closed’ (electrical equipment such as capacitors, transistors and electrical switching gear) and ‘open’ applications (such as paints and sealants). Although the open use of PCBs ceased in the 1970s, it is possible that building sealants containing PCBs may still be present in older properties. A significant amount of PCBs found in the environment will have arisen from past use of such products.

The manufacture of new PCB containing equipment was banned in 1985. However, given the life-span of electrical equipment, particularly larger equipment used in electrical distribution networks, a significant bank of ‘in-use’ equipment containing PCBs is expected. The Stockholm Convention listing does provide derogation for PCBs already in use at the time of listing in the Convention.

Owing to their high environmental persistence the residual bank of equipment containing these chemicals still being used, PCB emissions have been evident in the environment long after the ban was introduced. As required under Council Directive 96/59/EC on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (the PCB Directive), the Environment Agencies hold registers of known PCB holdings (including any transformer, capacitor or receptacle containing residual stocks) in the UK. These are available on request from Agency offices.

Under the EU Directive 96/59/EC on disposal of PCBs and PCTs, it was a requirement to identify and dispose of all di-electric equipment containing more than 5 litres of PCB by the end of 1999. This was intended to target the larger PCB based equipment still in use.

The method used to estimate the current number and size of PCB-containing items of equipment is complex and due to the difficulty in identifying PCB-containing equipment. The inventory contains many items that could contain PCBs between 50 and 500 ppm but it is not possible to check for certain because of the environmental and human health risks involved. This leads to uncertainties in the estimates of the current number and size of PCB-containing items of equipment. The UK Environment Agencies are working with companies on their PCB registers to establish more accurate records.

In September 2016, there were a total of 83 registered holders in the UK of which there were 75 holders in England and Wales and 8 holders in Scotland,. There were a total of 346,583 items of registered PCB-containing equipment. The number of registered items has increased significantly in England and Wales since the last NIP (2013) as a result of work undertaken by the EA to raise awareness of the Directive amongst companies belonging to the energy sector and still using PCB-containing equipment.

All UK agencies are continuing to work with companies on their PCB registers to establish more accurate records and to arrange for the disposal of items of PCB-containing equipment that are not transformers. In January 2017, in England and Wales, there were 287 items registered that were not transformers registered by two different companies. These companies are working to disposal plans agreed with the Environment Agency.

3.2.3.4 Dioxins and furans

Dioxins and furans are a family of chemicals which to date have no known commercial use, but are produced unintentionally as a combustion by-product. Their formation can occur under thermal conditions during a number industrial production processes. Dioxins and furans can also cycle through the environment, including the food chain.

Emissions of these chemicals have declined significantly following measures taken to control industrial releases. However, unintentional releases from diffuse sources, such as backyard burning, continue to present a challenge in achieving further reductions.

The Irish dioxin incident of 2008, in which highly contaminated feed was given to pig farms in the Republic of Ireland but a proportion of which reached beef and dairy farms in Northern Ireland, leading to the disposal or destruction of hundreds of tonnes of milk and beef and the culling of 5,000 cattle, remains the only major dioxin incident affecting the UK since 2007.

3.2.3.5 Polybrominated diphenyl ethers (tetra-, penta-, hexa- and hepta- BDEs)

Polybrominated diphenyl ethers (PBDEs) are a family of chemicals which have been used in different blends for application as flame-retardants. While different trade name products have been sold across the UK and Europe, three main blends have been used based on the primary homologue groups, 'penta-', 'octa-' and 'deca-BDEs'. Table 2 provides details of these blends and which homologue groups have been present in each blend.

Table 2 Commercial mixtures of polybrominated diphenyl ethers[15]

Commercial Penta BDE mixture as % wt/wt		Commercial Octa BDE mixture as %wt/wt		Commercial Deca BDE mixture as % wt/wt*	
Tetra	38-42%	Hexa	0.2 – 10%	Deca	>97%
Penta	55 – 65%	Hepta	13 – 44%	Nona/Octa	<3%
Hexa	5%	Octa	19 – 41%		
Hepta	2.7 – 4.5%	Nona	1 – 12%		
		Deca	1.3 – 50%		

*Concentrations of c.DecaBDE post 1995 expected to be aligned to OECD voluntary scheme.

Health and environmental concerns for PBDEs, particularly the lower order homologues which are expected to be more toxic, meant that a European ban on the commercial penta- and octa-BDE blends was enacted in 2004 through Council Directive 2003/11/EC. This is implemented through the UK Controls on commercial Pentabromodiphenyl Ether and commercial Octabromodiphenyl Ether Regulations 2004 and bans the use and placing on the market of Commercial penta and octa BDEs. The ban applies to goods marketed and manufactured in the UK.

While the ban on manufacture and use of the commercial mixture was imposed in 2004, existing stock and in-use goods were permitted to continue. Where the commercial penta- and octa- BDEs were used in plastics for electrical products and in vehicles, as well as soft furnishings, the life-span of these goods could be expected to extend for some years after the ban,

[15] Whiting et al, "A Further Update of the UK's Persistent Organic Pollutants Multi-media Emissions Inventory Annual report -2016. http://randd.defra.gov.uk/

creating a need for additional control during the waste management of these products.

Since 2007, the EU Waste Electrical and Electronic Equipment (WEEE) Regulation has regulated the disposal and recycling of electrical and electronic equipment containing the tetra-, penta-, hexa- and hepta- BDEs. This legislation is implemented in the UK through the Waste Electrical and Electronic Equipment Regulations 2013[16] .

Additional controls on the use and placing on the market of these substances are provided through the EU Chemicals Regulation (REACH, 1906/2007) and the EU Restriction of certain Hazardous Substances (RoHS) Directive (2011/65/EU).

3.2.3.6 Perfluorooctanesulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F)

Perfluorooctane sulfonic acid (PFOS) is produced as a commercial product, where its high surfactant properties make it well suited as a stain repellent, mist suppressant in metal manufacture and as a surfactant within fire-fighting foams. Additionally, releases to environment can occur unintentionally through the degradation of related anthropogenic chemicals once released into the environment.

PFOS is not manufactured within the UK, and manufacture within Europe was expected to decline after 2001 when the major manufacturer (3M) voluntarily phased out PFOS. Continued manufacture of PFOS is now limited to one member state within the EU.

Under the Stockholm Convention PFOS is listed within Annex B (restriction), with a number of acceptable purposes and specific exemptions in place for named applications.

Finding alternatives with comparable properties (particularly high surfactant properties at low doses) has proved challenging, meaning that for a small number of the applications stated under Annex B of the Convention, use in the UK still continues. This primarily relates to the use of PFOS within metal plating activities in the chrome industry, the use of small quantities in semi-conductor manufacture and limited applications in the photographic industry.

In the UK, PFOS-containing stockpiles have been notified to the EA for use as a wetting agent and mist suppressant in non-decorative hard chrome plating.

[16] http://www.legislation.gov.uk/uksi/2013/3113/made

The UK has conducted awareness raising campaigns with the sector; circulating information via the Surface Engineering Association (SEA) and UK PPC (pollution prevent and control) site inspectors. Hence between 2012 and 2013 the number of companies notifying increased from 4 to 6. In 2014 a total 33,837 kg of PFOS-containing material equating to 135 kg of PFOS were notified by six companies. Information from the manufacturer suggests that these quantities will diminish as alternatives are now being used and products reformulated.

Previous use of PFOS was dominated by the domestic market, particularly as a stain repellent in furniture and other furnishing items. These items which are still being used are likely to remain a source of PFOS emissions for an extended period.

In the UK, the main environmental release pathways are believed to be to water, where concerns have been raised about further de novo[17] formation of PFOS within waste water treatment works. However, very little substantiated data exists to be able to verify current emission estimates.

3.2.3.7 Lindane and isomers of technical Hexachlorocyclohexane (alpha- and beta-HCH)

The technical formulation of HCH was manufactured and used as an insecticide within the UK since the 1940s as a main alternative to the pesticide DDT. This product was primarily made up of a mixture of HCH isomers, where the alpha and beta isomers were the dominant form within commercial formulations. However, health and environmental concerns were raised with respect to these isomers, and manufacturers began altering formulations to reduce the content of these isomers in favour of the gamma isomer (lindane). The use of technical HCH comprising chiefly alpha and beta isomers was banned in the UK in 1982.

Lindane, a commercial formulation comprising 99% gamma HCH, ultimately replaced the technical HCH product. However, the production process was inefficient and for every 1 tonne of lindane produced, approximately 8 – 10 tonnes of hazardous waste containing chiefly alpha and beta HCH was generated.

In the UK, technical HCH and lindane was primarily used as an insecticide to protect timber stocks. Later applications for lindane also included use in specialist shampoos for treatment of head lice. The use of lindane within the UK was banned in 2002.

[17] Synthesis of PFOS from simple molecules

Lindane and technical HCH are no longer manufactured or used in the UK. Placing products on the market containing lindane or technical HCH is also banned in the UK. The use of lindane on timber stocks and potential long service life of such timber stocks means that it is possible some 'in-use' or waste wood contaminated with lindane may still remain in circulation in the UK. However, given that lindane has been banned for over ten years and use of lindane had begun to decline before the ban, this should mean that such stockpiles are in decline.

3.3 POPs regulated from 2013 ("new POPs")

The 'new' POPs are the substances hexabromocyclododecane (HBCDD), hexachlorobutadiene (HCBD), pentachlorophenol (PCP) and its salts and esters and polychlorinated naphthalenes (PCNs). They were listed in the Stockholm Convention at the 6th and 7th Conference of the Parties (COP) to the Stockholm Convention held in May 2013 and in May 2015, respectively. They were also listed in the POP Protocol at the 27th meeting of the Executive Body of LRTAP Convention held in December 2009.

3.3.1 Hexabromocyclododecane (HBCDD)

3.3.1.1 Current production, marketing use, and control

Hexabromocyclododecane (HBCDD) is a flame retardant used mainly in thermal insulation foams in the construction industry. It is used in the manufacture of expanded polystyrene (EPS) and extruded polystyrene (XPS) insulation foam boards. As these foam boards are required to meet stringent fire safety regulations in the UK, HBCDD provides the required level of performance, at a relatively low concentration. HBCDD has also been applied in the back coating of textiles, mainly for upholstered furniture and in vehicle upholstery. It has been used as an additive in the manufacturer of high-impact polystyrene (HIPS) which is used in electrical and electronic equipment and appliances. There are no significant unintentional production sources of HBCDD.

HBCDD was produced in the UK by one manufacturer until 2003. After this time HBCDD was imported into the UK from European suppliers (Albermarle, Chemtura and ICL). However information collated by the European Chemicals Agency indicates that an increasing proportion of HBCDD used in Europe was imported from outside of Europe. The estimated proportion of HBCDD used in Europe which was imported into the EU was 38% in 2003, rising to 48% in 2006. It is likely that a similar proportion of HBCDD was imported into the UK over this period.

HBCDD has been subject to review both under the Stockholm Convention as a POP but also under the EU Regulation on the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH). Under the latter it was identified as a substance of very high concern (SVHC) and subject to the authorisation process, which means permission would be needed for specific use in named applications. Under the Stockholm Convention, HBCDD was added to Annex A (banned) in 2013 with a specific exemption in place giving derogation to the EU REACH Regulation process.

In January 2016 authorisation was given to thirteen companies for two specific applications (use as a flame retardant in EPS boarding and in the manufacture of expanded polystyrene beads)[18]. The review period for these authorisations is two years and the authorisation will be assessed again in August 2017. The sunset date (after which new applications for authorisation cannot be made) for HBCDD was August 2015.

3.3.1.2 Historical use and release pathways

HBCDD is not produced in the UK and historical uses have not been found. However it is widely used in the UK as a flame retardant. Hence emissions of HBCDD into the environment would have occurred from the following:

- Manufacturing goods containing HBCDD;
- Use of goods containing HBCDD; and
- End of life goods containing HBCDD.

3.3.1.3 Stockpiles and compliance activity

Although HBCDD is not manufactured in the UK, it is imported for manufacturing of insulation foam boards. It is also possible that import of the finished goods fire proofed with HBCDD into the UK can occur. Under the REACH Regulation (see para 3.3.1.1.) the continued use of HBCDD has been controlled through the authorisation process so that only specific applications are permitted (i.e. insulation boarding) and produced/supplied by those manufacturers/importers that have an authorisation in place for such goods. Work to find viable alternatives is expected to be ongoing and the authorisations in place are due to be reviewed at the end of 2017.

For those goods already ‘in-use’, particularly within the housing market, at present there are some controls in place to manage the end-of-life and waste aspects, namely:

[18] ECHA news update: http://echa.europa.eu/view-article/-/journal_content/title/authorisations-granted-for-two-uses-of-hbcdd

- The Environmental Permitting (England and Wales) Regulations 2016 (Amendment) (No 2) 2016 (Statutory Instrument 2016 No. 475[19]) as amended. This lays down environmental controls on *(inter alia*) the landfill of waste materials;
- The Waste Electrical and Electronic Equipment (Amendment) Regulations 2007 (Statutory Instrument 2007 No. 3454[20]). Use of HBCDD in HIPs was a minor use, but it can be expected that in-use stockpiles exist, representing a waste legacy issue. This regulation lays down targets for recovery and recycling of waste electrical and electronic equipment. It includes record-keeping requirements;
- HBCDD has now been added to the EU POPs Regulation and a target threshold of 1000mg/kg for wastes has been set. Those substances with higher concentrations than the threshold are considered as hazardous waste; and
- The European brominated flame retardant industry operates a programme called the "Voluntary Emissions Control Action Programme (VECAP)." This aims to reduce emissions of a range of brominated chemicals, and covers producers and industrial users of these chemicals. This is now linked with a programme focused on management of HBCDD in the polystyrene foams supply chain, known as "SECURE." This programme has resulted in improvements in the control of HBCDD emissions at source. It covers 60 of the 73 European user sites for HBCDD, accounting for approximately 93% of HBCDD consumption in Europe.

3.3.2 Pentachlorophenol (PCP) its salts and esters

3.3.2.1 Current production, marketing, use and control

Pentachlorophenol (PCP) is a pesticide with particular use for treatment of timber against a range of pests. However, concerns over its environmental effects and human health have meant through regulation or restriction that its use globally has been in decline for a number of years. Globally, manufacture of PCP is now limited to the USA and Mexico where the latest available production data reported that 13,867 tonnes of PCP was produced globally in 2009. PCP is currently only used in Canada and the USA, primarily for utility poles and railway sleepers.

[19] http://www.legislation.gov.uk/ukdsi/2016/9780111143261

[20] http://www.legislation.gov.uk/uksi/2007/3454/pdfs/uksi_20073454_en.pdf

The salt of PCP (sodium-PCP) is also manufactured and used in India as an anti-fungal wood preservative at approximately 1,500 tonnes per annum.

In the UK, the commercial production of PCP stopped in 1978, although its use continued until 2008. During this period, PCP was imported from the USA (~30 tonnes per annum) and predominantly used for production of PCPL (~93% of imported PCP was synthesised to PCPL, of which ~70% was then exported). Use of PCPL in the UK was mostly for fabrics used by the military.

3.3.2.2 Historical use and release pathways

Pentachlorophenol was most commonly used as a biocide, pesticide, disinfectant, defoliant, anti-sapstain and anti-microbial agents, and wood preservative in the agriculture and forestry sectors (namely for wooden utility poles and wooden trays used in mushroom farming). Its salt, sodium pentachlorophenate (NaPCP), was also used as a pesticide, namely a molluscicide (a pesticide against molluscs). The NaPCP salt degrades to PCP under certain conditions. Furthermore, PCP was also used for the production of PCP's ester pentachlorophenyl laurate (PCPL) which was used on textiles and fabrics for heavy duty military transport, tent fabrics and leathers as well as rope used in awnings and sails. The use of PCPL protected such textiles from fungi and bacteria. At the height of production, approximately 90,000 tonnes were globally produced per annum.

Historical and current environmental release pathways include:

- Production of PCP and its ester (PCP is used for the production of PCPL) and salt (NaPCP degrades to PCP) (historical source);
- Processing including the application of PCP/ PCPL as well as the manufacturing process of products containing PCP and its derivatives (historical source);
- Evaporation during in service life of treated products and stockpiles. For example, PCP volatises from the surface of treated wood at ~5% of the total amount of the preservative applied. However, during the first 12 months evaporation rates are much higher, with around 30% of PCP evaporating within the first 12 months of treatment;
- Waste handling where PCP treated products are sent to landfill;
- Contaminated sites resulting from former PCP production and wood preservation plants; and
- Domestic or forest fires (temperatures exceeding 800 degrees centigrade are required for complete combustion – as achieved in modern incineration plants).

Pentachlorophenol is also a source of dioxins and furans and was at the centre of a dioxin food incident in 2007 when high levels of dioxins were identified in fruit yoghurt in the Czech Republic. The source of the contamination was traced to the fruit ingredient, which had been thickened with contaminated guar gum from India. The guar gum had been treated with PCP (a common practice for non-food grade guar gum) and had been fraudulently or accidentally introduced into the food chain. As a result of this incident special control measures at EU level were introduced and these still remain in place.

3.3.2.3 Stockpiles and compliance activity

Restrictions on the use of PCP entered into force in the EU in 1991 under Council Directive 91/173/EEC and a ban was placed with respect to the use of PCP as a synthesising or processing agent in industrial processes (including use as a wood preservative) under the Directive 1999/51/EC. Further restrictions on the use of PCP in the UK entered into force in 2008 under the REACH Annex XVII. legislation which stipulates that PCP levels should not exceed 0.1% of the weight of any product placed on the market.

3.3.3 Hexachlorobutadiene (HCBD)

3.3.3.1 Current production, marketing, use and control

In the EU, commercial production of hexachlorobutadiene (HCBD) stopped in 1993 and production in the UK ceased at the same time. The latest global estimate of HCBD emissions at the time of commercial production (1982) was approximately 10,000 tonnes. Although HCBD is no longer used in manufacturing processes and does not occur naturally, it is unintentionally released from certain chemical processes, including the production of chlorinated hydrocarbons, in particular carbon tetrachloride, trichloroethylene and tetrachloroethylene. The UK manufacture of carbon tetrachloride ceased in 1993, with the production rates of around 200,000 tonnes per annum before this point. Manufacture of trichloroethylene and tetrachloroethylene both ceased in the UK in 2008, with production rates in the early 1990s of 375,000 tonnes and 13,000 tonnes respectively per annum. At the point production ceased, only 4.5 tonnes per annum of trichloroethylene and tetrachloroethylene.

Other unintentional emission sources of HCBD include the electrolytic manufacture of magnesium. While magnesium is manufactured in the UK it is important to note that the electrolytic production pathway is not the preferred production route, and that manufacture of magnesium in the UK via this route is unlikely or at best minimal.

Unintentional releases from combustion outside of industry are less regulated (domestic combustion and accidental fires are of most relevance to HCBD), and there are comparatively fewer monitoring studies available identifying hazardous by-products. No studies reporting the unintentional release of HCBD in either domestic combustion or accidental fires have been identified in this review. However, in both cases it is expected that any HCBD releases will be minor given general improvements to the quality of materials burned in domestic combustion and the low frequency at which accidental hazardous fires occur.

3.3.3.2 Historical use and release pathways

Hexachlorobutadiene was used mostly as a chemical intermediate in the production of rubber compounds, and to a lesser extent in the production of chlorofluorocarbons (CFCs) and lubricants. It was also used in smaller quantities as a solvent, lubricating fluid (e.g. for gyroscopes, and heat transfer liquid hydraulic fluid). HCBD was also reportedly used as a fumigant for pesticide against *Phylloxera* (a type of aphid pest) as well as in the production of aluminium and graphite rods. However, such claims have since been reviewed and are no longer believed to be accurate.

Current environmental release pathways for HCBD include unintentional releases, given that there is no production or stockpiles of HCBD in the UK. Sources of unintentional releases, as identified in the literature, include:

- The production of chlorinated solvents, at a trace level – including the manufacture and use of trichloroethylene (used an industrial solvent) and the methanol-based production of chlorinated methanes;
- The production of polyvinyl chloride, PVC;
- Magnesium (by electrolysis);
- Waste disposal from the production of chlorinated hydrocarbons containing HCBD. Lenoir et al.[21] observed the by-product formation of organochlorine compounds including HCBD from incineration processes of acetylene, which was indicated as being present in flames of all incineration processes. HCBD entering such plants can be released to water and soil via sewage sludge;
- Previously, unintentional releases were also reported as a result of the use of perchloroethylene (which is still widely used in the dry cleaning sector, although strictly regulated under environmental permitting), and

[21] Formation and inhibition of chloroaromatic micropollutants formed in incineration processes. Chemosphere **43**, 107-114

from the manufacture of carbon tetrachloride (CTC). The production of CTC ceased in 1993; and

- Emissions from motor vehicles have also been indicated as a potential source for HCBD. However, no evidence has been developed to substantiate this and it is expected to be a minor emission source and therefore has not been considered in more detail.

Under the POPs Regulation (EC) No 850/2004[22]. the placing of HCBD on the market was prohibited in 2012 According to the Regulation, manufactured objects containing HCBD that were in use before 10 July 2012 are allowed to be placed on the market and used, and manufactured objects containing HCBD produced before that date were allowed to be placed on the market until 10 January 2013. As such it is possible that products containing HCBD are still continuing to be in use in the EU and the UK.

Unintentional releases of HCBD can also occur as a result of waste management, either through incineration plant, or landfill. For example, ethylene dichloride (EDC) used in the manufacture of polyvinyl chloride plastic (PVC), has been found to contain around 65% chlorine, of which 1.2% can form as HCBD during production processes[23]. These chlorines can be released to the environment during incineration if the appropriate waste management options are not in place. To address this issue in the EU, maximum concentration limits for releases of HCBD to the environment were established under Regulation (EU) 1342/2014[24]:

- Reasonable effort shall be made to avoid contamination from waste management. HCBD concentrations must not exceed 100 mg/kg (Article 7 of Regulation 850/2004)[25]; and
- HCBD concentrations must not exceed 1,000 mg/kg from wastes emitted from thermal processes and waste management facilities, as well as from construction and demolition wastes and those otherwise not specified (a comprehensive list is set out in Annex II of Regulation 1342/2014).

[22] Commission Regulation (EU) No 519/2012 of 19 June 2012 amending Regulation (EC) No 850/2004 of the European Parliament and of the Council on persistent organic pollutants as regards Annex I. OJ L159/1. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:159:0001:0004:en:PDF

[23] Thorton 2002 – Environmental Imapcts of Polyvinyl Chloride (PVC) Building Materials. A Briefing paper for the Healthy building Network

[24] Commission Regulation (EU) No 1342/2014 of 17 December 2014 amending Regulation (EC) No 850/2004 of the European Parliament and of the Council on persistent organic pollutants as regards Annexes IV and V Text. OJ L 363/67. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014R1342

[25] Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants amending Directive 79/117/EEC. OJ L158/7. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:158:0007:0049:EN:PDF

Emissions from unintentional releases are low and are controlled by incineration, among other techniques. Thus, there have been significant reductions in emissions from waste management, although some releases are still reported. In light of the thresholds established under Regulation (EU) 1243/2014, it is expected that these unintentional releases will continue to decline in the UK.

3.3.4 Polychlorinated naphthalenes (PCNs)

3.3.4.1 Historic and current uses and production

Polychlorinated naphthalenes *(*PCNs) were produced at the beginning of last century and were produced in high volumes (in the 1920s global production was approximately 9,000 tonnes per year) for a diverse range of uses and applications. PCNs are a good dielectic medium (heat transfer) with a high degree of thermal and chemical stability, and are compatible with other products such as petroleum waxes and chlorinated paraffins and are soluble in chlorinated and aromatic solvents. As such PCNs have had various uses including dielectric fluids, flame retardants, fungicides, wood preservation and dye carriers. With characteristics similar to those of PCBs, PCNs have also been produced for similar uses as PCBs such as cable insulation and di-electric fluids for capacitors.

Global production started to decline from 1977 over health concerns, with a complete phase-out now in place in many countries. Within the UK, PCN production stopped in the mid 1960s although there were some reports in 1970 and again in 2000 that small amounts of PCN were still being produced and imported to other countries. Across wider Europe, Bayer was one of the main producers of PCNs, producing between 100 and 200 tonnes per year between 1980 and 1983 after which it ceased production.

Production of PCNs was possible within the European Union until 2012 when PCNs were incorporated into the EU POPs regulation. Internationally, the main producers of PCNs were based in the USA, with all USA production ceasing in 1980; and Canada, with production and use being prohibited in 2013. Between 1920 and 1980 the total global PCN production was approximately 150,000 tonnes, roughly 10% of the quantity of PCBs produced in the same timeframe.

While the main production processes of PCNs have ceased, they are still created unintentionally. These substances can be produced during uncontrolled waste combustion, waste incineration (e.g. municipal, clinical and industrial waste) and other thermal (domestic and industrial) processes. This includes production of PCNs as by-products of the non-ferrous metal industry, coking, metal reclamation, industrial solvent production, and cement industry

processes which can be considered sources for ongoing small release quantities.

3.3.4.2 Emission sources and release pathways

Since production of PCNs has ceased, the main releases of PCNs to the environment are likely to be from unintentional production, historical stockpiles and existing products that contain PCNs. The main likely sources for the UK are:

- Landfills holding old PCB and PCN containing products;
- Disposal routes of capacitors and engine oils (commercially produced up to 30 years ago);
- Incineration of clinical, municipal and medical wastes;
- Thermal processes such as copper ore roasting, aluminium reclamation, magnesium production and Chlor-alkali that result in PCN emissions; and
- Sewage sludge application to land.

Landfills have been identified as being a potentially large source of PCNs due to the historical use patterns; however actual data to support this are scarce. Nonetheless, it is likely that, as the emissions from both PCN and PCB manufactured products declines, the dominance of unintentional formation and emission from these sources will also decrease.

3.3.4.3 Stockpiles, compliance activity and alternatives

As it is described above, PCNs had similar uses to that of PCBs i.e. used as halowaxes and heat-transfer fluids and therefore is likely to have a similar profile for use and stockpiles. Any stockpiles of PCN within di-electric equipment will have been subject to the same regulations and controls as PCBs. Notably Directive 96/59/EC on the disposal of di-electric equipment that may contain PCBs, would have similar benefits for the safe disposal and destruction of PCNs within these type of equipment.

3.4 Controls on unintentionally produced POPs

3.4.1 Current legislation on unintentionally produced POPs

The UK's legislation on unintentionally produced POPs (dioxins and furans, HCB, PCB, PCN and PCBz) is delivered through a combination of action at the national, European Union and international level (see section 2) In the UK, control measures via legislation and abatement technologies have led to a significant reduction in dioxins and furans, PCBs and PCBz emissions. These measures include a combination of pollution control equipment or substitute

process technologies. For major industrial sources these measures are listed in this section of the NIP. Full details of existing Community legislation are available in the Union Implementation Plan http://ec.europa.eu/environment/chemicals/international_conventions/index_en.htm

A summary of the control measures applied in the UK including the application of Best Available Techniques and Best Environmental Practices is provided at Annex 3.

Details about the emission source categories (as required for reporting purposes for the Stockholm Convention) to which these apply are given in Annex 5.

3.4.2 Control on industrial processes

Unintentionally produced persistent organic pollutants, including dioxins, furans and dioxin-like PCBs, are covered under several instruments in Community legislation that have an impact, either directly or indirectly, on the reduction of releases of these substances. The main release control measures are set out in the Industrial Emissions Directive ((IED, 2010/75/EU).

The IED lays down the legal framework for the control of releases of dioxins and furans and dioxin-like PCBs from industrial installations. Installations covered by Annex I of the Directive must have an environmental permit in order to operate. The requirements of IED, including specific standards on emissions and stringent limits on certain pollutants to air, water and land; waste minimisation and energy efficiency, are incorporated into an operator's permit. If an installation does not comply with these permit conditions, the regulator will take enforcement action, requiring the operator of the installation to make changes to meet the conditions as soon as possible. Should the conditions continue not to be met, the permit could be withdrawn. Continuing to operate without complying with the permit conditions, can lead to prosecution.

The Directive also requires regular monitoring and periodic, risk-based inspections. Operators either monitor their emissions all the time, i.e. continuous monitoring, or periodically at times defined in their permit. In both cases monitoring must meet the quality requirements set by the relevant regulator.

In the UK, the enforcement authorities are the Environment Agencies and local authorities. In England, the EA regulates industrial processes such as municipal waste incinerators, cement works, chemical manufacturing plants, oil refineries and steel works. Local authorities regulate some combustion/incineration and metal processes and crematoria. The agencies

SEPA, NIEA and NRW (see section 2.3.2) of the devolved Administrations regulate releases in their respective territories.

The implementation of Integrated pollution prevention and control (IPPC), which required new and existing installations to meet the requirements of the IPPC Directive by 30th October 1999, resulted in significant reductions in dioxin and furan emissions, particularly from municipal solid waste (MSW) incineration plants. Although reductions have been achieved for sinter plants, there remain significant emissions from this sector owing more to large gas volumes emitted than to high concentrations. Subsequently IPPC has been superseded by the industrial emissions directive (IED), which sets further restrictions and limits on emissions of dioxins and furans from regulated plant.

3.4.3 Other key legislation for dioxins, PCBs, HCB, and PCBz

The IED regulates most waste incineration facilities. Under this Directive, sector-specific, technical documents (known as Best Available Technique Reference documents - BREFs), apply mandatory emissions limits and environmental standards which must be reflected in an operators permit within 4 years after they are adopted. For waste incineration facilities, these requirements include a strict emission limit for dioxins and furans of 0.1 nanogramme I-TEQ per cubic metre of gaseous releases. A summary of how TEQ measurements are derived and the equivalent measures for dioxins and furans is attached in Annexes 4, 4A and 4B. The major reductions in dioxins and furans emissions achieved by the previous waste incineration IPPC Directive is expected to continue to be delivered by IED.

The European Pollutant Release and Transfer Register (E-PRTR), a Community-wide inventory of the principal emissions and responsible sources, was established by EU Regulation 166/2006. The register includes unintentionally produced POPs.

3.4.4 Controls on open agricultural burning

Since May 2006 agricultural waste has been included in national waste management controls. The unregulated open burning of agricultural waste has been banned since May 2007, with the exception of the open burning of small quantities of plant tissue which continues to be allowed under the Environmental Permitting (England and Wales) Regulations 2010. These regulations were updated in 2016 and cite the EA and NRW as the enforcing authorities. Schedule 3 of these Regulations provides an exemption from the need for an environmental permit, subject to certain conditions. However, it is an offence for a farmer to dispose of agricultural waste in a manner likely to cause pollution of the environment or harm to human health.

3.5 Marketing and use controls

Controls on the marketing and use of certain chemicals found to be contaminated with dioxins and furans have been put in place. These include:

- PCB-containing oils used as of heat transfer fluids in di-electric equipment. This requires the registration of PCB containing equipment, safe management of wastes and ultimately the phase-out of PCBs in UK stocks. Where PCB fluids contain dioxins and furans as a contaminant, there are would be synergistic benefits for the control of dioxins and furans also;
- Trichlorophenoxyacetic acid (2,4,5-T) was a herbicide for control of weeds. In 1976, the Seveso accident in Italy witnessed a release of 2kg of dioxins and furans into the immediate surrounding environment from a manufacturing plant producing 2,4,5-T. This culminated in the 'Seveso Directive' on mass hazards, which was transposed in the UK into the Control of Major Accident Hazard Regulations 1999[26] (amended 2015, COMAH). The normal production and use of 2,4,5-T can also contain low quantities of dioxins and furans as a contaminant. As 2,4,5-T is no longer approved for use in the UK, tariff codes are used to help identify imported goods that may contain 2,4,5-T; and
- Pentachlorophenol (PCP) was manufactured as a wood preservative for control of pests. The process meant that trace quantities of dioxins and furans as a contaminant could be present. Additionally the combustion of PCP treated wood particularly at low temperatures or in poorly aerated conditions can generate dioxins and furans. The use of PCP as a pesticide in the UK ceased in 1978, while the use of PCP as an intermediate for the manufacture of PCP Laureate (used in specialised textiles) continued until 2008. No further manufacture or use of PCP in the UK occurred after this time. As PCP is now listed in annex A of the Convention it is expected that this will have synergistic benefits for the creation of dioxins and furans as a contaminant of PCP.

3.6 Controls on diffuse sources

Industrial sources of POPs are now strictly regulated but some diffuse sources of dioxin and furans, PCBs, HCB and PCBz releases continue to make a significant contribution to emissions and will require further consideration. There is legislation restricting the lighting of domestic garden waste bonfires and open burning on domestic premises. Section 33 of the Environment

[26] http://www.legislation.gov.uk/uksi/2015/483/pdfs/uksi_20150483_en.pdf

Protection Act 1990 states that a person who disposes of controlled waste in a manner likely to cause environmental pollution or harm to human health commits an offence.

3.7 Occupational exposure to dioxins, PCBs, HCB, and PCBz

The Health and Safety Executive has responsibility for workplace health and safety in the UK, and it is the legal duty of those who create risk through work activities to understand those risks and ensure they are adequately controlled. This includes ensuring that duty holders/employers identify and obtain relevant information on the hazardous properties of the substance or materials they use or manufacture.

Exposure to harmful substances including dioxins, PCBs, HCB and PCBz arising from work activities is controlled under the Control of Substances Hazardous to Health Regulations (COSHH) 2002 (http://www.hse.gov.uk/coshh/index.htm).

COSHH applies in the workplace when hazardous substances are used or where processes are undertaken that generate hazardous substances. COSHH requires the employer to carry out a risk assessment to establish what, if any, hazards are associated with products/processes employees are using/undertaking and then to put measures in place to control exposure to that hazard.

Workplace Exposure Limits (WELs) http://www.hse.gov.uk/pUbns/priced/eh40.pdf) set the concentration in air of a substance that workers can be exposed to over a given time period. WELs are set in order to help employers protect the health of their workers by controlling the risk of exposure to harmful substances as part of a risk management programme. The WEL can also be used as a tool to monitor the efficacy of the control measures selected.

WELs are established under the legal framework COSHH, providing a point of reference for employers to use as part of a risk management programme, with the key purpose being to keep exposures at the WEL and ideally drive them down below it.

Dioxins and Furans**:** There is no WEL for dioxins. Schedule 1 of COSHH lists substances and processes defined as carcinogens and the 17 biologically active dioxin congeners are listed. Therefore, under COSHH there is a requirement for employers to reduce exposure to these compounds (dioxins) to a level as low as is reasonably practicable.

The HSE has issued specific guidance on how to reduce exposure to dioxins in the aluminium recycling industry: (http://www.hse.gov.uk/pubns/indg377.pdf).

Polychlorinated biphenyls (PCBs): There is a Workplace Exposure Limit (WEL) of 0.1 mg/m^3 for PCBs. In situations where exposure to PCBS may arise, employers must ensure that any exposure of their employees is either prevented or, where this is not reasonably practicable, adequately controlled.

Hexachlorobenzene (HCB): There is no occupational exposure limit for HCB. HCB has a 'harmonised classification' in the EU as a Category 1B carcinogen. This means that it is regarded as a potential human carcinogen and if it is present in the workplace either intentionally or as a process by-product, the employer has an obligation under the COSHH Regulations 2002 (as amended) to assess the risk and reduce any exposure to as low as is reasonably practicable.

Pentachlorobenzene (PCBz): There is no specific mention or reference to PCBz in the COSHH Regulations or in EH40 which lists the UK's WELs. If PCBz was used in the workplace, a high level of control would be expected under occupational health and safety legislation."

3.8 Food legislation on dioxins and dioxin-like polychlorinated biphenyls

Regulation (EC) 1881/2006 on setting maximum levels for certain contaminants in food as amended by Regulation (EC) 1259/2011 establishes maximum acceptable levels for dioxins, furans, dioxin-like PCBs and non dioxin-like PCBs in food. Limits are set in meat, liver (including fish liver), fish, marine oils, milk and dairy products, hen eggs and egg products, animal fats, vegetable oil and foods for infants and young children. The Commission's Recommendation 2013/711 establishes separate action levels for dioxins and dioxin-like PCBs at which an investigation should be considered, if possible to identify and eliminate any significant local sources.

3.9 Control of dioxins and polychlorinated biphenyls in animal feed

Measures to protect consumers from carry over from animal feed into meat, milk and eggs and other foodstuff are in place through Directive 2002/32/EC. Maximum permitted limits and action thresholds for dioxins, furans, dioxin-like PCBs as well as non-dioxin-like PCBs have been set on for in animal feed.

Section 4

Assessment of the data on current releases of the POPs

The following considers current releases of the POPs to the environment, data on emission trends in different environmental vectors (where available) and uptake through the food chain. It also outlines measures that are in place to control emissions of unintentionally produced POPs and to what extent these have resulted in reducing emissions from regulated sources. More detailed background about the existing POPs and those listed in 2013 and 2015 is provided in the following Defra reports:

- Review and update of the UK Source Inventories of Dioxins, Dioxin-Like Polychlorinated Biphenyls and Hexachlorobenzene for Emissions to Air, Water and Land (Report and Annex);
- A further update of the UK source inventories for emissions to air, land and water of dioxins, dioxin-like PCBs, PCBs and HCB, incorporating multi-media emission inventories for nine new POPs under the Stockholm Convention;
- Cost Benefit analysis of the addition of Hexabromocyclododecane (HBCDD) to the Stockholm Convention and the 1998 POPs Protocols; and
- A Further Update of the UK's Persistent Organic Pollutants Multi-Media Emissions Inventory – CB0489 – Annual Report 2016.

These reports are available at http://randd.defra.gov.uk/.

4.1 Monitoring of POPs

4.1.1 Toxic Organic Micro-Pollutants (TOMPS) monitoring network (air)

The Toxic Organic Micro-Pollutants (TOMPS) network measures ambient air concentrations for a range of pollutants at rural and urban locations in the UK. The network was set up in 1990 with current monitoring sites including two urban and four rural locations; London, Manchester, High Muffles (North Yorkshire), Hazelrigg (Lancashire), Weybourne (Norfolk) and Auchencorth (Midlothian), respectively. The TOMPs network reports quarterly data for 37 PCB congeners, four co-planar PCB congeners, ten furans congeners (PCDFs), seven dioxin congeners (PCDDs), and 22 PBDE congeners. The network has provided over 25 years of data and as such comprises a

considerable and important dataset which can be used to provide estimates of the change in atmospheric concentrations over time.

A summary of the data along with an interpretation of temporal and spatial trends may be found in Graf *et al* (2016)[27]. The continuous monitoring of these chemicals has demonstrated a constant decline in UK air concentrations in most locations over the last two decades, with average clearance rates[28] for dioxins and furans in urban locations of 4.9 years and for PCBs across all sites of 6 years. However, no significant decline in rural locations for dioxins and furans has been observed. Data for Stockholm Convention PBDE homolgues have shown a clear decline at the urban sites of Manchester and London and at the semi-rural site of Hazelrigg with atmospheric clearance rates of 3.4, 2.0 and 3.5 years, respectively. The paper from Brown et al (2013)[29] discusses twenty years of continuous monitoring of PAHs in the UK from the TOMPs and PAH networks. The TOMPs data have also shown a strong observable link between the declining ambient air concentrations for dioxins and furans, PBDEs and PCBs with emission reductions estimated in the annually produced National Atmospheric Emission Inventory (NAEI) dataset.

4.1.2 Monitoring of POPs in food

The Food Standard Agency (FSA) does not have an ongoing programme for monitoring POPs in food and animal feed. Resources are instead allocated on a risk basis, in line with Regulation 882/2004 on official controls. The FSA provides additional funding to local authorities for the testing of imported and locally-produced food and feed, which may include testing for dioxins and furans, PCBs and other Stockholm Convention POPs. The Agency also carried out its own targeted surveys and investigations into the occurrence of dioxins and furans, PCBs and other POPs in food and feed.

The Expert Committee on Pesticides Residues in Food (PRiF), as an expert committee of Defra, has an ongoing programme of monitoring for pesticide residues in food. This forms the UK's contribution to the European harmonised pesticide monitoring programme and undertakes testing of a range of foods including milk, fruit, vegetables, animal and cereal products

[27] Graf, C., Katsoyiannis, A., Jones, K.C. and Sweetman, A.J. (2016) The TOMPs Ambient Air monitoring Network - continuous data on the UK air quality for 20 years. Environmental Pollution special issue - Ten Years of Global Monitoring under the Stockholm Convention on Persistent Organic Pollutants (POPs): Trends, Sources and Transport Modelling, 217, 42-51.

[28] Clearance rates refers to the time taken for concentrations to reduce by 50%

[29] Brown, A.S. Brown, R.J.C., Coleman, P.J. Conolly, C. Sweetman, A.J. Jones, K.C. Butterfield, D.M., Sarantaridis, D., Donovan, B.J. and Roberts I. (2013) Twenty years of measurement of polycyclic aromatic hydrocarbons (PAHs) in UK ambient air by nationwide air quality networks. Environ. Sci.: Processes Impacts, 15 (6), 1199 – 1215

and infant food. The programme publishes quarterly results which can be found at:

http://www.pesticides.gov.uk/guidance/industries/pesticides/advisory-groups/PRiF/PRiF_Results_and_Reports/index-to-results-by-food-pesticide-residues.htm

4.1.2.1 Polybrominated diphenyl ethers (PBDEs)

The FSA has been investigating levels of PBDEs in food since 2003. Further to the work reported in the 2007 National Implementation Plan (NIP), which included trout and eels, farmed and wild fish and shellfish and a Total Diet Study (TDS), FSA has continued to investigate levels in other foods, as well as feed. Results have been supplied to the European Food Safety Authority (EFSA) within the scope of their continuous call for data, which includes Commission Recommendation 2014/118[30] on the monitoring of BFRs in food.

4.1.2.2 Perfluorooctane sulfonate (PFOS)

The FSA has included perfluorinated compounds (PFCs) in several investigations since 2007. Conclusions based on previous EFSA opinions were that dietary exposure to PFCs was not a health concern but a further EFSA opinion is expected in 2017, which may lead to a reassessment.

4.1.2.3 FSA work on POPs recently listed under the Stockholm Convention

Chemicals that meet the criteria for POPs and which are therefore considered as candidate compounds for listing under the Stockholm Convention are also likely to bioaccumulate in the food chain and were consequently identified as emerging risks by FSA. An initial investigation has recently been completed into levels of pentachlorobenzene (PCBz), hexachlorobutadiene (HCBD) and pentachlorophenol (PCP) in food and Total Diet Study (TDS) samples, following development and validation of the necessary analytical methods. As hexachlorobenzene (HCB) is easily measured with PCBz, this was also included. The data is still being reviewed but levels are generally low and no immediate human health concerns are apparent.

The FSA has previously attempted to investigate levels of short-, medium- and long-chain chlorinated paraffins (S/M/LCCPs) in food but the analytical methodology is complex and a fresh study has been ruled out until the European Reference Laboratory for Dioxins fulfils a request to develop a suitable method.

[30] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014H0118&qid=1475762535515&from=EN

Dioxin-like compounds

The FSA has been investigating brominated dioxins, furans and biphenyls (PBDD/F/PBBs) since 2004. The formation of PBDD/Fs is thought to be associated with the widespread use of brominated flame retardants (BFRs). The World Health Organisation (WHO) has concluded that the Toxic Equivalency Factor (TEF) used for the chlorinated congeners can be applied to their brominated analogues. More recently, the FSA has explored mixed halogenated (chlorinated and brominated) dioxins, furans and biphenyls (PXDD/Fs, PXBs). This work was prompted by an increasing number of reports of dioxin-like activity in environmental samples, in particular those collected near electronic waste handling sites, which could not be attributed to either pure chlorinated or brominated congeners.

Mixed halogenated dioxins and furans (PXDD/Fs) are thought to be formed during combustion when both chlorine and bromine are present, a circumstance that has become increasingly common with the widespread use of brominated flame retardents (BFRs). The mixed halogenated congeners are of potential importance as there have been some reports that they exhibit higher potency than the most toxic congener 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD). Owing to the much larger number of possible congeners and the limited availability of suitable reference standards, the work is very challenging. However, it has been shown that PXDD/Fs and PXBs are detectable in a wide range of foods. Most notably, a mono-brominated congener of PCB 126 was almost ubiquitous and the di- and even tri-bromo congeners were also regularly found. Following an initial investigation of a range of food samples, mixed halogenated dioxins and biphenyls have been measured in a recent TDS[31] and in a range of fish samples analysed to provide baseline data for Descriptor 9 within the scope of the Marine Strategy Framework Directive.

4.1.3 Monitoring of POPs in the marine environment

The Centre for Environment, Fisheries and Aquaculture Science (Cefas) undertake monitoring for some POPs in the marine environment. A range of organic contaminants has been determined in marine mammal tissues alongside the Cetacean Strandings Investigation Programme (CSIP)[32], funded by Defra. These have included PCBs, a range of organochlorine pesticides (such as DDT and its breakdown products, hexachlorocyclohexanes, hexachlorobenzene and dieldrin), polycyclic aromatic hydrocarbons, tributyltin

[31] http://tna.europarchive.org/20141103165934/http://www.foodbase.org.uk//admintools/reportdocuments/656-1-1109_C01050.pdf

[32] http://ukstrandings.org/

compounds, the flame retardants PBDEs (homologues identified under the Stockholm Convention) and HBCDD, and the perfluorinated compounds (PFCs) PFOS and PFOA. Within the UK's Clean Seas Environment Monitoring Programme (CSEMP)[33], Cefas also undertakes contaminant (PCBs, PBDEs, PAHs analyses) in surface sediments and biota from offshore regions around England and Wales. Cefas have performed several one-off studies on dioxins both under CSIP and CSEMP (completing 2017) and a one-off survey for PFCs under CSEMP. The UK's Marine Management Organisation (MMO) in collaboration with Cefas are involved in dredging operations in ports, harbours and estuaries and for licencing the disposal at sea of dredge material as well as monitoring disposal sites which entails POP substances.

4.1.4 Monitoring of POPs in the freshwater environment

As outlined in section 2.2.2 The Environmental Quality Standards (daughter) Directive (EQSD; 2008/105/EC) established standards (concentrations in surface waters) for priority, and priority hazardous substances, and other pollutants to be met by Member States (MS). This was amended in 2013 and an additional 12 substances were added to the list of substances (Priority Substances Directive; 2013/39/EU). Under the later directive, MS are required to report on levels substances including some POPs. These were endrin, hexachlorobenzene (HCB), dioxins, furans and dioxin-like polychlorinated biphenyls), DDT, the polybrominated diphenyl ethers (PBDEs) homologues identified under the Stockholm Convention, hexabromocyclododecanes (HBCDD), perfluorooctanesulfonic acid (PFOS), hexachlorocyclohexanes (HCHs), and pentachlorobenzene (PCBz). To achieve Water Framework Directive (WFD) objectives, MS are obliged to reduce or eliminate discharges, and emissions and losses to surface waters of those substances which behave like ubiquitous persistent, bioaccumulative and toxic substances some of which include POPs.

To further our understanding of harmful chemicals in the UK's surface waters and how they enter such, and to compliment the UK's WFD monitoring commitments, the UK's Water Industry Research (UKWIR) commissioned the Chemicals Investigation Programme (CIP)[34], to investigate the management and control of some of the priority and priority hazardous substances listed in the WFD daughter Directives along with other targeted chemicals. Phase 1 of CIP (CIP1; 2010-2013) investigated the occurrence, sources and removal of trace substances in over 180 wastewater treatment works (WWTW) effluents. This established a definitive basis for the overall national assessment of the

[33] https://www.bodc.ac.uk/projects/data_management/uk/merman/assessments_and_data_access/

[34] https://www.ukwir.org/site/web/news/news-items/ukwir-chemicals-investigation-programme

risk posed by harmful substances found in WWTW discharges. The CIP1 made it possible to identify substances that require further attention or investigation, to rule out others of little concern and to delineate the scale of likely improvements in effluent quality required to meet the objectives of the programmes of measures required under WFD. Associated research has provided estimates of the likely overall cost of such measures and identified several treatment options that might be employed, as well as defining the uncertainties that still need to be addressed. In the second phase (CIP2; 2015-2020), 600 WWTWs have been identified to undergo a programme of effluent screening and upstream and downstream river sampling for prioritised substances. The POPs included in this work are PBDE homologues covered by the Stockholm Convention, PFOS and HBCDD.

4.2 UK source inventories of POPs

Parties to the Stockholm Convention are required to evaluate current releases and develop and maintain source inventories and release estimates for substances listed under Annex C (unintentional releases arising from anthropogenic sources) of the Convention. Evaluation of the inventories enables the assessment of progress made towards the goal of continuing minimisation and to identify where further control measures are required.

The UK has established a range of inventories to monitor emissions including: (i) the National Atmospheric Emissions Inventory (NAEI) which provides a standard reference inventory for data on a wide range of POPs and other pollutants to air; (ii) pollution inventories of releases to air, water and land for large industrial processes which are regulated under the EU Industrial Emissions Directive (IED); (iii) the POPs multi-vector emission inventories covering those substances listed in Annex C of the Stockholm Convention to five vectors (air, land, water, residue, and product)[35] and are compiled annually. Additionally, under the requirements of the Environmental Quality Standards Directive, the UK has developed inventories of releases and losses to water, which are reported within river basin management plans and are updated on a four yearly basis.

The data provided by the UK pollution inventories is consolidated with data from other sources in the UK's Pollutant Release and Transfer Register (PRTR). The PRTR enables the UK to meet the obligations of the United Nations Economic Commission for Europe (UNECE) Aarhus Convention on

[35] Under the Stockholm Convention five emission vectors are defined, which include air, land, water, residue, and product. For clarity -The uncontrolled release of material to land (e.g. accidental building fires) is accredited as a 'land' vector release. The controlled placing of material to land (e.g. landfill) is accredited as a 'residue' vector release. The product vector denotes POPs placed to market within articles. For Annex A substances which are banned, the deliberate placing on the market without exemption would be illegal. However recycling of materials contaminated with POPs, particularly trace contamination would be a 'product' vector release.

public access to information and participation in decision-making and can be found at http://www.unece.org/env/pp/introduction.html .

Action undertaken as part of the UK's 2007 Dioxin Action Plan led to the development of multi-vector inventories for emissions to air, water, land, residue and product vectors for the unintentionally produced POPs dioxins and furans, HCB, PCBz and PCBs. The emission estimates to water, land, residue and product were not available for these substances in 2007. Estimates provided in the multi-vector inventories have been revised to reflect improved quality of POPs source data gained through further work undertaken to establish a better understanding of emission factors for these POPs. The time trend estimates of emissions to air provided in the 2007 NIP were based on the best available data at the time and have been superseded by those estimated for the air-vector in the more recent multi-vector inventories. This reflects the change in methodology used to calculate the estimates based on improved knowledge about emission sources and factors.

As a result of actions identified in the 2007 Dioxin Action Plan, an annual estimate of the release of dioxins and furans to air, water, land, residue and product has been undertaken. These estimates have been developed through standard emission inventory processes following the guidance set out within the European Monitoring and Evaluation Programme (EMEP) guidebook for the UNECE Convention on long range transboundary air pollution (CLRTAP). The UK also made use of the UNEP standardised toolkit for dioxins and furans where UK-centric data have not been available. The emission estimates have also drawn upon data reported by operators into the UK's Pollutant Release and Transfer Register (PRTR, http://prtr.defra.gov.uk/), noting that the PRTR is designed to cover a named set of economic activities which are largely dominated by industrial point sources.

In 2014 emissions to air within the UK's PRTR were estimated to be 30 g I-TEQ to air and 10 g I-TEQ to water. The 2014 PRTR notes that emission estimates for releases to soil were not reported by operators. However, it is important to note that the PRTR covers only industrial point sources and that the deliberate release of such materials to soil in the UK is illegal. Releases to air, water and soil will also include diffuse sources not covered by the UK PRTR. Where environmental regulation of industry has reduced emissions since 1990, the importance of diffuse emissions to total releases has proportionately increased; this includes sources such as backyard burning of waste, accidental building and vehicle fires, and the disposal of sewage sludge which can be consigned to agricultural land. The Food Standards Agency is investigating the risks to the food chain that might result from the application of certain end of waste streams, such as paper sludge and poultry litter ash, used wood, mechanically biologically treated (MBT) sludge and compost-like output (CLO), for agricultural uses including soil improvers,

fertilisers and animal bedding. All of these materials may contain dioxins and PCBs, among other environmental contaminants.

The time trend data for atmospheric emissions of dioxins and furans within the POPs multi-vector emission inventory shows that since 2007, there has been a ‘plateau effect’, with minor increases and decreases of dioxins and furans emissions from year to year. This ranges from 217 g I-TEQ to 224 g I-TEQ for the years 2007 – 2014. Further work has been undertaken since 2007 to reduce the uncertainty within the estimates for the dioxin and furan emission inventory. This has included work on hazardous and clinical waste incineration, non-ferrous metal production, sewage sludge and backyard burning (national waste burning habits survey).

As illustrated the increased control of emissions of combustion by-products such as dioxins and furans from industry has seen marked improvements in emission reduction of dioxins and furans from industry point sources. However and proportionately, the importance of diffuse sources to total releases has increased since 1990. It is thought to be difficult to quantify and apply further controls to these sources without significant effort and cost, specifically because of their diffuse nature, e.g. frequency and nature of bonfires in domestic premises annually across the whole of the United Kingdom. Total atmospheric emissions of dioxins and furans have fallen by 85% since 1990, where the 1990 release estimate was 1,304 g I-TEQ and the 2014 estimate is 217 g I-TEQ.

The UK will continue to use a combination of the UK emission inventories and the TOMPs monitoring network to provide evidence of the dioxin and furan releases and ambient concentrations, with continued efforts to continue to decrease emissions where applicable. However, it has also been shown that dioxins and furans can enter the human food chain via the use of contaminated feed or accidental contamination, and thus the monitoring of animal feed will also continue to ensure protection of UK consumers.

The UK is developing a set of regularly updated emission inventories to satisfy the requirements of Directive 2008/105/EC on environmental quality standards in the field of water policy. The inventories will include priority and priority hazardous substances, updated in accordance with -yearly reviews.

4.2.1 UK POPs emission inventory infrastructure

An overview of the scope of POPs information that is available from the UK data reporting mechanisms, including data for the new POPs is presented in Table 3.

Table 3 – Summary of UK POPs emission inventory infrastructure[36]

Table 3 Summary of UK POPs emission inventory infrastructure			
Substance	**NAEI**	**IED/EPR Pollution Inventories**	**UK PRTR**
Chlordecone			
Dioxins and furans			
Hexabromobiphenyl (HBB)			
Hexachlorobenzene (HCB)			
α- and β- Hexachlorocyclohexane (HCH)			
Lindane			
Polycyclic Aromatic Hydrocarbons (PAHs)			
Polybrominated diphenylethers (PBDEs)			
Polychlorinated biphenyls (PCBs)			
Pentachlorobenzene (PCBz)			
Perfluoro octane sulfonates (PFOS)			
Hexabromocyclododecane			
Hexachlorobutadiene			
Pentachlorophenol			
Polychlorinated Naphthalenes			
MEDIA			
Air			
Land			
Water			
Waste transfer			
SOURCE TYPES			
Point source			
Diffuse Source			

Key

NAEI - National Atmospheric Emissions Inventory –from 1990

IED/EPR Pollution Inventories – EU Industrial Emissions Directive/Environmental Permitting Regulations Pollution Inventories –from 1995

UK PRTR – United Kingdom Pollutant Release and Transfer Register from 2007

No data in inventory

Limited data in inventory

Data in inventory

[36] Not all Stockholm POPs are on this table. Reporting obligations are that only emissions above the threshold value are required to be reported.

4.3 Current releases of dioxins and furans, PCBs, HCB and PCBz in UK

The POPs multi-vector inventories provide estimates of emissions to air, land and water spanning the years from 1990 – 2014. The inventories show that emission rates of dioxins and furans, PCBs and HCB in the UK have declined over this period. However for PCBz, the emissions have slightly increased and these are due to a small increase in combustion from municipal waste and industrial sources and diffuse sources emissions. Table 4 below gives The percentage change in emissions from 1990 for the years 2010 and 2014 are presented in Table 4.

Table 4 Emission reductions in dioxins and furans, PCBs, HCB, and PCBz for the UK between 1990 and 2014

	% Reduction from 1990 for 2010 and 2014			
	All vectors		Air	
	2010	2014	2010	2014
Dioxins and furans	68	70	82	83
PCBs	94	96	88	89
HCB	99	99	99	99
PCBz	89	88	91	89

4.3.1. Dioxins and Furans

Inventories of dioxins are reported as a total of dioxins and furans as a measure of toxic equivalency factors (TEQ). A summary of how TEQ measurements are derived and the equivalent measures for dioxins and furans are attached at Annexes 4, 4A and 4B. There are two systems in current use for presenting toxic equivalency factors for dioxins; the International TEQ (I-TEQ) and the more recent World Health Organisation the TEQ (WHO TEQ).

A comparison of the estimated annual releases of dioxins[37] in 2010 and 2014 is shown in Table 5. The 2014 release estimates for different Stockholm Convention categories indicate that diffuse sources such as the small-scale combustion of waste and accidental fires remain major contributors of dioxin emissions (Annex 5A1). The heat and power generation sector is the main industrial emission source. Emissions to land/landfill are dominated by open burning processes and waste disposal. However it can be seen that for the water and product vectors, there is a small increase to that of the 2010 figure. For the water vector the increase is due to emissions from waste that goes to landfill and heat and power generation. For the product vector, the increase is due to the recycled ashes and residues as aggregates.

Table 5 Annual release of dioxins in 2010 and 2014 (g I-TEQ/year

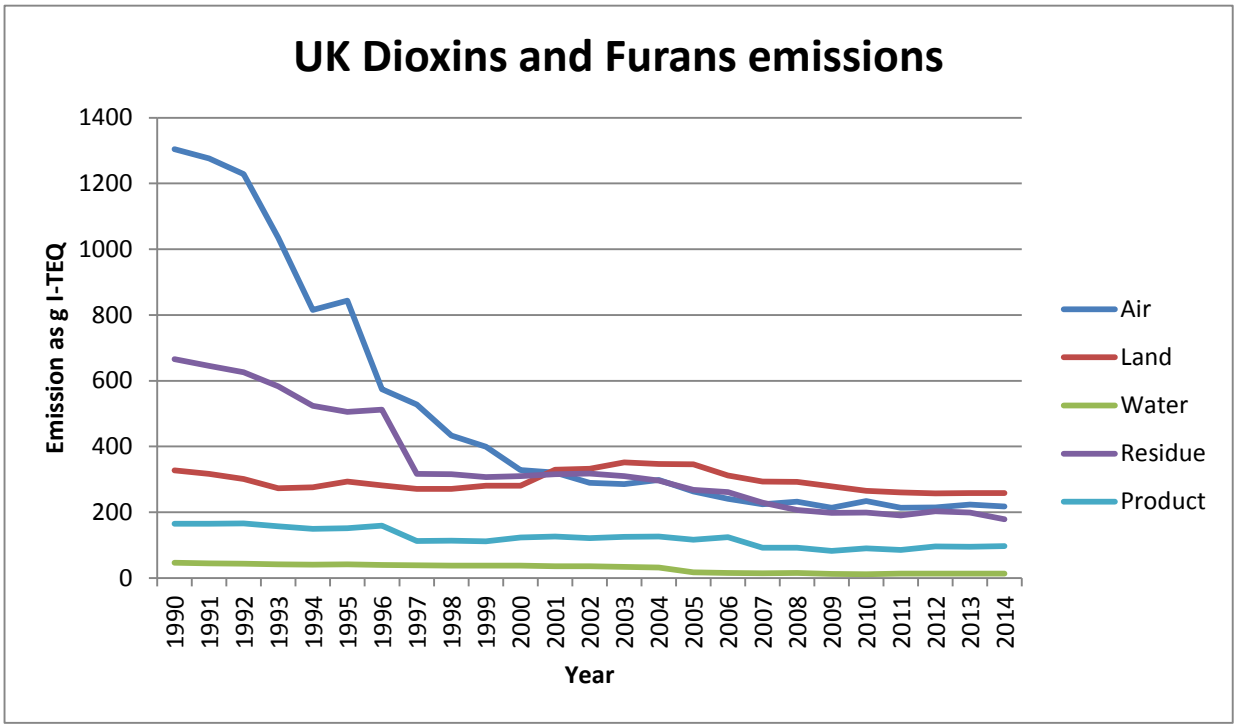
	2010	2014
Air	235	218
Land	265	259
Water	12	14
Residue	200	179
Product	91	97

4.3.1.1 Emission trends for dioxins and furans

The decline in emissions of dioxins and furans between 1990 and 2014, as stricter controls on industrial sources have taken effect is shown in Figure 1. Emissions continue to level off suggesting that it is likely to become increasingly difficult to achieve further significant reductions.

[37] The term dioxin includes dioxins (polychlorinated dibenzo-p-dioxins (PCDD)) and furans (polychlorinated dibenzofurans (PCDF))

Figure 1: Dioxin and furan emissions for the UK 1990 - 2014



4.3.2 Polychlorinated biphenyls (PCBs)

These are a family of chemicals made up of many individual congeners which can exhibit different physical, chemical properties as well as toxicities. Releases of PCBs into the environment will contain complex mixtures of these congeners which would require full analyses to better understand the ratios of the different congeners. This information is limiting and can be difficult to derive at the individual congener level. Internationally, the practice is to quote emissions as total PCBs based on a common number of congeners, with the potential for including the 'dioxin-like PCB' fraction as a sub-total where possible. The inventory reports estimates of the total weight of PCBs released.

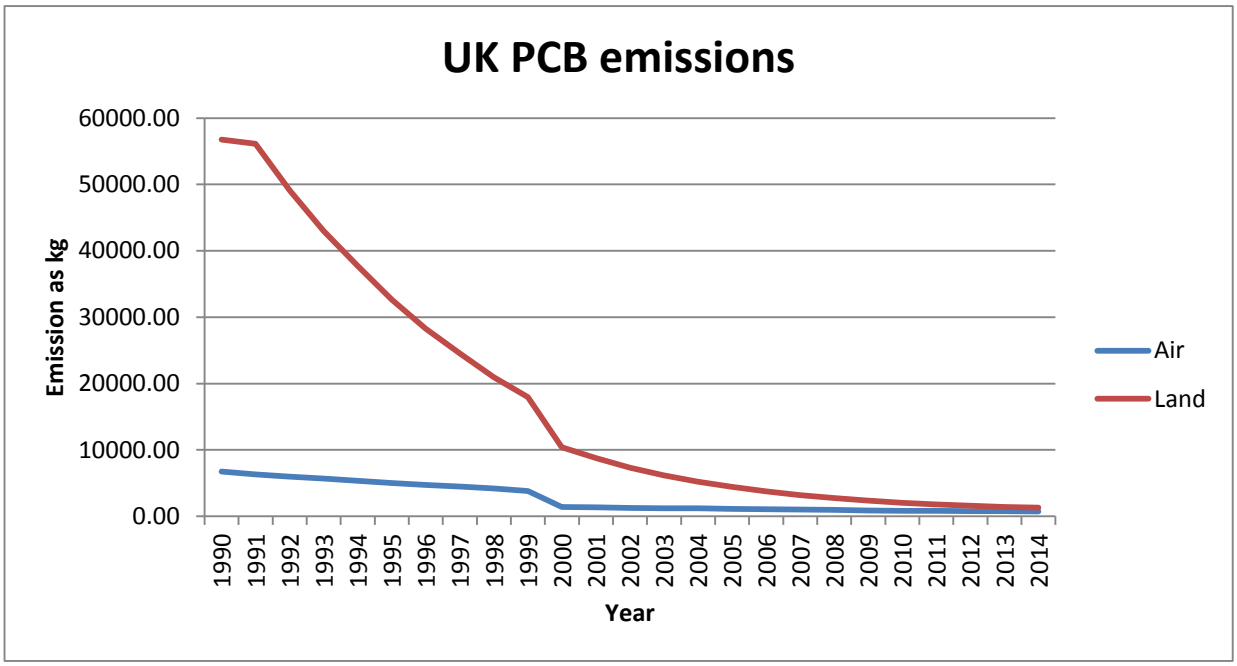
The 2007 NIP reported that releases of PCBs to air were estimated to be 1330 kg in 2004. Owing to recent improvements in the estimation methods, this figure has now been revised to 1196 kg for 2004.

Annual air releases of PCBs in 2014 were estimated to be 733 kg/year, which represents a 463 kg (39%) reduction on the revised 2004 estimates. Although PCBs have not been manufactured and used in the UK for many decades, old PCB-containing equipment continues to exist and may still account for the majority of all air emissions in 2014 at 52% (see Table 6). However comparison with the 2010 emission figure (56%) indicates that the emissions are decreasing steadily.

Table 6 Key Sources of PCB emissions to air in 2010 and 2014				
Source of PCB emissions	**2010**		**2014**	
	Release of PCB to air (kg/year)	**% of total PCB emissions to air**	**Release of PCB to air (kg/year)**	**% of total PCB emissions to air**
Di-electric equipment	473	56	380	52
Electric Arc Furnaces	113	13	93	13
Backyard burning	82	10	82	11
Accidental fires vehicles and buildings	24	3	24	3
Power station combustion of coal	34	4	32	4
Basic Oxygen Furnaces (Iron production)	13	2	18	3
Iron and steel sintering	17	2	23	3
Other sources	64	8	60	8

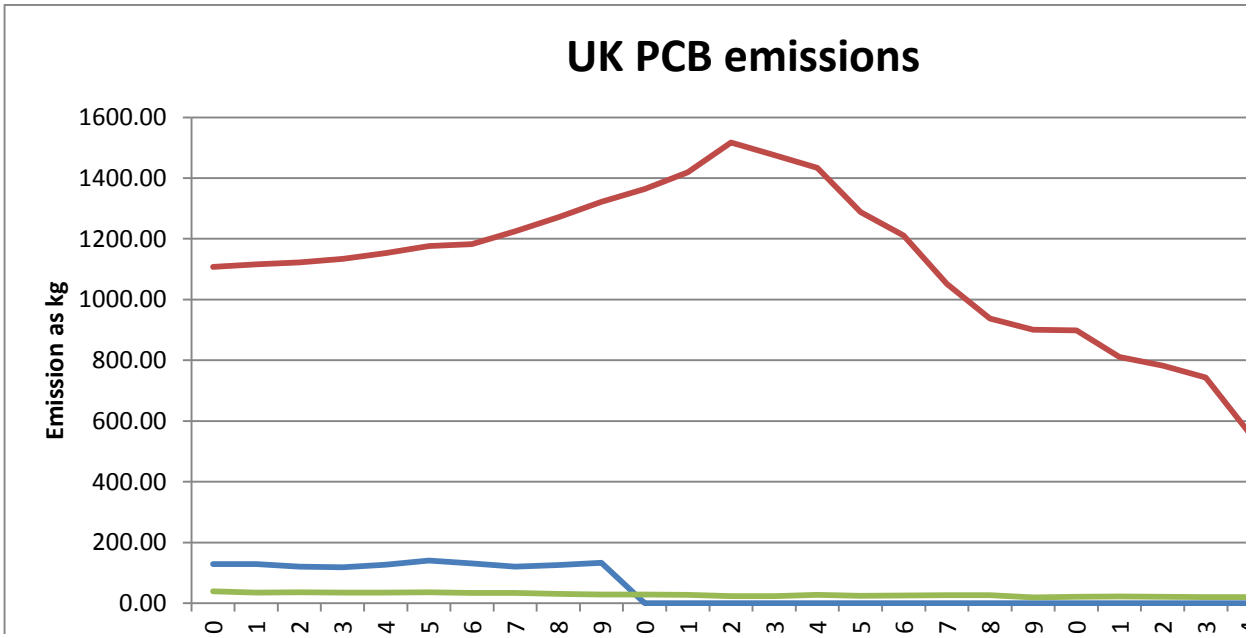
In 2014, PCB releases to land, including waste to landfill were estimated to be 1293 kg/year. Compared to data modelled over the last twenty years this represents a highly significant reduction since 1990 (Figure 2). The figure also demonstrates that levels of PCB releases to both air and land significantly reduced following an awareness campaign in 2000 that resulted in the identification, removal and destruction of large PCB containing equipment from the environment.

Figure 2: UK PCB emissions to air and land for 1990 – 2014



Releases to product and residue have been reported for the first time and are shown in Figure 3. The emissions inventory indicates that the emissions from the residue vector are dominated by waste to landfill. However the figure demonstrates that since 2002, these have declined. This is because after 2002, an increase in recycling meant that residues were not sent to landfill after being burnt. For the product vector the use of recycled ash and residues as aggregate largely in cement manufacture and road building are the main source of emissions and this has declined since 1990.

Figure 3: UK PCB emissions to water, residue and product for 1990 – 2014



4.3.3 Hexachlorobenzene (HCB)

The annual releases for HCB in 2014 indicate a continuing decline in emissions to air and land since 1990 with negligible releases to water over the last twenty years (Table 7).

Table 7 UK HCB emissions (kg) for 1990, 2010 and 2014

Emissions to:	1990	2010	2014
Air	3753	33	22
Land*	48	9	4
Water	3	2	2

*Land emissions are associated with agricultural pesticide use only.

Since the ban on the use of hexachloroethane (HCE) in secondary aluminium manufacture (2003), the dominant source of emissions of HCB to the environment in the UK has been through the use of pesticides.

The previous emission estimates quoted in the UK's 2007 NIP were based on UK agricultural statistics and literature emission factors assuming 100% release to air at the maximum allowable concentrations under UK and

European law. As part of the POPs multi-media inventory development carried out in 2009 the model for emissions was revised based on Fong (2008)[38] to account for spray drift. This apportioned the pesticide used based on air, land and water compartments more accurately. The further update of the UK POPs inventories carried out in 2010 included a sampling and analysis regime for chlorothalonil, the main pesticide related to HCB emissions. This work was used to review the emission factor used for HCB emission from chlorothalonil to provide the best 'working concentration' estimates. The previous estimates were based on work by Bailey (2001)[39], which was based on the 40 ppm regulatory threshold. The 2010 sampling and analysis programme took 30 samples (23 from chlorothalonil products and 7 from a related product as exploratory work) at point of usage and analysed for both chlorothalonil and HCB. Based on market share, this gives a new weighted average of 8 ppm. The estimates assume that the 1998 (and before) factors are correct and extrapolated between 1998 - 2009. Assuming that 1998 will be 40 ppm and 2009 will be 8 ppm.

4.3.4 Pentachlorobenzene

Pentachlorobenzene (PCBz) is a pollutant included within the substance data-set for PRTR[40] reporting, with all emissions above 1 kg per annum to air, land and water required to be reported. To date there has only been one reported occurrence of emissions above the reporting threshold. This was an emission to air in 2009 of 1 kg from the oil refinery sector.

Based on the POPs multi-vector emission inventory, estimated PCBz emissions to air have declined significantly, with emissions in 2014 only 11% of the 1990 estimate total emission to air (301 kg). This has been due to legislative control measures on industrial sources and the development of effective abatement technologies. The comparatively low 2014 PCBz emission estimates to air (33 kg) are now dominated by a handful of sources, notably iron and steel manufacture (36%), industrial combustion of coal for heat and power generation (15%) and energy from waste plants (13%). Within the domestic sector, the combustion of wood and coal within residential premises also accounts for 12% of total air emissions (Figure 4).

Estimated PCBz releases to air form the dominant vector for 2014 (33 kg) with other vectors having smaller quantities of estimated releases. Land is the sector most important vector (9 kg) with leaks from di-electric equipment being

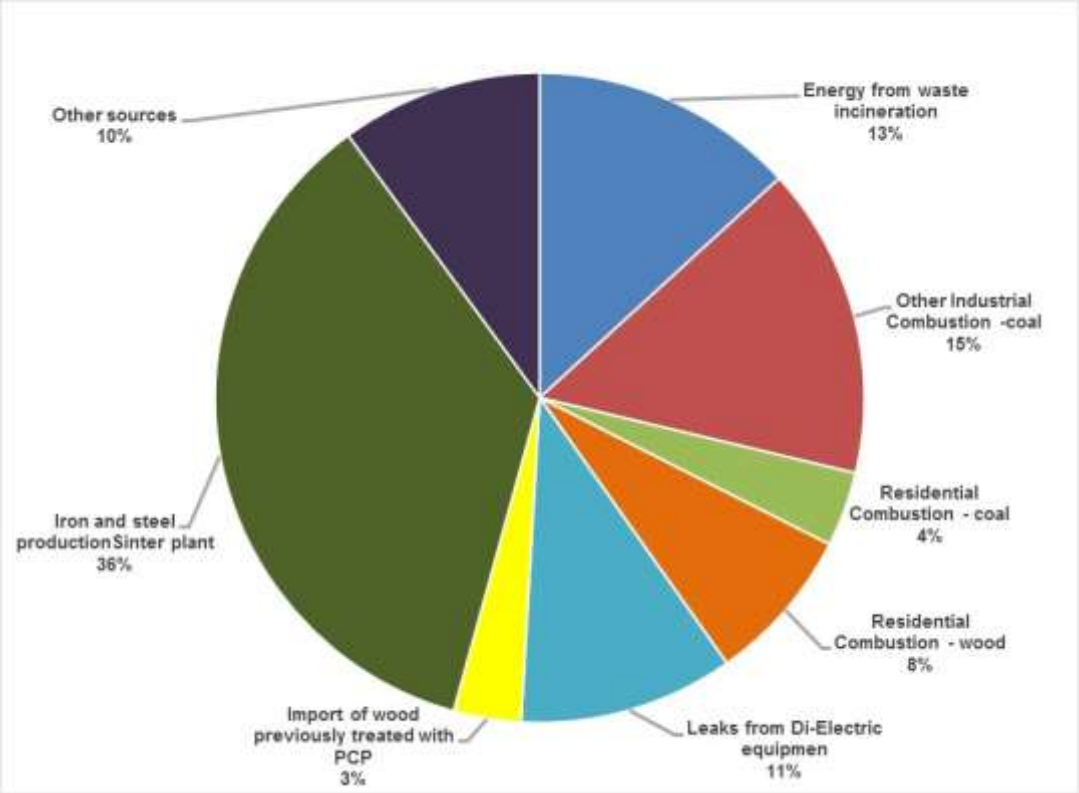
[38] Yongfu Xu (2008) 'Review and update of the HCB inventory emissions to air, land and water, paper published by AEA.

[39] Bailey RE (2001) Global HCB emission, published in Chemosphere 43, pp 167 – 182

[40] The UK PRTR will include all emissions of POPs from industrial sources at IPPc part A2 and greater, provided they exceed a pre-set annual emission threshold

the key source, the ‘residue’ vector had estimated releases to controlled landfill of 5 kg in 2014, while estimated releases to water and recycled into products were 3 kg and 1 kg respectively.

Figure 4: UK Pentachlorobenzene emissions to air 2014 (33 kg total emission).



4.4 Current emissions of selected POPs

In addition to the POPs discussed above, there are two additional POPs where emissions are being monitored in the UK because of significant legacy uses.

4.4.1 Perfluorooctane sulfonic acid (PFOS) emissions

The UK environmental releases of PFOS in 2014 were estimated to be around 0 kg to air, 2 kg to land and 150 kg to water. The emission estimates of PFOS to surface waters via discharge from waste water treatment works (WWTWs) and to agricultural soils via the use of sewage sludge as a fertiliser were refined from 2012 estimates using additional field measurement data. The PFOS concentrations provided by sampling campaigns carried out in 2013/14 were combined with mass flow data from two WWTPs to provide chemical mass flows for PFOS. The PFOS was detected in all wastewater samples collected with influent concentrations ranging from 6.4 to 25 ng/L (mean 15.2 ng/L) and effluent concentrations ranging from 1.9 to 58 ng/L (mean 22.3

ng/L). Using a mass balance approach, the calculated per person emission rates from WWTPs to surface waters ranged from 5 to 10 µg/person/day. For the UK, assuming a population of 62 million with a 95% WWTP connection rate, this provides an estimate of the PFOS emissions to water of 150 kg per year.

The emission factors for PFOS to soil via the application of sewage sludge using data collected for the 2012 emission estimates ranged from 32 to 64 µg/person/year. These data when scaled up to the UK provided an emission of approximately 2 to 4 kg per year to sludge. As approximately 60% of sewage sludge produced in the UK is used as an agricultural fertiliser, between 1 to 2 kg was estimated to be emitted to soil per year. More recent data from the sampling campaign in 2013/14 provided an upper estimate of 18 kg per year to soil receiving sewage sludge, although PFOS concentrations in sludge collected from one WWTP were below reporting limits and so emission to soil from this sludge would be considerably lower. As a result the emission estimates for 2014 to soil remained at 2kg per annum.

4.4.2 Polybrominated diphenylethers (PBDEs)

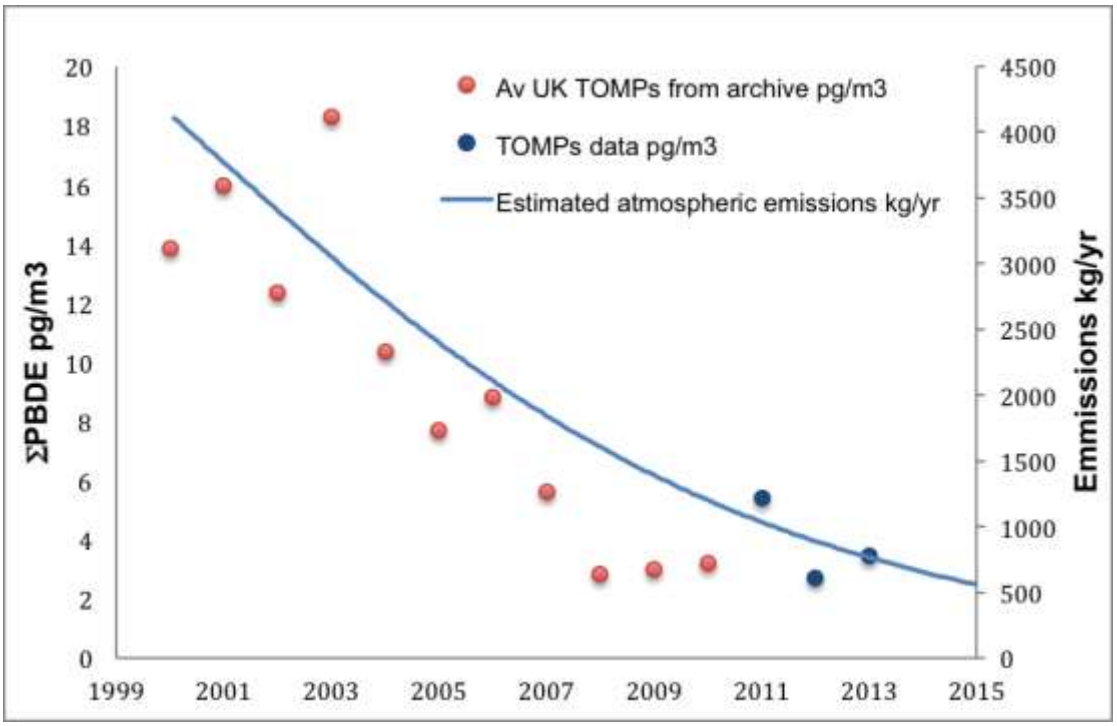
The TOMPs network provides a sample archive that can be retrospectively analysed to determine concentrations of additional POP chemicals of interest. This archive was used to assess PBDEs in the UK atmosphere which showed consistent decreases in concentrations over recent years with the observed decline starting during the period 2001-2003 (Birgul et al. 2012)[41]. This is illustrated in Figure 5 for the sum of 9 PBDE congeners using average data for four sites, which included London, Manchester, Hazelrigg and High Muffles. The figure also shows a comparison with an updated UK atmospheric emission data based on the method developed by Prevedouros et al. (2004)[42] and recent data from the TOMPs network.

The emission estimates are based on a dynamic model of historical estimates of PBDE manufacture, incorporation into products (e.g. polyurethane foams) and subsequent emission from each product type using specific emission factors over their respective life cycles. The strong correlation between the estimated emissions and the measured concentrations from the TOMPs network and this suggests that on-going releases from articles containing the penta-BDE commercial mixture continue to control the long-term trends in the UK atmosphere.

[41] Birgul, A., Katsoyiannis, A., Gioia, R., Crosse, J., Earnshaw, E., Ratola, N., Jones, K.C., and Sweetman, A.J. (2012) Polybrominated diphenyl ethers (PBDEs) in the United Kingdom atmosphere. Environmental Pollution, 169, 105-111

[42] Prevedouros, K., Jones, K.C., and Sweetman, A.J. (2004) Production, Consumption and Emission Estimates for Pentabrominated Diphenyl Ether (PeBDE) in Europe (1970 to 2000). Environmental Science and Technology, 38(12), 3224-3231.

Figure 5: Comparison of estimated annual emissions of PBDE in the UK to the average annual concentrations of ΣPBDEs provided by the TOMPs network using archived samples (red markers) and current network data (blue markers).



4.5 Overview of the emission data for the new POPs

All of the four new POPs added to the Stockholm Convention in 2013 and 2015 have restrictions under relevant EU regulations and therefore either banned in the UK and/or had their use restricted. In addition PCNs and HCBD is also listed in the UNECE's convention on long range transboundary air pollution (CLR-TAP).

4.5.1 Annex A substances, pesticides (Pentachlorophenol (PCP))

The UK has reviewed its emissions inventory for PCP and expanded it to include all five emission vectors. The PCP emissions to air are the dominant vector with 99% of all releases to this vector (Table 8). This largely arises from legacy treated timber stockpiles which can emit during the course of their service life. For land there are only two sources of emissions. During the active treatment of timber it is assumed 750 kg per annum was lost to soil per year from spillages. Then after active treatment ceased in 1998, these emissions will have fallen to zero. The other major source comes from application of sewage sludge to land. The assumed emission factor in this case is expected to decline significantly after 1998 when treating timber with PCP ceased.

Table 8 Releases of PCP to all vectors (all values are in kg)						
Vector	**1990**	**1995**	**2000**	**2005**	**2010**	**2014**
Air	1,050,008	935,262	770,478	538,716	436,915	340,534
Land	3350	3395	2713	1377	630	638
Water	396	421	221	21	15	23
Residue	4383	4381	4378	4664	14	12
Product	1	1	1	1	1	2*

*Slight increase in emissions to 'product' come about as recycling rates increase year on year. Concentrations within articles would still be declining.

The emissions from the residue vector highlight a significant decline between 2005 and 2010 by more than 90%. The reason for this relates to the use of PCP with heavy textiles. As with treated timber (UK stocks + imported), a 'bank' of in-use supply has been developed with a notional assumption that service life for heavy textiles such as tent canvass has a service life of 10 years. After which the goods and any remaining residues therein are consigned to landfill. As treatment of these goods ceased around 2000, any remaining in-use textiles should have ceased being used by 2010. The remaining sources for residue will be fly-ash from combustion sources. This source has been disaggregated between landfill and recycling into road aggregates based on a similar approach for other POPs covered within the multi-vector inventories.

The remaining vector is water, which in the early part of the time-series is dominated by industry wastewater releases for treatment of textiles with pentachlorophenyl laurate (PCPL). Again this activity ceased around 2000. The other major sources are based on the data from the UK–PRTR and back-calculated for earlier years based on the average of the data reported into the PRTR which spans between 6 – 7 years depending on source, and includes urban waste water treatment works (WWTWs) , paper and pulp production and manufacture of basic organic chemicals. On a per annum basis and for these sources, WWTWs constitute around 14 kg, paper and pulp around 5 kg and basic organic chemicals manufacture constitutes around 3.5 kg.

Since the use of PCP for timber and textile treatment ceased in the UK for over a decade now, there is no ongoing active use of PCP, Sodium pentachlorophenate (NaPCP) or PCPL in the UK for commercial purposes. However the widespread use of PCP and long-lasting service life of treated timber represents a significant legacy issue. This aspect has proved difficult to quantify as no data are available on the quantities of timber that were treated with PCP and which might still be in use. However, a number of references and authors have attempted to gauge the likely size of this stockpile and resulting emissions.

The UK PCP emissions to air fell between 1990 and 2002, from 538 to 437 tonnes (t), which compares to the NAEI range of 750 falling to 540 t, and the current estimates of 1,000 declining to 690 t[43]. In Scotland, monitoring of PCP in water stopped in 2006 since PCP concentrations were found to be below the environmental quality standard (EQS) of 0.4 µg L^{-1} for surface waters, and reporting was no longer deemed necessary.

The United Nations Environment Programme (UNEP)[44] has stated that PCP emissions in the UK would arise from wood that has been treated within the last 16 years. Releases to air from in-use, treated wood were estimated to be 300 t in 2012 in the UK and show a declining trend since the 1990s, this compares to 308 t in the NAEI and 380 t in the current estimates.

4.5.1.1 Monitoring information in water pentachlorophenol

The Environment Agency (EA) carries out water monitoring for PCP under the EQS compliance requirements for the WFD. Monitoring data for 2013 to 2015 have shown that of the water bodies sampled, none of them failed the EQS.

4.5.2 Annex A substances, Industrial chemicals (hexabromocyclododecane and hexachlorobutadiene)

4.4.5.1 Hexabromocyclododecane (HBCDD)

A 2010[45] study commissioned by the UK provided estimated UK annual release inventories of HBCDD and this is set out in Table 9 below.

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[43] Webster et al. 2010 Exploration of management options for Pentachlorophenol (PCP). Paper for the 8th meeting of the UNECE CLRTAP task Force on Persistent Organic Pollutants, Montreal, May 2010

[44] Report off the Persistent Organic Pollutants Review Committee on the work of its tenth meeting, Addendum: risk management evaluation on pentachlorophenol and its salts and esters - 2014

[45] Costs and Benefits of the Addition of HBCDD to the Stockholm Convention and the 1998 POPs Protocol. (AEA) 2010. http://randd.defra.gov.uk/

Table 9 UK estimated release inventory for HBCDD (2010 and 2030)						
Source	**Estimated annual release (kg)**					
	Air (vapour)	**Air (dust)**	**Water**	**Uncontrolled landfill**	**Recycling**	**Total**
Manufacture of goods containing HBCDD	7		730	60	-	800
Manufacture of EPS/XPS	4.2		4.9	42	-	51
Manufacture of HIPS	0.3		0.4	3	-	3.7
Manufacture of Textiles	2.6		720	15	-	740
Use of goods containing HBCDD	130000	9600	13000	91000	-	240000
Use of EPS/XPS		7000	-	91000	-	98000
Use of HIPS		50	-	-	-	50
Use of Textiles	130000	2500	13000	-	-	140000
Disposal/recycling of goods containing HBCDD (2010)	3000	2800	0	240000	-	240000
Disposal/recycling of goods containing HBCDD (2030)	270	7200	0	460000	20000	490000
Disposal/recycling of EPS/XPS (2010)		2800	-	140000	-	140000
Disposal/recycling of EPS/XPS (2030)		7200	-	350000	-	360000
Disposal/recycling of HIPS	49		0	20000	20000	40000
Disposal/recycling of Textiles	220		-	88000	-	89000
Total (2010)	130000	120000	13000	330000	0	490000
Total (2030)	130000	170000	13000	550000	20000	730000

The values presented in the table are order of magnitude estimates only, and are to be used to focus attention on key sectors and sources.

The data in Table 9 indicates that the most significant environmental releases of HBCDD are:

- Disposal to land of Expanded Polystyrene(EPS)/Extruded Polystyrene(XPS) boards is forecast to become increasingly significant up to 2030. In 2030, disposal to land of EPS/XPS is estimated to account for 49% of all HBCDD releases;
- Emissions to air of HBCDD from textiles, estimated to account for 18% of all HBCDD releases in 2030;
- Disposal to landfill of waste EPS/XPS boards during installation is estimated to account for 13% of all HBCDD releases in 2030; and
- Disposal of end-of-life textiles containing HBCDD to landfill is estimated to account for 12% of all HBCDD releases in 2030.

4.4.5.1.1 Monitoring information in water for HBCDD

The EA commenced water monitoring for HBCDD in 2016 under the EQS requirements for the WFD. Only limited data are available at the present time.

4.4.5.2 Hexachlorobutadiene (HCBD)

In the UK, no emissions or releases have been reported or measured in the past decade. As reported by Weber et al.[46] although there is a wealth of data concerning historical emissions, there are no reliable emission data for HCBD for unintentional releases at a global level. A summary of available information is presented in the Table 10 below. It is important to note that no information for the UK has been identified, and so development of full UK emission estimates is not been possible.

[46] Unintentionally produced hexachlorobenzene and pentachlorbenzene POPs waste from solvent productions – The need to establish emission factors and inventories

Table 10 Estimated unintentional releases of HCBD

Year	Estimated unintentional releases	Geographic scope	Reference
1975	454 tonnes/ year (to air)	U.S.	U.S. EPA (2003)
2000	2 tonnes/ year (to air)	U.S.	UNEP-POPS-POPRC 9-13-Add
2000	2.59 tonnes/year-1 (to air from the manufacture of chlorinated chemicals)	UNECE Europe	Van der Gon et al. 2007[47]
2004	<100 g (to air)	Canada	UNEP-POPS-POPRC 9-13-Add
2010	88.9 kg (to water from waste and waste water management)	EU-27	E-PRTR (only includes releases over the emission limit of >1 kg per year, and no UK facilities were included)
2011	538 kg/year (comprising 360 kg fugitive air emissions and 122 kg point source emissions)	U.S.	UNEP-POPS-POPRC 9-13-Add
2012	~0.7 – 500 kg/ year (from the manufacture of chlorinated chemicals)	EU-27	European Commission, 2012
2012	6 kg/ year (to sewage sludge)	EU-27	European Commission, 2012
2015	10,080 kg/ year (to air)	China	Zhang et al., 2015[48]

4.4.5.2.1 Monitoring information in water for HCBD

Under the requirements of the WFD, the EA has demonstrated that monitoring data for the 2013 – 2015 period has indicated that none of the surface water bodies sampled failed the EQS value.

[47] Emissions of persistent organic pollutants and eight candidate POPs from UNECE-Europe in 2000, 2010 and 2020 and the emission reduction resulting from the implementation of the UNECE POP protocol

[48] Highly chlorinated unintentionally produced persistent organic pollutants generated during the methanol-based production of chlorinated methanes: A case study in China

4.5.3 Annex A and C substances, Industrial chemical, unintentional by - product (polychlorinated naphthalenes (PCNs))

The UK has developed an emissions inventory for PCNs for the period 1990 – 2014 using data from the literature and other supporting information. Estimates of the total emissions of PCNs to the UK are given in Figure 6, with the 'land' and 'air' vectors dominating all emissions across the time period. These are dominated by the use of PCNs in di-electric fluids for energy distribution networks. Since the cessation of PCN production (1960s), use of PCNs within new di-electric equipment has also ceased. However a substantial 'bank' of in-use, old equipment and long service life (up to 45 years), means the potential for emissions through di-electric leak are possible, both directly to land and also through volatilisation to air.

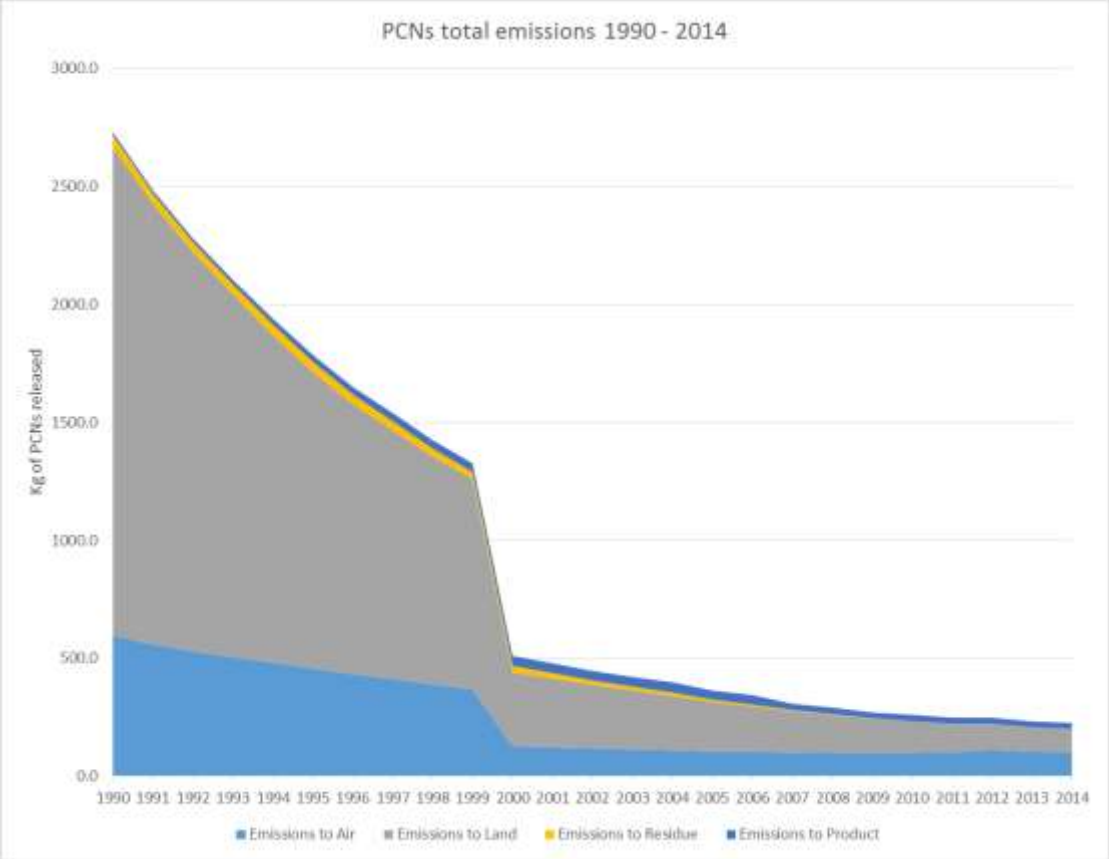
The European Directive 96/59/EC on the use of di-electric equipment that may contain PCBs, had a requirement for all 'industrial' grade equipment (i.e., equipment assumed to contain >5 kg fill size for heat transfer fluids) should have been removed from service by 2000 and irreversible destroyed. Furthermore under the EU POPs Regulation, it is a requirement for Member States to develop and maintain registers of in-use di-electric equipment that may contain PCBs. Based on these facts and review of available data, the decline in existing stocks and emissions from PCB contaminated di-electric equipment saw a significant step change around 2000 with around 75% of the stockpiles removed from service. Where PCNs and PCBs were used in a similar capacity, it can be expected that this campaign of removal would have also seen similar levels of PCNs removed from the existing di-electric stockpiles.

The remaining stockpiles of equipment post-2000 would continue to decline with the resultant emissions also continuing to steadily decrease. In 2014, based on the inventory estimates, the emission vectors have shifted slightly so that 'air' and 'land' vectors become equally dominant. The air vector emissions (2014) are dominated by a) releases into the atmosphere from thermal processes, in the majority of cases through unintentional production of PCNs as by-products; and b) residual PCNs found within dielectrics (e.g. capacitors) and other products that have been stockpiled or have a 'significant' product lifespan.

The 'land' vector emissions are also dominated by the presence of capacitors and other dielectric fluid producing products as sources within the environment. A large number of dielectric containing products (e.g. capacitors and transformers) end up in landfills when they get towards the end of their 'working' life, resulting in leakage of dielectric fluids to land over time. Based on the inventory created there was estimated to be ~92 kg of PCNs released

to land from dielectrics, with another 5.7 kg attributed to more ‘managed’ forms of emissions to land (sewerage sludge spreading) during 2014.

Figure 6: Estimations of the UK’s total emissions of PCN for all vectors (1990 – 2014).



4.6 Human exposure to POPs

Human exposure to POPs can be through air, water, soil, food, dermal contact and occupational exposure. Studies on the original POPs had indicated that in contemporary industrialised settings, more than 90% exposure of the general population to these compounds was through food. However in the UK, the decline in industrial emissions of POPs has resulted in a reduction in food-related exposure. With regard to the newer POPs, there is increasing evidence that other exposure routes may also be significant, for example inhalation and ingestion of dust containing the likes of brominated flame retardants in the home environment and via drinking water in the case of perfluorinated compounds.

4.7 Evaluation of POP concentrations in the marine environment

The Centre for Environment, Fisheries and Aquaculture Science (Cefas) undertake monitoring for some POPs in the marine environment. Their

monitoring using stranded Harbour porpoises (*Phocoena phocoena*) have shown concentrations of:

- PBDEs (summed tetra to hexa-BDE congeners) in the range from not detected to 15.7 mg/kg lipid weight (l.w.) between 1992 – 2008, with the peak concentration observed in a porpoise stranded in 1993. Monitoring has shown concentrations have declined significantly since 1998;
- HBCDD concentrations rose until around 2003 but have been declining since then;
- HCHs (alpha and gamma isomers) have declined over time with concentrations over the period 1992-2008 ranging from not detected to 2.0 mg/kg (l.w.) and the peak concentration occurring in a porpoise stranded in 1992;
- HCB concentrations have declined steadily from 1992 to 2008;
- Total DDT concentrations (predominantly DDE in marine mammals) have declined during the period 1992 to around 1998, then stabilised or 'plateaued', but since then have declined significantly;
- Similarly, for the organochlorine pesticide, dieldrin, concentrations have declined significantly from 1992 to ~1998;
- However, the exception to these observable and steady declines has been for PCBs. Following an initial decline after regulations were introduced in 1981, concentrations have plateaued since around 1997 and have remained steady thereafter. However, PCB levels are still at toxicologically significant concentrations and each year approximately 40% of porpoises have blubber concentrations above a threshold value. Such concentrations increases the risk of infectious disease immune suppression which may lead to reduced fecundity and possible mortality.
- In addition, recent work funded by Defra and other sources have shown elevated PCB concentrations in other marine mammal species such as the killer whale (*Orcinus orca*) across northern Europe and the Mediterranean. In UK waters, concentrations are in killer whales are above the higher threshold established for reproductive impairment and/or failure.

4.8 Evaluation of concentrations in the freshwater environment

Under the second phase of the UK' Water Industry Research Chemicals Investigation programme (CIP2), early results seem to suggest that several

POPs (PFOS, PFOA and HBCDD) are exceeding the environmental quality standards (EQS) detailed in the 2013 Priority Substances Directive (daughter of the Water Framework Directive). Concentrations of PFOS in surface waters downstream of treated sewage effluent discharges generally exceed the EQS for this substance and this appears to be a widespread phenomenon. For HBCDD this substance appears to be present in effluents at some locations and less so at others.

4.9 Effectiveness evaluation of current legislation on emissions

Without exception, monitoring surveys in the UK have demonstrated a decline in emissions of dioxins and furans, PCBs, HCB and PCBz (see Annexes 5A to 5D for data on time series to air, land and water).

Section 5

Update on strategies and measures to further reduce the emissions of POPs

5.1 Overarching national environmental policies

The UK Government is committed to protecting and improving the natural environment. This is to safeguard the enormous range of valuable benefits the natural environment provides to UK citizens, from clean air and water through to diverse wildlife, beautiful landscapes and urban green spaces. In order to do this Defra will published a 25 year environment plan in 2017 which sets out the framework to achieve this in England. The aim is to make this the first generation to leave the natural environment in a better state than it is now.

The framework adopts an integrated mangement approach which recognises that natural assets and the benefits they provide do not exist in silos, but are part of a wider system. There are interactions and dependencies within environmental systems that need to be understood and managed so that the potential benefits which can be obtained from the environment are realised in practice. The natural assets that the UK considers are important are water, land, plants and wildlife, air, marine environment, resources, recycling and waste, and the low carbon economy. The mangement of hazardous chemicals has played and will continue to play a key role in helping to fulfil the objectives of Defra's 25 year environment plan in all of these key natural assets.

Under the Environment (Wales) Act 2016, Welsh Ministers are required to publish a statutory Natural Resources Policy in 2017. The Natural Resources Policy will form a key part of the delivery of the sustainable management of natural resources by setting out what Welsh Ministers consider to be the key risks, priorities and opportunities for the sustainable management of natural resources in Wales. This will include what should be done in relation to biodiversity and climate change and policies for contributing to the sustainable management of natural resources.

5.2 Update of the 2013 National Implementation Plan's measures to manage UK emissions of POPs

5.2.1 Assessment of the potential emissions from legacy pesticide production and application

In the 2013 NIP, the UK undertook to identify and quantify potential stockpiles of legacy, unused treated wood as emission sources for the organochlorine pesticide, lindane (gamma-hexachlorocyclohexane). In 2015/2016 research was carried out by the Environment Agency (EA) to assess the potential emissions from legacy lindane production and application. This analysis did

not find any non-compliance for the presence of the substance in timber being supplied by the UK market leaders and no further work is planned in this area.

It is known, however, that wooden railway sleepers were treated with lindane in the past. An investigation of previously used lindane in these materials will be carried out by the EA via a review of the known largest UK holder of railway sleepers.

The UK is also planning further investigations into the potential for leaching from land-spreading of wood chip compost.

5.2.2 Emission from consumer products and domestic activity

Studies have been carried out to assess concentrations of the brominated flame retardants, PBDEs in waste domestic and office soft furnishings[49], plastic products, namely rainwater pipes and shower curtains, UK waste electrical and electronic (WEEE) equipment[50], and end-of-life vehicles (ELV)[51]. Most of these studies found very low concentrations levels of these POPs. However, due to legacy risks, the UK Government will continue to investigate the likely impact of PBDE-containing electrical and electronic equipment and end-of-life vehicles in waste streams, as well as the presence of PBDEs on the UK market from goods imported from outside of the EU.

5.2.3 Food chain pathway, mechanisms and livestock uptake of POPs

The Food Standards Agency (FSA) has carried out an investigation into the uptake of pharmaceuticals, veterinary medicines and personal care products from the environment into food. As none of the chemicals detected were identified as POPs, the UK has decided to make this a low priority for further study.

The FSA has also commissioned two investigations into the use of former waste materials in agricultural applications. All of these materials may contain quantities of dioxins and furans and other POPs and it is important to ensure that the proposed uses do not lead to an unacceptable uptake into crops or exposure of grazing animals. At the time of writing, this work is still ongoing[52,53] .

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[49] Harrad S et al. Appendix 5 -A Further Update of the UK's Persistent Organic Pollutants Multimedia Emissions Inventory Final Report 2016, "Analysis of polybrominated diphenyl ethers in waste domestic and office soft furnishings". http://randd.defra.gov.uk/

[50] Peacock et al, Analysis of Poly-Brominated Biphenyl Ethers (PBDEs) in Selected UK waste Streams: PBDEs In waste electrical and electronic equipment (WEEE), February 2012

[51] Turrell J et al, Analysis of Poly-brominated Biphenyl Ethers (PBDEs) in selected UK Waste Streams: PBDEs in end of life vehicles December 2012

[52] https://www.food.gov.uk/science/research/chemical-safety-research/env-cont/fs102009a

[53] https://www.food.gov.uk/science/research/chemical-safety-research/env-cont/fs102009b

5.2.4 Development and maintenance of multimedia emissions inventory for new and existing POPs

Since 2013, the UK has expanded its multimedia source inventories to provide assessment of emissions of dioxins and furans, PCB, HCB, PCNs and PCBz emissions to product and residue vectors as well as air, water and land.

5.3 Further planned work for managing POPs emissions in the UK

5.3.1 Further developments to the TOMPS monitoring network and multimedia emissions inventory

The TOMPs network will continue to monitor the original Annex C POPs at all sampling sites. However, there is good justification that monitoring intensity could be reduced as the time series emission data indicates that emissions of these POPs have now decreased to low levels. The Government will therefore review the frequency of the monitoring for these substances and consider whether to select new POPs to monitor to ensure that it continues to target its monitoring efforts on the POPs of greatest concern. Government will also continue to develop its multimedia source inventories to reflect changes in data that is available.

5.3.2 Addressing POPs legacy use

The UK recognises there is an ongoing issue about POPs legacy uses which is particularly problematic within the context of waste and recycling. In relation to brominated flame retardants (BFR) in waste electronic and electrical equipment (WEEE), the UK is developing new treatment guidance which will introduce new threshold limits from the European POPs Regulation into the national standards for the output streams. This will require operators to establish a system for screening the input waste stream to isolate plastics and other materials that contain BFRs above the threshold limit and which must be removed and sent for irreversible destruction. Further studies will also be carried to assess whether POPs are present in recycled plastics and articles. (See Table 11)

The UK recognises that waste in landfill is a potential source of POPs release into groundwater. Previous work by the EA has revealed the presence of chemicals in leachate and groundwater but at the time it was not possible to analyse for POPs. However the methodology has since been improved and in view of this, the EA are looking to repeat this study before 2020 to assess if POPs are finding their way into leachate and/or groundwater.

Finally, as mentioned in section 5.2.1, the UK will review historical lindane material found predominantly in railway sleepers and will investigate the potential for leaching from land-spreading of wood chip compost.

5.3.3 POPs in the aquatic environment

As part of its obligations under the Water Framework Directive (WFD), the EA has developed estimates of emissions of hazardous substances, some of which are classed as POPs. However, preliminary results indicate a discrepancy in the data obtained from the different methodologies for calculating emissions data under the WFD and the UK POPs multimedia source inventories for the water vector. The UK intends to resolve this discrepancy to ensure that an accurate picture of the levels of POPs concentrations which enter the surface water environment is available, and which aims to harmonise emission data generated by the two approaches.

There are plans to measure POPs in sludge material generated from waste water treatment operations. This work will provide information on the removal efficiencies of treatment process, on emissions to surface waters and the prevalence of these substances downstream of discharges. Risk assessments on such substances can then be undertaken which will feed into risk management proposals potentially identifying measures to control further emissions to the wider aqueous environment.

Concentration data show that POPs continue to enter the marine environment and that this is potentially having localised impacts marine animals. The presence of POPs in the marine environment is currently being addressed under the Marine Strategy Framework Directive (MSFD). The MSFD requires Member States to develop a programme of measures to achieve objectives of good environmental status[54]. Government will monitor progress achieved towards these targets and we will report this progress to the extent of how the measures have realised the targets set in the next update of this NIP.

5.3.6 POPs alternatives

Article 9 of the Stockholm Convention includes a requirement on information exchange relevant to the reduction or elimination of the production, use and release of POPs and alternatives to POPs. The UK plays an important role in the substitution of POPs and ensures that industry and other organisations are compliant with the obligations under the Convention, and also in demonstrating to other parties that substitution of POPs is feasible. A study is being carried out to investigate alternative chemicals, for the BFRs, Deca-BDE and HBCDD. The UK will look at ways in which new information on alternatives can be disseminated wider.

5.3.7 Summary of planned work for managing POPs emission of POPs in the UK

A summary of the planned work to be taken together with time schedules is presented in Table 11.

[54] These are set out in the UK Marine Strategy part 3 https://www.gov.uk/government/publications/marine-strategy-part-three-uk-programme-of-measures.

Table 11 Implementation schedule for planned work for managing POP emissions in the UK		
Activity	**Actors**	**Timing**
POPs monitoring and inventory		
Development and maintenance of multimedia emissions inventory for new and existing POPs	Defra	On-going
Further development and maintenance of TOMPS Monitoring network (Air)	Defra	On-going
Addressing POPs legacy issues		
Review of historical lindane found in railway sleepers	EA	2017-2020
Assessment of PBDEs within end of life vehicles	Defra	2015 – 2016
Assessment of PBDEs in recycled plastics	Defra	2016- 2017
Assessment of PCP and PCBz in finished articles	Defra	2017- 2018
Analysis of landfill leachate	EA/Defra	2017-2020
Food chain pathway, mechanisms and livestock uptake		
Investigation of use of former waste materials in agricultural applications (section 5.2.3)	FSA	Ongoing
POPs in water		
Analysis of sludge for POPs	Defra	2017- 2020
Measures under the MSFD	Defra	2018
Measures under the WFD	Defra	Ongoing
Information exchange		
POPs alternatives for DecaBDE and HBCDD	Defra	Ongoing

Section 6

Reduction or elimination of POP releases from stockpiles and wastes

Article 6 of the Stockholm Convention requires that appropriate strategies should be developed to identify stockpiles and wastes consisting of, containing or contaminated with POP substances. Stockpiles identified by these strategies should be managed in a safe, efficient and environmentally sound manner.

The Stockholm Convention defines which stockpiles are deemed as waste and requires that they are handled, collected and transported in an environmentally sound manner. The Convention requires wastes to be disposed of in such a way that the POPs content is destroyed or irreversibly transformed. However, waste can be otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option, or where the POP content is below a certain threshold concentration value. The Stockholm and Basel Conventions are working together to agree low POP content levels for the banned substances.

The Basel Convention adopted technical guidelines, including low POP content values, for the environmentally sound management of wastes consisting of seven groups of POPs in 2015. These values have been adopted on a provisional basis and will be reviewed in 2017.

Regulation (EC) 850/2004 on POPs contains provisions that go beyond those required by the Stockholm Convention and defines waste management options. Under Article 7, the Regulation requires that waste consisting of, containing or contaminated by POPs shall be disposed of or recovered in such a way as to ensure that the POPs content is destroyed or irreversibly transformed by physico-chemical treatment, incineration on land or use as secondary fuel.

Regulation (EC) 850/2004 was amended in 2014 (Commission Regulation (EU) No 1342/2014) to include additional chemicals to the list of POP substances with concentration limit values for Annex IV of the POPs Regulation. Values for low POP content limits in Annex IV of the Regulation provide trigger levels above which all POPs in wastes are to be destroyed or irreversibly transformed. Derogations from this requirement are allowed in Article 7(4)(b), where destruction or irreversible transformation is not the environmentally preferable option. The wastes to which this exemption may apply, and the maximum concentration limits up to which the exemption is applied, are listed in Annex V. However, the derogations are only to be used

by Member States in exceptional cases. It is UK Government policy that no waste should be exported from the UK for disposal.

In addition, those dealing with waste consisting of, containing or contaminated with POPs will be subject to other waste controls regulations, as appropriate. These include duty of care and controls for hazardous waste.

The concentration limits in the POPs regulation are listed in Table 13 below.

Table 13 Persistent **organic pollutants concentration limits in waste - Annex IV - Low POPs concentration limits**

Substance	Concentration Limit
Endosulfan	50 mg/kg
Perfluorooctane sulphonic acid and its derivatives C8F17SO2X (X=OH, Metal salt {O-M+}, halide, amide, and other derivatives including polymers)	50 mg/kg
Hexachlorobutadiene	100 mg/kg
Polychlorinated naphthalenes	10 mg/kg
C10-C13, short chain chloroalkanes (SCCPs)	10 000 mg/kg
Tetrabromodiphenyl ether, Pentabromodiphenyl ether, Hexabromodiphenylether, Heptabromodiphenyl ether	Sum of the concentrations of tetra, penta, hexa and penta diphenyl ether:1000 mg/kg
Dioxins/Furans	15 µg/kg
Polychlorinated biphenyls	50 mg/kg
Hexabromocyclododecane	1000 mg/kg (subject to review by the Commission by 20/4/2019
Other Persistent organic pollutants	50 mg/kg

6.1 Stockpiles relating firefighting foams containing perfluorooctane sulphonic acid (PFOS)

The production and supply of PFOS-containing firefighting foams were phased out under the REACH Regulation and the use of such foams was then banned in 2011 under the POPs Regulation 850/2004 (as amended). The Environment Agency undertook a communications and compliance campaign for PFOS in 2011. Primarily, this focussed on raising awareness of requirement to cease use and dispose of PFOS-containing foams. The targeted sectors included fire and rescue services (FRS) and large industry with involvement in flammable liquids – particularly the petrochemicals industry, downstream oil industries, and aviation authorities. It has been confirmed by the FRS that PFOS-foams are no longer in use and several industrial holders of foams notified disposal of the material following the communications campaign.

The use and disposal of PFOS-foams are no longer considered to be a current concern. However, the substance may be present in residual forms in land resulting from PFOS-foam/water run-off occurring during past industrial incidents.

6.2 Stockpiles relating to HBCDD

Under the Regulation 850/2004 (as amended), if a holder has 50 kg or more of a material that consists or contains a POP substance and is held for an exempt purpose, they must submit information about the size and nature of stockpile to the enforcing authority 12 months after the substance is listed in Annex I or II of the Regulation. The holder must update the notification every 12 months thereafter, and must ensure that the stockpile is managed in a safe, efficient and environmentally sound manner.

As the brominated flame retardant, HBCDD is now regulated as a POP, the requirement to notify exempt stockpiles of HBCDD-containing materials will apply as from March 2017. Whilst there are active REACH authorisations for the continued use of HBCDD in expanded polystyrene (EPS) manufacturing in Europe, none of the manufacturing companies are located in the UK. It is therefore expected that stockpile notifications will only be received from importers and distributors of construction materials where the holder has 50 kg or more of HBCDD-containing EPS on site. Construction companies are considered unlikely to notify their on-site stockpiles as it is understood that they order materials from suppliers to arrive on-site as required, rather than having their own stores of materials at a depot or site lock-up.

The EA will be working with construction industry associations to raise awareness of the requirement to notify stockpiles of HBCDD-containing

materials, and also with waste industry associations to clarify requirements for the proper handling and disposal of HBCDD-containing foams during building demolition.

Section 7

Other obligations of the Stockholm Convention

The principal obligations of the Convention require Parties to adopt and implement measures aimed at reducing or eliminating the release of POPs into the environment. This section considers a range of other obligations listed in the Convention and what the UK is doing to implement them.

7.1 Information exchange, awareness and education

Article 10 includes obligations for Parties to facilitate 'Public information, awareness and education' on POPs. Specifically, it requires that "each Party shall, within its capabilities promote and facilitate *inter alia* "training of workers, scientists and educators, policy and decision makers". In the UK it is standard practice when developing decision making on environmental policy to consult stakeholders and make information publicly available through a range of media including publications of consultation documents, research reports and the internet. In addition, Defra provides and exchanges information with Parties to Convention via the Convention Secretariat.

Making information about the environment publicly available is essential in achieving sustainable development. By providing access to environmental information, the public is able to make informed decisions in the full knowledge of the likely environmental implications and to participate more effectively in decision-making processes that affect the environment. Openness also promotes transparent decision making and greater public accountability of how authorities undertake their duties and responsibilities in the UK.

Since 1992, the public has had a statutory right of access to environmental information held by public authorities. This stems from the European Community Directive 90/313/EEC on the freedom of access to information on the environment. In 2003, the 1990 Directive was replaced by EC Directive 2003/4/EC on public access to environmental information, which takes account of advances in technology, reflects international developments in access rights, learns from the experience of the earlier regime, and ensures the consistent application of the UNECE Aarhus Convention in the European Union.

The Defra website www.defra.gov.uk contains a wide range of information on what the Government is doing to protect the environment in a range of areas such as chemicals, air quality, soil and contamination and water quality. It

includes information on national, EU and international chemicals policy, Government position statements, advisory committee papers and reports, and developments in research.

The National Air Quality Information Archive is the UK's national archive of air quality information and reports, including detailed air quality monitoring data and statistics, plus major sections on local air quality management and air quality research. This may be found at:
www.airquality.co.uk/archive/index.php

Openly accessible information on chemical emissions is also included in the UK's National Atmospheric Emissions Inventory, which compiles estimates of emissions from UK sources including road transport, power stations and industrial plants. This may be found at: www.naei.org.uk

The EA's Pollution Inventory is an annual record of pollution in England from activities that it regulates. One of its main objectives is to provide the public with easily accessible information about pollution from industrial and other sources in their local area and nationally. It records pollution that is released into air, discharged into rivers or the sewerage network, or is transferred off-site as waste. This feeds into the National Atmospheric Emissions Inventory, and both the UK and European Pollutant Release and Transfer Register (PRTR). The pollution inventory home page can be found at:
http://www.environment-agency.gov.uk/

Similarly, the Scottish Environment Protection Agency (SEPA) provides a wide variety of environmental information in reports and on its website, which also contains an education homepage: http://www.sepa.org.uk/default.aspx

The Scottish Pollutant Release Inventory (SPRI)' is an annual record of pollution prepared by SEPA and can be found at:
http://www.sepa.org.uk/air/process_industry_regulation/pollutant_release_inventory.aspx

The Northern Ireland Environment Agency also compiles emission data for Northern Ireland and submits this to the UK Pollutant Release and Transfer Register (PRTR).

The data provided by the UK pollution inventories is consolidated with data from other sources and can be found at:
http://prtr.defra.gov.uk/

For some POPs, such as dioxins and furans, the major route of human exposure is through diet. It is therefore important that the public has access to information on food. The Foods Standards Agency provides this information which, along with every other public authority, has a legal duty under Section

19 of the Freedom of Information Act 2000[55] to: adopt and maintain a scheme which relates to the publication of information; have the scheme approved by the Information Commissioner; publish information in accordance with that scheme; and to review the scheme periodically. The Agency's publication scheme brings together in one place the many differing types of information that are issued by the Agency in the discharge of its public functions and it categorises the information type and provides details on how to obtain it.

The FSA produces a wide range of publications for the public and the food industry. Many of these are available free of charge and some of which can be downloaded from its website: www.food.gov.uk .

7.2 Research, development and monitoring

Article 11 requires that Parties facilitate, support and encourage research, development, and monitoring and data collection of POPs. Focus is on their sources, releases, transport, levels and trends, and effects on humans and the environment.

The UK Government continues to fund and support scientific research to underpin policy development on POPs. Monitoring is commissioned and carried out by a range of organisations for a variety of purposes. These include compliance monitoring for international, European and national legislation, trend monitoring and addressing knowledge gaps regarding particular chemicals including POPs. Details about Defra's past and on-going research can be found at the following website:

http://randd.defra.gov.uk/

A number of other Government Departments and agencies have significant research portfolios on POPs. Examples of these include: the Department of Health's research through the National Institute for Health Research (NIHR) on Environmental Health, Air Pollution and Toxicology; the EA's Air Quality, Human Health Effects and Diffuse Pollution work; the FSA's chemical contaminants in food programme and the Scotland and Northern Ireland Forum for Environmental Research, Information on these can be found at the following:

http://www.ncl.ac.uk/hpru/

http://hieh.hpru.nihr.ac.uk/

[55] http://www.legislation.gov.uk/ukpga/2000/36/contents

https://www.journalslibrary.nihr.ac.uk/programmes/

http://www.environment-agency.gov.uk/research/

http://food.gov.uk/science/

www.sniffer.org.uk

Details of mandatory monitoring of food and animal feed undertaken by the FSA can be found at the following website: www.food.gov.uk

7.3 New and emerging POP issues

Article 8 of the Stockholm Convention sets out process and criteria by which new POPs are processed, assessed and listed in the Annexes of the Convention. The UK Government will continue to respond to new and emerging issues addressing both requirements under the Stockholm Convention and the UNECE POPs Protocol.

The UK continues to participate in international assessments of POPs and plays an active role to input into the work of technical committees under both the Stockholm Convention and the UNECE POPs Protocol to assess substances that meet the criteria of a POP. The UK, in partnership with the European Community and its Member States has nominated substances to be added to the Stockholm Convention.

In addition, the UK continues to survey the environment and food for existing and emerging POPs substances. Details of previous and ongoing studies may be found at the Food Standards Agency (FSA) and Centre for Environment, Fisheries and Aquaculture Science (Cefas) web pages below:

http://www.food.gov.uk/science/research/contaminantsresearch/env-cont/organic-cont/

https://www.cefas.co.uk/cefas-data-hub/research-and-publications-list/?page=490

7.4 Effectiveness evaluation

Article 16 requires that Parties in accordance to their technical and financial capabilities and using existing monitoring programmes and mechanisms (where possible) cooperate on a regional basis, when appropriate and contribute to a global monitoring programme for the Convention.

The UK has, in the past, submitted information gained from its POP monitoring programmes in food and air to the European Food Safety Authority

and the Convention's Secretariat, respectively. The UK will continue to maintain liaison and collaboration with the Secretariat in contributing towards a global monitoring plan and consideration of inclusion of new POPs in future research and monitoring programmes.

7.5 Provision of technical assistance

Article 12 requires Parties to recognise that rendering timely and appropriate technical assistance in response to requests from developing country Parties and Parties with economies in transition is essential to the successful world-wide implementation of the Convention. Provision of technical assistance includes taking into account the particular needs of developing countries and countries with economies in transition to develop and strengthen their capacity to implement their obligations under the Convention. Much of the UK's regional and bilateral development assistance is focused on helping developing countries to mainstream sound management of chemicals including POPs in poverty reduction strategies and development assistance. The principle routes for providing assistance to developing countries and countries with economies in transition are listed below:

(i) The Global Environment Facility (GEF)

The GEF was created in 1991 to channel multilateral funds into projects that create global environmental benefits, initiated by people in developing countries. It brings together 182 member Governments, leading development institutions, the scientific community and a wide spectrum of private sector and non-Governmental organisations. It has allocated US$14.5 billion in grants and an additional US$75.4 billion in co-financing from other sources to support more than 4000 projects in 167 countries. These projects are implemented by the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank. More information on the GEF can be found at:www.gefweb.org

In 2002 persistent organic pollutants became a GEF focal area. In 2014 the GEF-6 replenishment allocated US$554 million for chemicals, and $US375 million specifically for projects involving POPs, providing financial and technical assistance to countries in meeting their Stockholm Convention's obligations. The UK is contributing £210 million to the GEF-6 replenishment budget of US$4.433 billion.

(ii) UK contributions to the Stockholm Convention

The UK previously contributed to the 'POPs Club' which was established under UNEP to support the development of what is now the Stockholm Convention. Since the Convention entered into force in May 2004, the UK has

an obligation to make annual assessed contributions to support the activities of the Secretariat and participation of developing countries. In 2015, the UK's assessed contribution was $US 349,209.

7.6 Reporting obligations under the Stockholm Convention

Under Article 15, Parties are required to report periodically on the measures taken and on their effectiveness in meeting the objectives of the Convention.

Reporting will include:

(a) Data on the total quantities of production, import and export of the chemicals listed in Annexes A and B;

(b) A list of countries from which it has imported and exported each of these.

The purpose of reporting is to assess progress towards meeting obligations under the Convention. As required under Article 12 of the EU POPs Regulation, the UK has submitted annual and triannual reports to the European Commission since 2007 outlining the progress made towards meeting the objectives of the Convention.

The UK's international reporting requirements and a schedule for the next four years to 2021 are outlined in Table 14 below:

Table 14: The UK's reporting requirements 2016 - 2021

Report	Reported to	Date for submission to Convention Secretariat
National Implementation Plan (update)	Stockholm Convention Secretariat	November 2016
4th Stockholm Convention Article 15 report	Stockholm Convention Secretariat	2018 and periodically as required
EU POPs Regulation Article 12 Annual Report	EU Commission	Annually
EU POPs Regulation Article 12 Triannual Report	EU Commission	Triennially (next report due in 2019

ANNEXES

Annex 1: Glossary of Terms and Units used

Anthropogenic	Caused or influenced by human activity
BAT	Best Available Techniques
BFRs	Brominated Flame Retardants
BREFs	Best Available Technique Reference Documents
Biologically active	A material is considered bioactive if it has interaction with or effect on any cell tissue in the human body
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CLRTAP	Convention on Long-Range Transboundary Air Pollution
COMAH	Control of Major Accident Hazard Regulations 1999
Congener	A congener is any single, well-defined chemical compound within a closely related group. As an example, a polychlorinated biphenyl (PCB) congener is a well-defined chemical compound in the PCB category. The name of a PCB congener is associated with the total number of chlorine substituents and the position of each chlorine
COP	Conference of the Parties

COSHH	Control of Substances Hazardous to Health Regulations
COT	Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment
DAERA NI	Department of Agriculture, Environment &Rural Affairs Northern Ireland
DEFRA	Department for Environment, Food and Rural Affairs
DDT	The chemical name for DDT is 1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane or dichlorodiphenyltricloroethane. The term DDT generally refers to *para, para'*DDT. However the compound's structure permits several different isomeric forms including *ortho, para* and *meta, para'-DDT*.
De Novo	Synthesis of a compound from simple molecules under certain favourable conditions
DFID	Department for International Development
Dioxin-like PCBs	PCB congener which has the same toxic action as to the most toxic dioxin congener (2,3,7,8-tetrachlorodibenzo-p-dioxin) but at a different level of potency on the basis of which it is assigned a TEF value
EA	Environment Agency
EC	European Commission

ECHA	European Chemicals Agency
ELVs	Specified Emission Limit Values
EFSA	European Food Standards Agency
EMEP	European Monitoring & Evaluation Programme
EPA	Environmental Protection Act
E-PRTR	European Pollutant Release and Transfer Register, which is based on Regulation (EC) No 166/2006 - implementing the obligations of the UN-ECE PRTR Protocol signed in May 2003 by 36 countries and the European Community.
EQS	Environmental Quality Standard
EU	European Union
FSA	Food Standards Agency
GEF	Global Environment Facility
HBCDD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCE	Hexachloroethane
HCH	Hexachlorocyclohexane
HSE	Health and Safety Executive
HMRC	Her Majesty's Revenue and Customs

IED	Industrial Emissions Directive – integrated approach to controlling pollution from industrial sources across the European Union
Inter alia	Among other things
IPPC	Integrated pollution prevention and control
Isomer	An isomer is a chemical species with the same number and types of atoms as another chemical species, but possessing different properties. There are structural isomers, geometric isomers, optical isomers and stereoisomers.
I-TEQ	International – Toxic Equivalent Quotient is the Nato (1989) based system of toxic equivalents used to present a quantity of dioxin and furan congeners as a single value based on the relative toxicity of all congeners to the most harmful congener – TCDD.
LR-TAP	Long-Range Transboundary Air Pollution
mg/m^3	milligrammes per cubic metre
mg/g	milligrammes per gram
mg/kg	milligrammes per kilogram
MMO	Marine Management Organisation
MSFD	Marine Strategy Framework Directive
MSW	Municipal Solid Waste

NAEI	National Atmospheric Emissions Inventory
NDPB	Non-departmental public body
NIEA	The Northern Ireland Environment Agency
NRW	Natural Resource Body for Wales
OECD	Organisation for Economic Cooperation & Development
OSPAR	Oslo and Paris Conventions
PAH	Polycyclic aromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PCBz	Pentachlorobenzene
PCDD	Polychlorinated dibenzo-p-dioxins (also known as ‘dioxins’)
PCCD/F	Mixture of congeners of PCDD and PCDF (referred to collectively as ‘dioxins’)
PCDF	Polychlorinated dibenzofurans (also known as ‘furans’)
PCNs	Polychlorinated naphthalenes
PCP	Pentachlorophenol
PCTs	Polychlorinated terphenyls
PERC	Perchloroethylene

PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PFOS-F	Perfluorooctane sulfonyl fluoride
PHE	Public Health England
PI	Pollution Inventory
PIC	Prior Informed Consent
POPs	Persistent Organic Pollutants
PPC	Pollution Prevention and Control Regulations
PRTR	Pollutant Release and Transfer Registers
PVC	Polyvinyl chloride
REACH	Registration, Evaluation, Authorisation of Chemicals
SAICM	Strategic Approach to International Chemical Management
SCCPs	Short chain chlorinated paraffins
SEPA	Scottish Environment Protection Agency
SPRI	Scottish Pollutant Release Inventory
TCDD	2, 3, 7, 8-tetrachlorodibenzo-p-dioxin
TDI	tolerable daily intake
TDS	Total Diet Study

TEF	Toxic equivalency factor
TEQ	Toxic equivalent quotient
TOMPs	Toxic Organic Micro-Pollutants
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
WEEE	Waste Electrical & Electronic Equipment
WFD	Water Framework Directive
WHO	World Health Organisation

Annex 2: Descriptions of the persistent organic pollutants

Aldrin	A pesticide applied to soils to control termites, grasshoppers, corn rootworm, and other insect pests.
Chlordane	Used extensively to control termites and as a broad-spectrum insecticide on a range of agricultural crops.
Chlordecone	Is a synthetic chlorinated compound, which was mainly used as an agricultural pesticide. It was first produced in 1951 and introduced commercially in 1958.
Dichlorodiphenyltrichloroethane (*p,p'*-DDT)	DDT was widely used during World War II to protect soldiers and civilians from malaria, typhus, and other diseases spread by insects. It continues to be applied against mosquitoes in several countries to control malaria.
Dieldrin	Used principally to control termites and textile pests, dieldrin has also been used to control insect-borne diseases and insects living in agricultural soils.
Dioxins	Dioxins are families of structurally related compounds and belong to a class of environmental pollutants known as organochlorines. Dioxins is an umbrella description for polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF)
Endosulfan	Is an insecticide that has been used since the 1950s to control crop pests, tsetse flies and ectoparasites of cattle and as a wood preservative. As a broad-spectrum insecticide, endosulfan is currently used to

	control a wide range of pests on a variety of crops including coffee, cotton, rice, sorghum and soy.
Endrin	This insecticide is sprayed on the leaves of crops such as cotton and grains. It is also used to control mice, voles and other rodents.
Furans	Unintentionally produced compounds from many of the processes that produce dioxins, and also during the production of PCBs. Included in reference to dioxins
Hexabromobiphenyl (HBB)	Is an industrial chemical that has been used as a flame retardant, mainly in the 1970s. It is no longer produced or used in most countries.
Hexabromodiphenyl ethers and Heptabromodiphenyl ethers	Are the main components of commercial octabromodiphenyl ether mixture which has been used as a flame retardant.
Tetrabromodiphenyl ether and pentabromodiphenyl ether	Are the main components of commercial pentabromodiphenyl ether mixture which has been used as a flame retardant.
Heptachlor	Primarily employed to control soil insects and termites, heptachlor has also been used more widely to control cotton insects, grasshoppers, other crop pests, and malaria-carrying mosquitoes.
Hexachlorobenzene (HCB)	First introduced in 1945 to treat seeds, HCB was primarily used as a fungicide. It was widely used to control wheat bunt. It is also a by-product of certain industrial chemicals and exists as an impurity in several pesticide formulations. HCB emissions may also arise from combustion sources.

Hexachlorocyclohexane (alpha and beta HCH)	Are still produced as a by-product of lindane, although the intentional use of alpha- and beta- HCH as an insecticide was phased out years ago.
Lindane (gammaHCH)	Is the common name for the gamma isomer of hexachlorocyclohexane Lindane has been used as a broad-spectrum insecticide for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human applications.
Mirex	This insecticide is applied mainly to combat fire ants and other types of ants and termites. It has also been used as a fire retardant in plastics, rubber, and electrical goods.
Pentachlorobenzene (PCBz)	PCBz was used in PCB products, in dyestuff carriers, as a fungicide, a flame retardant and as a chemical intermediate e.g. previously for the production of quintozene. PCBz might still be used as an intermediate. PCBzis also produced unintentionally during combustion, thermal and industrial processes. It also present as impurities in products such as solvents or pesticides.
Perfluoroctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F)	PFOS is both intentionally produced and an unintended degradation product of related anthropogenic chemicals. The current intentional use of PFOS is widespread and includes: electric and electronic parts, fire fighting foam, photo imaging, hydraulic fluids and textiles.
Polychlorinated biphenyls (PCBs)	These compounds were used in industry as heat exchange fluids, in electric transformers and capacitors, and as additives in paint, carbonless copy paper,

	sealants and plastics. They can also be formed unintentionally as by-products in some chemical and combustion processes. It is now known that some PCBs exhibit similar biological activity to dioxins and these compounds are therefore referred to as dioxin-like PCBs.
Toxaphene	This insecticide, also called camphechlor, is applied to cotton, cereal grains, fruits, nuts, and vegetables. It has also been used to control ticks and mites in livestock.
Hexabromocyclododecane (HBCDD)	This is a brominated flame retardant. Its primary application is in extruded (XPS) and expanded (EPS) polystyrene foam that is used as thermal insulation in the building industry.
Hexachlorobutadiene (HCBD)	Used mostly as a chemical intermediate in the production of rubber compounds, and to a lesser extent in the production of chlorofluorocarbons (CFCs) and lubricants.
Pentachlorophenol (PCP)	Most commonly used as a biocide, pesticide, disinfectant, defoliant, anti-sapstain agent, anti-microbial agent and wood preservative in the agriculture and forestry sectors (namely for wooden utility poles and wooden trays used in mushroom farming).
Polychlorinated Naphthalenes (PCNs)	PCNs were produced for a diverse range of uses and applications. These are use as dielectric fluids, flame retardants, fungicides, wood preservation and dye carriers.

Annex 3: The Current UK requirements for Stockholm Convention Annex C Part II and Part III source categories

Annex C - Part II source categories

These source categories are regulated through one or a combination of the following regulations, depending on their potential to pollute. The UK 2007 NIP (Annexes 5A) provided detail about how these applied for each sector.

The Industrial Emissions Directive (IED) is implemented in England and Wales through the Environmental Permitting Regulations (EPR). The IED lays down rules on integrated prevention and control of pollution arising from industrial activities. It also lays down rules to prevent or, where that is not practicable, to reduce emissions into air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment taken as a whole. It applies to those installations which are known in EPR as A (1) or A(2) installations, small waste incineration plants (SWIPs) or solvent emission activities (SEAs) in EPR.

A (1) installations are regulated by the Environment Agency in England, Natural Resources Wales in Wales, Scottish Environment Protection Agency in Scotland and by Northern Ireland Environment Agency in Northern Ireland. A (2) installations, SWIPs and SEAs are regulated by local authorities in England, Wales and Northern Ireland and SEPA in Scotland.

Local authorities also regulate installations known in the EPR as Part B installations. Part B installations have a lower potential to pollute the environment than A (1) and A(2) installations, and are regulated for emissions to air only. Part B installations are not covered by IED.

All these systems require the operators of certain industrial and other installations to obtain a permit to operate. Once an operator has submitted a permit application, the regulator then decides whether to issue a permit. If one is issued, it will include conditions aimed at reducing and preventing pollution to acceptable levels.

BAT conclusions determined in accordance with Article 13 of the IED published by the European Commission are the reference for setting permit conditions.

Sector guidance (SG) notes are issued by the Secretary of State for Environment, Food and Rural Affairs and by the Welsh Government under regulation 64 of the EPR. They form statutory guidance on what constitute the

Best Available Techniques for A (2) installations for each of the main sectors regulated.

Process Guidance (PG) notes are issued by the Secretary of State for Environment, Food and Rural Affairs under regulation 64 of the EPR. They form statutory guidance on what constitute the Best Available Techniques (BAT) for Part B installations for each of the processes regulated.

Annex C - Part III source categories

The Convention also requires the promotion, in accordance with its action plan, of the use of BAT and BEP for new and existing sources within source categories such as those within Part III of Annex C. The UK 2007 NIP (Annexes 5B) provided detail about how these are applied for each sector.

The narrative outlined for Part II sources is also relevant for many of the Part III sources. However some of the Part III source categories are not covered in this way, specifically residential combustion sources and motor vehicles. Some processes are also covered or prohibited by other regulations – e.g. open burning of waste, shredder plants for end of life vehicles.

Annex 4: TEQ Schemes for Dioxins and Furans, and dioxin-like PCBs

Measurement of toxicity for dioxins (Toxic Equivalency Factors)

Dioxins are found and released to the environment as complex mixtures of chemical congeners. There are 210 congeners in total. Only 17 of these congeners are considered biologically active and exhibit toxicity similar to that of 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD), the most toxic congener. In order to give a single measure of the toxicity of a sample and to simplify the handling of data on these compounds various 'toxic equivalent quotient' (TEQ) schemes have been proposed. These schemes provide a series of 'toxic equivalency factors' (TEFs) that are applied to the measured concentrations or amount of each congener to give a measure of the overall toxicity of a mixture. The toxic equivalent concentration is the amount of 2, 3, 7, 8-TCDD that is estimated to give the same overall effect as the mixture present.

There are two systems in current use for presenting toxic equivalency factors for dioxins; the International TEQ (I-TEQ) and the more recent World Health Organisation the (WHO TEQ). The latter also includes the dioxin-like PCBs. These are given in Annex 4a and 3b.

In the UK, the Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) adopted the use of WHO-TEQ, while the I-TEQ scheme is widely used in UK and EU legislation. For purposes of this document both terms I-TEQ and WHO-TEQ will be used where appropriate. The 2005 WHO-TEFs have been incorporated into legislation relating to contaminants in food through Commission Regulation 1259/2011 and in feeding stuffs through Commission Regulation 277/2012.

Annex 4a: Toxic Equivalent Quotient (TEQ) schemes for dioxins and furans

	I-TEQ (Nato 1989)	WHO TEQ (1997/98)[56]	WHO TEQ (2005 update)[57]
Dioxins		Humans/Mammals	Humans/Mammals
2,3,7,8-TCDD	1	1	1
1,2,3,7,8-PeCDD	0.5	1	1
1,2,3,4,7,8-HxCDD	0.1	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01	0.01
OCDD	0.001	0.0001	0.0003
Furans			
2,3,7,8-TCDF	0.1	0.1	0.1
1,2,3,7,8-PeCDF	0.05	0.05	0.03
2,3,4,7,8-PeCDF	0.5	0.5	0.3
1,2,3,4,7,8-HxCDF	0.1	0.1	0.1

[56] Van den Berg et al (1998) toxic equivalent factors for PCBs, PCDDs and PCDFs for humans and wildlife. Environmental Health Perspectives, 106, 12

[57] Van den Berg et al: The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. WHO TEQ 2005 revised values, quoted from WHO website: http://www.who.int/foodsafety/chem/tef_update/en/index.html

1,2,3,7,8,9-HxCDF	0.1	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1	0.1
1,2,3,4,6,7,8-1HpCDF	0.01	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01	0.03

Annex 4b: Toxic Equivalent Quotient (TEQ) schemes for dioxin-like PCBs

	Ahlborg et al (1993)[58]	WHO-TEQ(1997/8)	WHO TEQ (2005)
Non-Ortho PCBs		Humans/Mammals	Humans/Mammals
3,4,4',5-TCB (81)		0.0001	0.0003
3,3',4,4'-TCB (77)	0.0005	0.0001	0.0001
3,3',4,4',5PeCB (126)	0.1	0.1	0.1
3,3',4,4',5,5'-HxCB(169)	0.01	0.01	0.03
Mono-Ortho PCBs			
2,3,3',4,4'-PeCB (105)	0.0001	0.0001	0.00003
2,3,4,4',5-PeCB (114)	0.0005	0.0005	0.00003
2,3',4,4',5-PeCB (118)	0.0001	0.0001	0.00003
2',3,4,4',5-PeCB (123)	0.0001	0.0001	0.00003
2,3,3',4,4',5-HxCB (156)	0.0005	0.0005	0.00003
2,3,3',4,4',5'-HxCB (157)	0.0005	0.0005	0.00003

[58] *Chemosphere,* Vol. 28, No. 6, pp. 1049-1067, 1994

2,3',4,4',5,5'-HxCB (167)	0.00001	0.00001	0.00003
2,3,3',4,4',5,5'-HpCB (189)	0.0001	0.0001	0.00003
Di-Ortho PCBs			
2,2',3,3',4,4',5-HpCB (170)	0.0001	0	0
2,2',3,4,4',5,5'-HpCB (180)	0.00001	0	0

Annex 5 (A1): Emissions of dioxins and furans to air (g I-TEQ per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	g I-TEQ	484.37	479.12	460.23	312.59	146.38	160.93	53.73	31.43	16.47	15.34	15.07	14.72	14.45	14.83	13.96	14.20	12.92	13.62	13.09	12.52	12.61	12.62	12.95	13.56	14.38
Ferrous and Non Ferrous Metals	g I-TEQ	118.49	107.29	105.82	108.53	112.35	114.62	114.71	118.92	93.05	76.83	61.29	53.37	41.66	40.70	48.79	48.74	44.69	39.80	39.31	32.62	49.18	38.97	36.43	33.27	29.94
Heat and Power generation	g I-TEQ	331.08	352.64	353.13	358.83	313.50	328.46	181.49	166.11	133.70	131.28	110.92	107.59	91.84	83.50	77.78	67.47	64.83	65.18	78.62	75.31	90.09	82.63	89.11	100.81	101.47
Production of Mineral Products	g I-TEQ	9.28	7.73	7.06	7.17	8.12	7.99	7.90	8.93	4.82	5.63	5.02	5.28	2.33	2.53	25.02	2.03	1.84	2.03	1.61	1.70	3.18	1.30	1.17	2.45	1.60
Transportation	g I-TEQ	176.22	158.29	144.07	129.04	117.94	106.27	96.88	89.12	75.25	55.64	27.24	26.62	25.89	25.74	25.97	25.89	26.57	25.52	25.71	24.44	22.96	21.68	19.95	18.34	16.92
Open Burning Processes	g I-TEQ	114.99	106.83	93.55	58.74	58.00	58.01	58.02	58.03	58.04	58.05	58.06	58.07	58.08	58.09	58.10	58.11	42.91	33.49	32.61	32.62	32.64	32.65	32.66	32.68	32.68
Production of chemicals and consumer goods	g I-TEQ	5.01	5.49	5.35	4.77	4.51	3.66	3.62	2.49	1.88	1.26	0.80	1.09	1.08	1.08	1.04	1.16	1.13	1.17	1.18	1.03	1.09	1.24	0.92	1.30	1.06
Waste Disposal	g I-TEQ	2.39	2.40	2.40	2.41	2.42	2.49	2.50	2.50	2.47	2.39	2.32	2.27	2.24	2.10	1.92	1.80	1.68	1.56	1.42	1.21	1.03	0.91	0.80	0.70	0.62
Miscellaneous	g I-TEQ	62.30	56.76	56.65	53.45	52.29	60.99	55.74	50.49	47.36	52.78	48.18	51.46	52.54	57.33	45.95	43.64	44.38	41.90	38.90	32.28	21.66	21.95	20.73	20.65	18.80
Total	**g I-TEQ**	**1304.13**	**1276.56**	**1228.25**	**1035.53**	**815.50**	**843.41**	**574.58**	**528.01**	**433.03**	**399.19**	**328.89**	**320.46**	**290.10**	**285.90**	**298.53**	**263.03**	**240.95**	**224.26**	**232.45**	**213.73**	**234.45**	**213.94**	**214.72**	**223.77**	**217.48**

Annex 5 (A2): Emissions of dioxins and furans to land (g I-TEQ per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	g I-TEQ	1.10	1.11	1.10	1.14	1.09	1.11	1.11	1.12	1.10	1.11	1.09	1.07	1.09	1.11	1.06	1.06	1.04	1.04	1.06	1.03	1.03	1.03	1.06	1.09	1.09
Ferrous and Non Ferrous Metals	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	g I-TEQ	0.79	0.81	0.90	0.92	0.90	0.87	0.87	0.86	0.86	0.86	0.85	0.84	0.83	0.83	0.93	1.05	1.17	1.30	3.48	3.78	4.87	4.25	5.39	6.30	6.02
Production of Mineral Products	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	g I-TEQ	180.22	174.81	165.87	142.09	141.80	142.03	142.26	142.49	142.72	142.95	143.18	143.41	143.67	143.94	144.19	144.46	110.62	89.98	88.35	88.60	88.89	89.16	89.54	89.90	89.90
Production of chemicals and consumer goods	g I-TEQ	4.71	4.66	4.07	3.56	3.12	2.70	2.33	2.03	1.72	1.47	0.84	0.69	0.58	0.48	0.40	0.34	0.29	0.25	0.22	0.19	0.16	0.14	0.13	0.11	0.10
Waste Disposal	g I-TEQ	78.47	78.67	73.38	72.08	76.98	85.57	79.60	73.67	76.80	81.41	86.02	131.32	130.23	141.00	151.01	151.69	151.41	154.17	155.11	147.57	142.83	138.68	135.17	134.61	134.61
Miscellaneous	g I-TEQ	62.22	56.43	56.25	53.24	52.34	61.10	56.00	51.00	47.85	53.39	49.12	52.41	56.29	64.20	49.63	47.12	47.69	46.62	44.18	37.75	27.33	27.66	26.72	26.74	26.82
Total	**g I-TEQ**	**327.51**	**316.48**	**301.57**	**273.03**	**276.23**	**293.38**	**282.18**	**271.16**	**271.05**	**281.19**	**281.10**	**329.74**	**332.70**	**351.55**	**347.23**	**345.72**	**312.21**	**293.36**	**292.38**	**278.92**	**265.11**	**260.93**	**258.02**	**258.75**	**258.54**

Annex 5 (A3): Emissions of dioxins and furans to water (g I-TEQ per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	g I-TEQ	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	g I-TEQ	0.22	0.19	0.20	0.20	0.23	0.24	0.24	0.24	0.22	0.21	0.23	0.21	0.19	0.18	0.18	0.14	0.15	0.08	0.08	0.07	0.08	0.07	0.07	0.07	0.07
Heat and Power generation	g I-TEQ	1.99	1.99	2.02	2.04	2.22	2.17	2.20	2.21	2.10	2.00	2.01	2.03	2.04	2.05	2.08	2.05	2.08	2.07	2.07	2.05	2.05	2.05	2.05	2.08	2.08
Production of Mineral Products	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	g I-TEQ	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Production of chemicals and consumer goods	g I-TEQ	10.34	9.68	8.86	8.02	7.75	7.61	6.59	6.64	5.95	5.41	5.18	3.92	3.83	3.57	3.06	2.77	2.16	1.46	1.39	1.28	1.11	1.14	1.10	1.08	1.07
Waste Disposal	g I-TEQ	34.09	33.18	32.27	31.35	30.44	32.09	30.50	29.88	29.58	29.72	29.96	30.13	29.64	28.21	26.86	12.50	11.16	10.94	11.88	9.01	8.71	10.69	10.37	10.32	10.32
Miscellaneous	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**g I-TEQ**	**46.76**	**45.15**	**43.45**	**41.71**	**40.74**	**42.21**	**39.63**	**39.06**	**37.94**	**37.44**	**37.48**	**36.38**	**35.80**	**34.10**	**32.27**	**17.55**	**15.63**	**14.64**	**15.51**	**12.49**	**12.03**	**14.03**	**13.67**	**13.64**	**13.63**

Annex 5 (A4): Emissions of dioxins and furans to residue (g I-TEQ per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	g I-TEQ	316.95	313.79	300.85	266.15	194.79	177.76	194.14	3.53	3.70	3.77	3.84	3.90	3.97	3.44	2.91	2.38	1.86	1.96	2.03	1.89	1.94	1.76	1.51	1.51	1.07
Ferrous and Non Ferrous Metals	g I-TEQ	126.30	107.97	105.54	105.05	111.12	106.40	99.73	94.37	81.99	72.98	69.26	59.10	48.75	42.07	36.29	27.48	23.80	14.86	12.24	8.01	6.36	6.43	5.96	6.08	6.00
Heat and Power generation	g I-TEQ	70.04	70.04	67.06	58.58	61.38	60.21	56.30	52.67	57.18	50.76	53.61	57.64	56.97	60.64	58.52	58.85	65.08	61.80	60.97	60.13	63.38	64.42	81.58	81.13	83.34
Production of Mineral Products	g I-TEQ	5.35	4.56	4.13	4.21	4.69	4.52	4.61	4.72	4.72	4.54	4.35	4.01	4.07	3.97	3.99	3.93	3.95	3.87	3.47	2.54	2.62	2.80	2.49	2.68	2.67
Transportation	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	g I-TEQ	11.86	12.11	11.27	10.45	10.76	11.02	11.30	11.59	11.62	11.56	11.44	12.05	12.97	14.20	14.49	15.63	16.39	15.76	14.02	14.32	15.01	15.19	15.42	16.53	16.26
Waste Disposal	g I-TEQ	135.13	136.68	136.94	138.49	141.43	145.20	145.79	150.23	156.67	163.59	168.00	179.19	190.71	185.63	179.82	159.65	150.50	131.28	114.43	110.95	110.34	99.52	96.14	91.50	69.57
Miscellaneous	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**g I-TEQ**	**665.62**	**645.14**	**625.80**	**582.92**	**524.16**	**505.12**	**511.87**	**317.11**	**315.88**	**307.18**	**310.49**	**315.90**	**317.44**	**309.95**	**296.01**	**267.92**	**261.57**	**229.53**	**207.16**	**197.82**	**199.65**	**190.12**	**203.11**	**199.42**	**178.91**

Annex 5 (A5): Emissions of dioxins and furans to product (g I-TEQ per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	g I-TEQ	165.52	165.59	165.88	157.52	149.97	151.50	159.41	112.34	114.11	112.17	123.78	125.94	121.70	125.49	126.41	116.39	124.43	92.40	91.87	82.48	90.52	85.80	96.56	95.21	96.82
Transportation	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	g I-TEQ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**g I-TEQ**	**165.52**	**165.59**	**165.88**	**157.52**	**149.97**	**151.50**	**159.41**	**112.34**	**114.11**	**112.17**	**123.78**	**125.94**	**121.70**	**125.49**	**126.41**	**116.39**	**124.43**	**92.40**	**91.87**	**82.48**	**90.52**	**85.80**	**96.56**	**95.21**	**96.82**

Annex 5 (B1): Emissions of polychlorinated biphenyls to air (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	11.68	11.45	10.93	9.84	7.29	6.04	5.39	1.53	1.71	1.63	1.54	1.46	1.37	1.18	1.01	0.86	0.73	0.64	0.51	0.45	0.45	0.43	0.41	0.42	0.42
Ferrous and Non Ferrous Metals	kg	537.54	462.78	479.00	496.79	464.59	435.26	415.53	439.47	387.44	231.77	223.43	202.30	168.18	171.79	199.11	179.73	183.25	199.70	196.15	140.48	151.17	155.82	135.00	139.36	140.86
Heat and Power generation	kg	120.79	120.24	111.37	99.67	83.73	75.20	70.12	60.24	61.05	54.82	56.32	59.59	54.54	57.01	54.09	52.98	56.53	52.25	48.73	41.41	43.25	42.86	54.13	51.32	41.19
Production of Mineral Products	kg	1.54	1.50	1.32	1.33	1.19	0.98	0.95	0.86	0.64	0.65	0.54	0.50	0.44	0.40	0.33	0.27	0.28	0.26	0.35	0.24	0.23	0.26	0.18	0.26	0.25
Transportation	kg	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	126.20	126.06	125.82	125.14	125.14	125.17	125.19	125.21	125.23	125.26	125.28	125.31	125.34	125.36	125.38	125.41	99.68	83.73	82.25	82.27	82.30	82.33	82.36	82.39	82.43
Production of chemicals and consumer goods	kg	5670.95	5327.88	5010.44	4716.02	4421.78	4150.53	3899.98	3667.23	3451.01	3249.78	847.14	793.40	746.55	703.30	663.21	626.00	591.29	558.87	528.50	499.97	473.20	448.09	424.26	402.04	380.83
Waste Disposal	kg	112.64	112.94	105.47	103.65	98.94	96.89	78.25	61.45	52.35	43.00	32.26	43.46	38.61	35.63	32.93	27.76	22.46	17.46	12.03	6.16	2.86	2.72	2.59	2.46	2.41
Miscellaneous	kg	151.73	143.63	142.91	138.84	136.49	146.24	138.27	130.61	125.19	130.11	122.73	126.01	127.49	133.74	120.25	117.22	118.10	115.10	111.13	102.93	89.34	89.51	88.01	84.49	84.13
Total	**kg**	**6733.10**	**6306.52**	**5987.29**	**5691.29**	**5339.17**	**5036.33**	**4733.71**	**4486.62**	**4204.61**	**3837.02**	**1409.27**	**1352.03**	**1262.51**	**1228.40**	**1196.31**	**1130.23**	**1072.33**	**1028.02**	**979.64**	**873.91**	**842.80**	**822.03**	**786.95**	**762.75**	**732.50**

Annex 5 (B2): Emissions of polychlorinated biphenyls to land (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.44	0.48	0.43	0.47	0.41	0.30	0.30	0.29	0.27	0.28	0.23	0.22	0.17	0.15	0.13	0.10	0.10	0.11	0.16	0.16	0.19	0.18	0.21	0.23	0.22
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	56422.37	55790.95	48758.33	42691.71	37424.12	32279.82	27932.96	24253.91	20601.15	17613.23	10035.31	8295.80	6895.33	5761.63	4842.02	4094.35	3484.85	2986.46	2577.51	2240.66	1961.97	1730.29	1536.67	1373.92	1236.27
Waste Disposal	kg	345.25	346.16	322.87	317.15	338.69	376.53	350.23	324.17	337.93	358.20	378.48	475.12	424.09	408.12	382.47	329.30	273.91	223.13	168.36	106.79	59.99	58.25	56.77	56.54	56.54
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**56768.06**	**56137.60**	**49081.62**	**43009.32**	**37763.22**	**32656.65**	**28283.50**	**24578.36**	**20939.34**	**17971.72**	**10414.02**	**8771.14**	**7319.59**	**6169.89**	**5224.62**	**4423.75**	**3758.86**	**3209.70**	**2746.04**	**2347.61**	**2022.15**	**1788.72**	**1593.65**	**1430.69**	**1293.03**

Annex 5 (B3): Emissions of polychlorinated biphenyls to water (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	128.62	128.96	120.28	118.15	126.18	140.27	130.48	120.77	125.89	133.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**128.62**	**128.96**	**120.28**	**118.15**	**126.18**	**140.27**	**130.48**	**120.77**	**125.89**	**133.45**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Annex 5 (B4): Emissions of polychlorinated biphenyls to residue (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	8.27	8.17	7.71	7.25	6.79	6.32	5.86	5.40	5.43	5.47	5.50	5.53	5.57	4.75	3.95	3.16	2.39	2.50	2.57	2.34	2.39	2.15	1.84	1.82	1.23
Ferrous and Non Ferrous Metals	kg	32.01	27.34	28.25	29.14	29.62	30.50	28.69	30.42	26.54	25.28	24.91	22.49	18.45	17.98	21.54	19.03	19.27	21.32	21.29	15.16	16.96	17.81	14.71	14.19	14.49
Heat and Power generation	kg	16.54	16.69	15.81	13.62	12.58	11.67	10.58	9.37	9.34	8.16	8.76	9.47	8.78	9.45	9.03	9.23	10.09	9.24	8.64	7.33	7.71	7.73	9.91	9.10	9.64
Production of Mineral Products	kg	0.41	0.43	0.38	0.40	0.37	0.30	0.31	0.27	0.22	0.23	0.19	0.18	0.16	0.14	0.11	0.09	0.09	0.08	0.11	0.11	0.11	0.10	0.08	0.10	0.10
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.41	0.45	0.44	0.37	0.36	0.30	0.32	0.18	0.10	0.12	0.06	0.12	0.13	0.14	0.13	0.14	0.14	0.15	0.15	0.13	0.13	0.16	0.12	0.18	0.03
Waste Disposal	kg	1050.10	1062.75	1069.29	1083.17	1103.34	1127.34	1137.16	1178.72	1229.31	1282.56	1324.89	1380.85	1484.00	1443.32	1399.05	1256.21	1178.84	1018.02	904.77	876.06	870.81	782.63	755.76	717.54	536.58
Miscellaneous	kg	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**1107.78**	**1115.87**	**1121.91**	**1133.98**	**1153.09**	**1176.46**	**1182.95**	**1224.37**	**1270.96**	**1321.82**	**1364.32**	**1418.65**	**1517.08**	**1475.80**	**1433.82**	**1287.88**	**1210.83**	**1051.32**	**937.53**	**901.14**	**898.11**	**810.60**	**782.42**	**742.94**	**562.07**

Annex 5 (B5): Emissions of polychlorinated biphenyls to product (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	39.27	34.80	35.47	35.00	35.08	35.70	33.39	34.19	30.55	28.55	28.82	27.45	23.55	23.67	27.00	24.60	25.27	26.67	25.94	19.08	21.11	22.06	20.74	19.62	20.24
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**39.27**	**34.80**	**35.47**	**35.00**	**35.08**	**35.70**	**33.39**	**34.19**	**30.55**	**28.55**	**28.82**	**27.45**	**23.55**	**23.67**	**27.00**	**24.60**	**25.27**	**26.67**	**25.94**	**19.08**	**21.11**	**22.06**	**20.74**	**19.62**	**20.24**

Annex 5 (C1): Emissions of hexachlorobenzene to air (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	4.71	4.66	4.48	3.98	2.97	2.72	2.95	0.26	0.26	0.26	0.27	0.27	0.27	0.24	0.21	0.18	0.14	0.14	0.13	0.13	0.13	0.13	0.12	0.14	0.14
Ferrous and Non Ferrous Metals	kg	3047.00	3015.50	3479.36	4158.14	4833.64	5052.07	5056.00	5231.07	5541.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat and Power generation	kg	1.50	1.55	1.72	2.22	3.21	3.47	3.26	3.91	5.52	5.40	5.65	6.11	6.64	6.77	6.54	6.50	7.25	7.37	7.66	9.19	9.70	10.00	12.27	12.07	10.27
Production of Mineral Products	kg	0.15	0.12	0.11	0.11	0.13	0.13	0.13	0.13	0.14	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.07	0.08	0.08	0.07	0.08	0.08
Transportation	kg	0.81	0.79	0.79	0.76	0.71	0.72	0.76	0.80	0.81	0.62	0.54	0.55	0.45	0.51	0.57	0.60	0.74	0.70	0.80	0.76	0.66	0.72	0.62	0.60	0.55
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	699.16	639.54	622.03	403.21	220.84	232.38	230.63	135.65	127.46	85.13	70.80	61.17	56.12	51.28	64.98	61.70	56.69	47.42	43.21	24.13	22.74	13.54	11.05	8.05	10.44
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**3753.33**	**3662.16**	**4108.48**	**4568.43**	**5061.49**	**5291.49**	**5293.72**	**5371.82**	**5676.04**	**91.54**	**77.38**	**68.21**	**63.60**	**58.92**	**72.41**	**69.10**	**64.95**	**55.75**	**51.90**	**34.29**	**33.31**	**24.46**	**24.14**	**20.94**	**21.48**

Annex 5 (C2): Emissions of hexachlorobenzene to land (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	47.72	29.46	34.08	35.46	34.67	37.47	37.92	36.39	33.89	7.84	7.80	6.20	6.16	6.77	6.77	7.18	7.18	5.42	5.42	9.86	9.30	5.52	4.50	3.27	4.25
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**47.72**	**29.46**	**34.08**	**35.46**	**34.67**	**37.47**	**37.92**	**36.39**	**33.89**	**7.84**	**7.80**	**6.20**	**6.16**	**6.77**	**6.77**	**7.18**	**7.18**	**5.42**	**5.42**	**9.86**	**9.30**	**5.52**	**4.50**	**3.27**	**4.25**

Annex 5 (C3): Emissions of hexachlorobenzene to water (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	1.66	1.02	1.18	1.23	1.20	1.30	1.32	1.26	1.18	0.60	0.43	0.36	0.36	0.36	0.59	0.56	0.50	0.40	0.38	0.34	0.32	0.19	0.16	0.11	0.15
Waste Disposal	kg	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28	1.29	1.29	1.30	1.30	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.38	1.39	1.40	1.41	1.42
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**2.91**	**2.28**	**2.45**	**2.50**	**2.47**	**2.57**	**2.59**	**2.54**	**2.46**	**1.89**	**1.72**	**1.66**	**1.66**	**1.67**	**1.90**	**1.88**	**1.84**	**1.75**	**1.74**	**1.71**	**1.70**	**1.58**	**1.55**	**1.52**	**1.57**

Annex 5 (C4): Emissions of hexachlorobenzene to residue and product (kg per year)

No emissions to the residue or product vector have been reported for hexachlorobenzene.

Annex 5 (D1): Emissions of pentachlorobenzene to air (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	24.32	24.17	23.26	21.29	17.50	16.38	16.91	7.24	7.32	7.39	7.47	0.75	0.76	0.67	0.59	0.50	0.41	0.40	0.37	0.35	0.37	0.35	0.32	0.32	0.27
Ferrous and Non Ferrous Metals	kg	190.04	187.14	210.20	248.47	281.61	293.55	297.42	305.14	323.68	14.31	12.70	11.51	9.98	11.93	11.87	11.88	12.47	12.78	11.82	8.94	8.43	7.72	8.38	11.04	11.78
Heat and Power generation	kg	29.63	30.90	31.26	28.81	28.90	25.86	24.50	24.73	28.93	29.25	27.76	9.46	8.85	8.35	7.60	7.43	7.92	7.78	9.96	10.51	11.89	11.77	13.66	15.61	15.67
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.11	0.10	0.10	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.08	0.07	0.07	0.06	0.05	0.06	0.05	0.05	0.05
Production of chemicals and consumer goods	kg	57.40	54.36	51.83	49.32	46.79	44.35	42.16	40.06	38.07	65.30	42.85	42.25	41.70	9.62	9.09	8.60	8.14	7.71	7.31	6.92	6.55	6.19	5.86	5.54	5.23
Waste Disposal	kg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**301.51**	**296.68**	**316.67**	**347.99**	**374.92**	**380.25**	**381.11**	**377.28**	**398.10**	**116.36**	**90.88**	**64.08**	**61.40**	**30.68**	**29.26**	**28.51**	**29.04**	**28.76**	**29.53**	**26.79**	**27.30**	**26.10**	**28.27**	**32.57**	**33.01**

Annex 5 (D2): Emissions of pentachlorobenzene to land (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	1.18	1.14	1.13	1.11	1.10	1.17	1.14	1.10	1.07	1.12	1.08	1.11	1.12	1.15	1.07	1.05	0.89	0.77	0.73	0.69	0.61	0.61	0.60	0.61	0.61
Production of chemicals and consumer goods	kg	114.66	108.62	103.04	97.74	92.45	87.38	82.66	78.19	73.96	81.92	30.34	16.44	15.60	14.81	14.06	13.34	12.66	12.02	11.41	10.83	10.29	9.76	9.27	8.80	8.36
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**115.83**	**109.76**	**104.17**	**98.86**	**93.55**	**88.56**	**83.79**	**79.28**	**75.03**	**83.04**	**31.42**	**17.55**	**16.72**	**15.96**	**15.13**	**14.40**	**13.55**	**12.79**	**12.15**	**11.52**	**10.89**	**10.38**	**9.88**	**9.41**	**8.97**

Annex 5 (D3): Emissions of pentachlorobenzene to water (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.45	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	2.90	2.90	2.91	2.91	2.92	2.92	2.93	2.94	2.94	2.95	2.96	2.98	3.00	3.01	3.02	3.04	2.96	2.94	2.88	2.89	2.92	2.96	2.98	3.00	3.02
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**2.94**	**2.94**	**2.94**	**2.95**	**2.95**	**2.96**	**2.97**	**2.97**	**2.98**	**3.40**	**3.41**	**2.98**	**3.00**	**3.01**	**3.02**	**3.04**	**2.96**	**2.94**	**2.88**	**2.89**	**2.92**	**2.96**	**2.98**	**3.00**	**3.02**

Annex 5 (D4): Emissions of pentachlorobenzene to residue (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	2.15	2.12	2.03	1.82	1.42	1.31	1.36	0.35	0.34	0.34	0.33	0.33	0.32	0.27	0.22	0.18	0.13	0.13	0.13	0.12	0.12	0.11	0.09	0.09	0.06
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.57	0.59	0.66	0.83	1.20	1.29	1.19	1.42	2.01	1.96	2.06	2.23	2.43	2.47	2.39	2.37	2.64	2.68	2.78	3.34	3.50	3.63	4.47	4.69	4.70
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**2.73**	**2.72**	**2.68**	**2.65**	**2.62**	**2.60**	**2.56**	**1.76**	**2.35**	**2.30**	**2.39**	**2.56**	**2.75**	**2.74**	**2.61**	**2.55**	**2.78**	**2.82**	**2.91**	**3.45**	**3.62**	**3.73**	**4.56**	**4.78**	**4.76**

Annex 5 (D5): Emissions of pentachlorobenzene to product (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.58	0.59	0.60	0.62	0.63	0.64	0.66	0.50	0.66	0.65	0.68	0.73	0.79	0.79	0.76	0.75	0.80	0.81	0.82	0.96	1.03	1.05	1.27	1.31	1.33
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**0.58**	**0.59**	**0.60**	**0.62**	**0.63**	**0.64**	**0.66**	**0.50**	**0.66**	**0.65**	**0.68**	**0.73**	**0.79**	**0.79**	**0.76**	**0.75**	**0.80**	**0.81**	**0.82**	**0.96**	**1.03**	**1.05**	**1.27**	**1.31**	**1.33**

Annex 5 (E1): Emissions of polychlorinated naphthalenes to air (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	30.41	30.13	28.94	25.75	19.21	16.15	20.79	1.24	1.10	1.10	1.10	1.11	1.11	1.00	0.88	0.76	0.65	0.61	0.54	0.50	0.54	0.53	0.50	0.44	0.45
Ferrous and Non Ferrous Metals	kg	20.04	17.46	18.37	19.39	20.26	20.86	20.05	21.14	19.12	18.58	17.96	16.79	14.43	14.04	15.83	14.43	14.60	14.66	14.48	10.50	11.46	11.86	10.86	9.94	10.27
Heat and Power generation	kg	6.35	6.42	7.81	11.21	17.60	17.62	20.76	21.44	22.44	21.71	22.61	24.48	26.47	26.97	25.98	25.79	28.96	29.42	30.62	37.09	39.13	42.57	56.85	51.77	52.92
Production of Mineral Products	kg	3.14	2.58	2.35	2.38	2.74	2.70	2.76	2.89	2.99	2.86	2.77	2.56	2.44	2.48	2.52	2.44	2.47	2.11	1.98	1.84	1.91	2.06	1.92	1.99	1.99
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	566.98	532.66	500.92	471.50	442.08	414.97	389.91	366.67	345.07	324.95	84.70	79.31	74.62	70.29	66.29	62.56	59.09	55.85	52.81	49.96	47.28	44.76	42.39	40.15	38.04
Waste Disposal	kg	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25	0.25	0.24	0.23	0.22	0.21	0.19	0.28	0.24	0.19	0.15	0.11	0.10	0.09	0.08	0.08
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**627.18**	**589.50**	**558.65**	**530.49**	**502.15**	**472.56**	**454.53**	**413.64**	**390.98**	**369.45**	**129.39**	**124.48**	**119.29**	**114.99**	**111.70**	**106.18**	**106.04**	**102.88**	**100.62**	**100.05**	**100.43**	**101.89**	**112.63**	**104.37**	**103.74**

Annex 5 (E2): Emissions of polychlorinated naphthalenes to land (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	2043.54	1842.16	1667.10	1514.35	1361.61	1231.18	1119.06	1022.00	937.40	863.15	284.99	254.75	229.67	208.27	189.89	173.99	160.12	147.96	137.20	127.63	119.04	111.31	104.29	97.89	92.03
Waste Disposal	kg	25.40	25.20	24.48	24.24	25.08	26.52	25.28	32.20	28.63	28.87	27.13	36.11	39.27	41.71	40.23	36.22	30.29	27.21	24.08	18.28	14.00	10.02	5.31	5.67	5.67
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**2068.94**	**1867.36**	**1691.58**	**1538.59**	**1386.69**	**1257.70**	**1144.34**	**1054.20**	**966.03**	**892.03**	**312.12**	**290.86**	**268.94**	**249.99**	**230.12**	**210.20**	**190.42**	**175.17**	**161.28**	**145.91**	**133.04**	**121.33**	**109.60**	**103.56**	**97.69**

Annex 5 (E3): Emissions of polychlorinated naphthalenes to water (kg per year)

No emissions have been reported to water for polychlorinated naphthalenes.

Annex 5 (E4): Emissions of polychlorinated naphthalenes to residue (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
Ferrous and Non Ferrous Metals	kg	51.61	43.61	42.40	42.20	45.79	44.32	41.44	39.14	33.89	30.18	28.94	24.36	20.11	17.00	14.84	10.51	8.73	4.30	3.09	1.57	0.60	0.61	0.65	0.56	0.56
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**51.66**	**43.66**	**42.45**	**42.25**	**45.84**	**44.37**	**41.48**	**39.18**	**33.93**	**30.22**	**28.98**	**24.41**	**20.16**	**17.04**	**14.87**	**10.53**	**8.76**	**4.33**	**3.11**	**1.59**	**0.62**	**0.63**	**0.67**	**0.57**	**0.57**

Annex 5 (E5): Emissions of polychlorinated naphthalenes to product (kg per year)

Stockholm Convention Categories	Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Incineration	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ferrous and Non Ferrous Metals	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heat and Power generation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of Mineral Products	kg	13.74	14.45	17.12	20.43	26.30	29.97	32.83	36.22	36.55	37.98	42.76	42.31	41.42	41.94	44.52	38.88	41.43	26.78	27.84	24.45	28.10	26.21	26.92	25.40	25.40
Transportation	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open Burning Processes	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Production of chemicals and consumer goods	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Disposal	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**kg**	**13.74**	**14.45**	**17.12**	**20.43**	**26.30**	**29.97**	**32.83**	**36.22**	**36.55**	**37.98**	**42.76**	**42.31**	**41.42**	**41.94**	**44.52**	**38.88**	**41.43**	**26.78**	**27.84**	**24.45**	**28.10**	**26.21**	**26.92**	**25.40**	**25.40**