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MINISTRY OF ENVIRONMENT

Study Report
Prepared for the project:

Promotion of Strategies to Reduce Unintentional Production of POPs in the Red Sea and Gulf of Aden (PERSGA) Coastal Zone

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Regional Organization for the Conservation of Environment of the Red Sea and Gulf of Aden (PERSGA)

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Project team

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CONTENT

SUMMARY

This report adopted the method described herein as a means of tools aimed at the preparation of the inventory process through the use of the model prepared by the secretariat of Stockholm Convention. The working team has adequate experience and inventory for Yemen in 2005. Through the program of the training course the working groups were able to pool the required information from the sources and estimate the quality and quantity of releases as dioxins and furans.

The information was collected by Mr. Salim Baquhaizel and assisted by Abdulla Abu Alfotooh in several trips to different provinces of Yemen.

Most of the subcategories of primary sources were tackled. Many source categories do not exist in Yemen, especially the most dangerous ones such as chlorinated phenols, chloranil among others.

Table 1: Categories of primary sources, and annual releases in gram Total Equivalent/year (g TEQ/a).

o	Subcategories of Main Category	Potential Release Route				
		Air	Water	Land	Product	Residue
1	Waste Incineration	16،969	0،000	0،000	0،000	30،188
2	Ferrous Metal -errous and NonF Production	124،783	0،000	0،000	0،000	43،012
3	Heat and Power Generation	1،441	0،000	0،000	0،000	0،105
4	Production of Mineal Products	14.77	0،000	0،000	0	0،000
5	Transport	3،866	0،000	0،000	0،000	0،000
6	sesOpen Burning Proces	136،425	0،000	231،151	0،000	0،000
7	Production and Use of Chemicals and Consumer Goods	0،000	0،000	0،000	0،034	0،000
8	Miscellaneous	0،001	0،000	0،000	0،000	0،195
9	Disposal	0،000	0،299	0،000	2،446	3،298
10	Identification of Potential Hot-Spots				0،000	0،000
	Total	**283،484**	**0،299**	**231،151**	**2،480**	**76،798**
	Grand Total					**594**

This report has been prepared under the responsibility of PERSGA to protect the environment and resources from the persistent organic pollutants (POPs).

The inventory of sources and quality of release of dioxins and furans was implemented mainly in coastal governorates of the Republic of Yemen, with funding from PERSGA. Table (1) summarizes the categories of primary sources, the annual releases in the Republic of Yemen as obtained in the inventory of dioxins and furans emitted, in gram Total Equivalent/year (g TEQ/a).

1INTRODUCTION

More precisely, polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are two compounds falling within the twelve persistent organic pollutants stable in the environment, which are included in the Convention of POPs (Stockholm Convention). Dioxins and furans are considered typical persistent organic pollutants (POPs).

Dioxins and furans together with polychlorinated biphenyls (PCBs) and hexachlorobenzene, (HCB) are included as persistent organic pollutants in Annex (C) of the Stockholm Convention for POPs.

The Convention stipulates that all compounds listed in the Annex (C) of the Stockholm Convention on POPs require "further reduction to the minimum and wherever possible, get rid of them finally. "

Paragraph (a) of Article (5) of Stockholm Convention requires the development and implementation of an action plan to identify and characterize these compounds and exposure must include "the development and operation of the inventory of sources of these compounds and estimate their emissions".

Based on the report of the Commission on Tourism and Environment issued by the Yemeni Shura Council, dated September 2002, the air has become polluted, especially in the large cities and industrial areas. This is clearly reflected by the increasing amount of smoke and dust in addition to the invisible and non smell gases in the air. These contaminants arise from the processes of production, energy generation, transportation, household waste and residues, agricultural operations, quarries and other sources like moving wind in all directions and speed of movement, proliferation and the impact on the surrounding environment.

Requirements and needs of the growing population with rapid population growth and high rates reached 3.5 % in addition to the high levels of pollution associated with development activities and social sectors, particularly transport and energy.

The breadth of urban growth, proliferation, construction of many roads and the establishment of many factories have led to the seizure of large tracts of the finest types of agricultural soils adjacent to the urban centers. As long as population growth continues to increase dramatically, together with continuous migrations from the countryside to cities, urbanization will continue to expand and spread. This has meant that aggression on agricultural land will continue to be serious unless regulations are enforced that will direct the urban growth to non-agricultural land. This requires a serious government policy in the area of town planning.

Pesticides and chemical fertilizers used for agricultural production lead to the pollution of the soil, causing salinity. The use of waste materials in irrigation without purifications leads to the corruption of the soil as they still contain many chemicals that affect the soil, and make it unfit for cultivation.

The Environmental Action Program of the government has elevated in the 1990s and reflected in the establishment of the Environmental Protection Authority.

The government has also prepared the Environmental Protection Act and was promulgated No 26 for the year 1995; thus in Yemen the environmental issue became a priory. The government's interest in the affairs of the environment and natural protectorates has been reflected in the constitutional amendments. Article (35) of the amended Constitution provides that "the State's responsibility to protect the environment and society and is a religious and patriotic duty of every citizen." Ministry of Tourism and Environment was established in 2001, then the Ministry of Water and Environment was established in 2003, as well as the establishment of civil society organizations, which were represented in several associations for the protection of the environment.

In the area of studies and research, the Environmental Protection Authority has pursued more than twenty environmental studies and reports, in addition to the training and rehabilitation of some of the capabilities and expertise in this area, and a number of conventions and international protocols were signed.

The Republic of Yemen became an active member in many conventions, convinced by the importance of international and regional cooperation in this area.

This study has been initiated and supported by PERSGA in its continuous interest in following up the environmental issues in the region of the Red Sea and the Gulf of Aden.

2 METHODOLOGY

The work methodology followed collection of data through The Yemen Authority for Environmental Protection by Mr. Salim Baquhaizel and Mr. Abdulla Abulfotooh as local experts. The work was supervised and prepared by Prof. Ali El-Shekeil as a national consultant.

2.1 Formation of dioxins and furans

Dioxins and furans are formed inadvertently as secondary products in some processes and activities specified in annex (C) of the Stockholm Convention, in addition to the fact that the compounds of dioxins and furans are formed in-intentionally in industrial processes and discharges. They could inter into the operations as pollutants in raw materials involved in an industrial process and thus could exist within the process even when not formed. There are two methods of preparation of dioxins and furans:

2.2 Formation in thermal processes through two basic mechanisms

1. The manufacturing mechanism known as De Novo in which they are formed by non-extracted carbon structures and this does not correspond to the final product of dioxins and furans.

2. Through interactions of causing substances through aromatic radicals derived from oxidation and other chemical processes.

Conditions of formation of the compounds of dioxins and furans in the thermal processes are:

1. High temperature (cooling period of 200-450 ^{0}C), or incomplete combustion.
2. The presence of non-organic carbon.
3. The presence of free chlorine.
4. Products containing dioxin and furan compounds.

2.2.1 Formation in wet chemical processes

Conditions of formation of dioxins and furans from chemical processes are:

1. High temperature (higher than 150 ^{0}C).
2. Basic medium conditions (especially during purification processes).
3. UV or free radicals.

The main sources where dioxins and furans are evolved directly:

- Air.
- Water.
- Land residues (waste liquid, sludge, and solid residues that are handled and disposed of as waste, or perhaps recycled).
- Products like chemical structures and consumer goods such as textile and paper.

The following operations are responsible for sources emissions of dioxins and furans compounds:

- Chemical production processes such as production of phenols, chlorine, oxidation of foodstuffs and chlorinated solvents.
- Thermal and combustion processes, such as producing ash from wastes, burning of liquid and solid fuel and metal processing.
- Biological processes.
- Warehouses sources such as sites of old waste dumping, soils and polluted sediments, which accumulate over a long period.

Evolution of dioxins and furans in the air result from the following processes:

- Combustion processes.
- Manufacturing processes for metal casting and smelting.
- Drying and roasting operations: homes of roasting and meat smoking.
- Other industrial thermal processes, heat destruction, ash recycling, thermal pyrolysis.

Emission of dioxins and furans in water result from the following processes:

- Burning of wastewater produced from paper pulp industry particularly using elemental chlorine.
- Burning of wastewater from chemical processes using elemental chlorine.
- Burning wastewater containing preservative and dyes.
- Burning waste materials from natural processes of household: washing machines and washing and ironing of clothes.

Evolution of dioxins and furans to soil result from the following processes:

- Use of waste products contaminated with dioxins and furans, pesticides, wood preserving materials.
- Use of sewage sludge in irrigation of agricultural areas and use of fermented waste.
- Disposal of waste containing dioxins and furans directly such as ash remaining after combustion and open burning on the ground.

Evolution of dioxins and furans in waste result from the following processes:

- Emissions from remnants result from:
- Garbage and waste (municipal, industrial, hazardous and medical).
- Waste resulting as by-product from combustion and thermal processes (volatile ash).
- Remnants of production processes and residual products (deposits, the remnants of production, chemical and sludge from sewage treatment: pesticides' waste and used electrical transformer oils).

Emissions from secondary categories of dioxins and furans:

- Secondary groups to produce ferrous and non-ferrous metals.
- Secondary groups of power, heating and cooking e.g. fossil fuels, solar energy, wind, electricity and nuclear energy.
- Production of mineral materials like asphalt, brick, ceramics, lime, cement.
- Transport vehicles fuel (leaded or lead-free gasoline, diesel oil, light or heavy fuel).
- Secondary categories of burning waste.
- Uncontrolled combustion processes (raw materials, materials containing chlorine).
- Production and use of chemicals and consumer goods (certain raw materials).
- Disposal of waste (sewage sludge and landfill of waste oils).

Hot points including production of chlorinated organic compounds, production of chlorine using chlorinated phenols, wood manufacturing and processing, electrical transformers and condensers filled with PCB, waste disposal landfill, extracting sediment sites and related accidents, ceramic and porcelain sites.

Miscellaneous: drying processes, the burning of wood for fuel, textile, leather, the burning of animal carcasses and smoking

3 RELEASE ESTIMATES IN THE MAIN CATOGERIES

The release estimates into the main source categories will be detailed in the following paragraphs.

3.1 Main category 1- Waste Incineration:

3.1.1 Municipal solid waste incineration

Currently there are no incinerators to burn municipal solid waste in Yemen. In other words, no provision was noticed. Burning of solid municipal waste will be covered elsewhere in this study.

3.1.2 **Hazardous waste incineration**: Not monitored**.**

3.1.3 Light–fraction shredder waste incineration:

3.1.3.1 General information

Non-controlled sporadic combustion, without a system for controlling air pollution

The National Company of Industry and Commerce: Taiz Governorate, Alhouban, Ha-el Said.

3.1.3.2 Activity data

Two light–fraction shredder waste incinerators were watched, operating continuously (24) hours/day, 6 days/week. The number of working days is 320 days/year. Each incinerator burns 1 ton/day i.e. 320 tons/year. Total amount burnt is 640 tons/year.

Quantity of ash is 20 tons/year for the two incinerators. Ashes are disposed of by burying. Wastewater is treated through a treatment station, and sludge is disposed of by burying.

3.1.3.3 Factory of packaging (The Industrial Complex):

3.1.3.3.1 Activity data

Three incinerators were found for light-fraction waste incineration working semi-continuously at 8 hours/day.

- Total number of operating hours is 16 hours/day.
- Number of operating days per week is 6 days/week.
- Number of working days per year is 280 days/year.
- Incinerator I: burns 2.4 tons/day = 672 tons/year.
- Incinerator II: burns 2.4 tons/day = 672 tons/year.
- Incinerator III: burns 1.6 tons/day = 448 tons/year.
- Total amount burned is 1792 tons/year.

Controlled by low air pollution, every incinerator has one main room temperature of 1000 degrees Celsius.

The quantity of ash is 156 tons/year. For the three incinerators, the disposed of ashes are buried. The wastewater is treated in a treatment station, and sludge disposed of would be buried.

Table (3) illustrates the light–fraction shredder waste incineration, Taiz Governorate, annual emissions (g TEQ/t).

- Total quantity of light–fraction shredder waste incineration in Taiz Governorate/year = 2432 tons/year.

3.1.3.3.2 Emission factors

- Total annual releases of dioxins and furans to air resulting from the total quantity of light–fraction shredder waste incineration in Taiz Governorate per annum is $1792x50x10^{-6} + 640x1000x10^{-6} = 0.73$ g TEQ/a.

3.1.3.3.3 Result

Table (3): Light–fraction shredder waste incineration, Taiz Governorate, annual emissions (g TEQ/a).

No.	*Factory*	*Incinerator 1 T/a*	*Incinerator 2 T/a*	*Incinerator 3 T/a*	*Annual Production T/a*	*Possible releases (µg TEQ/a)*	*Annual releases (g TEQ/a)*
						Air	Air
1	No. 1	320	320		640	1000	0.64
2	No. 2	672	672	448	1792	50	0.09
			Total		2432		0.73

Light fraction in Taiz is controlled and calculated as potential releases to air 50 for the 1792 t/a but calculated as 1000 for the non-controlled 640 t/a giving a total of 0.73 g TEQ/a.

3.1.3.3.4 Incomplete information

There is no incomplete information

3.1.4 Sewage sludge incineration: Not monitored.

3.1.5 Waste wood and biomass incineration:

3.1.5.1 General information

Old furnaces, with intermittent system, there is no or only little use of air pollution control equipment. Table (4) summarizes the burning of waste wood and biomass and the annual releases.

3.1.5.2 Activity data

- Total burning of waste wood and biomass in Taiz/year = 25000 tons/year.
- Total annual releases furans and dioxins into the air resulting from burning of waste wood and biomass in Taiz/year = $25000 \times 100 \times 10^{-6}$ = 2.5 g TEQ/a.

3.1.5.3 Emission factors

- Total annual releases of dioxins and furans to the remnants furans and volatile ashes resulting from the burning of waste wood and biomass in Taiz/year = $25000 \times 1000 \times 10^{-6}$ = 25 g TEQ/a.

3.1.5.4 Result

Table (4): Burning of waste wood and biomass and annual releases.

Province	*Annual Production*	*Possible annual releases (µg TEQ/a)*		*Annual releases (g TEQ/a)*	
		Air	Residue/volatile ash	Air	Residue/volatile ash
Taiz	25000	100	1000	2.5	25

3.1.5.5 Incomplete information

There is no incomplete information

3.1.6 Animal carcasses burning: Not monitored

3.1.7 Medical waste incineration:

A number of hospitals in some coastal provinces have working incinerators, namely: Taiz, Abyan, Hajja and Lahj. They all have un-controlled intermittent combustion, without a system for controlling air pollution. Combustion controlled by the kind of intermittent, well-controlled air pollution was noticed in Lahj, Khaldoon Hospital:

3.1.7.1 Taiz:

3.1.7.1.1 General information

- There is an incinerator in Khalifah General Hospital in the city of Turbah. It works for a period ranging between 3 and 12 hours per day.
- Number of beds is 100.

3.1.7.1.2 Activity data

- Quantity of waste generated = 2.43 kg / bed / day
- Quantity of waste generated 87.84 tons / year.
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3.1.7.1.3 Emission factors

- Quantity emission of dioxin and furans to air / year = 40,000 x 10^{-6} x 87.84 = 3.51 g TEQ/a.
- Quantitative emission of dioxins and furans to residues (ashes) / year = 200 x 10^{-6} x 87.84 = 0.018 g TEQ/a.
-

3.1.7.2 Abyan

3.1.7.2.1 General information

There is an incinerator in Razi Hospital; it burns (50) kg / hour of waste and is operated 4 hours / day.

3.1.7.2.2 Activity data

- Quantity of waste burned = 50 x 4 = 200 kg / day.
- It is operated (6) days a week.
- It is operated (312) days / year.
- Quantity of waste burned each year = 312 x 200 = 62.4 tons / year.
- The incinerator is a room, where the main room temperature is 200 C.

3.1.7.2.3 Emission factors

- Quantity of emission of dioxins and furans to air/year = 62.4x40000 x10^{-6} = 2.50 g TEQ/a.
- Quantitative emission of dioxins and furans of residues (ashes)/year = 62.4x200x10^{-6} = 0.0125 g TEQ/a.

3.1.7.3 Hajja:

3.1.7.3.1 General information

The incinerator in the Saudi German Hospital is sporadic.

3.1.7.3.2 Activity data

- It works for 5 hours/day.
- The total number of operating days is 240 days/year

- Quantity of medical waste burned = 120 tons/year.
- The incinerator's main room temperature range is 450-600 C.
- Quantity of ash generated = 2.4 tons / year.

3.1.7.3.3 Emission factors

- Quantity of emission of dioxins and furans to air/year =120x40000x10^{-6} = **4.80 g TEQ/a.**
- Quantity of emission of dioxins and furans of residues (ash)/year = 120 x 200x10^{--6}= 0.024 g TEQ/a.

3.1.7.4 Lahj:

3.1.7.4.1 General information

Combustion controlled by the kind of intermittent, well controlled air pollution:

3.1.7.4.2 Activity data

There is an incinerator in Ibn Khaldoon hospital burning (15.5) tons/day.

- Quantity of waste burned annually = 15.5x360 = 5580 tons/year.
- Incinerator operates as system rooms, where the main room temperature is 1200 C, and the secondary room temperature 850 C.
- Length of the chimney is 8 meters, diameter 300 mm.
- Incinerator uses diesel fuel 15 liters/day.
- Quantity of diesel is 5400 liters/year.

3.1.7.4.3 Emission factors

- Quantity of dioxins and furans emission to air/year = 525x5580x10^{-6} = 2.93 g TEQ/a.
- Quantitative emission of dioxins and furans to residues (ash)/year = 920 x5580x10^{-6} = 5.134 g TEQ/a.

3.1.7.5 Result

Table (2) summarizes the medical waste monitored in some hospitals in the four governorates and their annual releases (g TEQ/t).

Total quantity burnt is 5830 tons/year. There are six working incinerators. Some incinerators were seen in each of Mukalla and Hodaida but were not operational due to a shortage of spare parts and lack of qualified technical cadre.

Table (2): Medical waste monitored in some hospitals in four coastal governorates and their annual releases (g TEQ/a).

No	*Governorate*	*Hospital*	*Quantity t/a*	*Annual releases (g TEQ/a)*		
				Air	Lower ash	Volatile ash

	Un-controlled combustion, intermittent, and without a system for controlling air pollution					
1	Taiz	Khalifa General	87.84	3.51	0.018	
2	Abyan	Razi	62.4	2.50	0.0125	
٣	Hajja	Saudi German	120	4.80	0.024	
	Total		270.24	10.81	0.0545	
	Combustion controlled by the kind of intermittent, good governing air pollution					
4	Lahj	Ibn Khaldoon	5580	2.93	0.05	5.19
	Grand total		5850.24	13.74	0.055	5.19

3.1.7.6 Incomplete information

There is no incomplete information

3.2 MAIN CATEGORY 2 – FERROUS AND NON-FERROUS METAL PRODUCTION

3.2.1 Iron ore sintering:

3.2.1.1 General information

High waste recycling, including oil-contaminated materials.

A new plant to produce iron in Aden through the process of recycling of scrap iron is seen.

3.2.1.2 Activity factors

The amount of recycled iron is 120,000 tons/year. Table 5 shows the production of iron and annual releases.

3.2.1.3 Emission factors

Total annual releases of furans and dioxins into the air resulting from the production of recycled iron/year = 150225x20x10^{-6} = 3.01 g TEQ/a

3.2.1.4 Result

Table (5): Production of iron in some coastal governorates and annual releases.

No.	*Plant*	*Gover.*	*Production t/a*	*Potential release route (µg TEQ/t)*		*Annual release g TEQ/a*	
				Air	Residues	Air	Residues
1	Cooling tanks factory	Hodaida	6900	20	0.003	0.138	0
2	Iron fences and pipes factory	Taiz	4800	20	0.003	0.096	0
3	Iron bags and furniture factory	Taiz	1050	20	0.003	0.021	0
4	Blades Factory	Taiz	75	20	0.003	0.002	0
5	Zenit factory for iron pipes	Hodaida	7500	20	0.003	0.15	0
6	Iron wire factory	Hodaida	9900	20	0.003	0.198	0
7	Aden steel	Aden	120000	20	0.003	2.4	0.0005
	Total		150225	20	0.003	3. 01	0.0005

3.2.1.5 Incomplete information

There is no incomplete information

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3.2.2 Charcoal production: No gas cleaning:

3.2.2.1 General information

Charcoal is one of the daily goods consumed in large quantities in Yemen. A number of factories in some governorates were observed. It is well known that the amount allocated to the factories do not represent all the factories and quantities produced, since coal is used in many great applications, ranging from use of hubble-bubble (Almadah) and cooking as one of the best ways of cooking especially meat, fish, chicken, etc.

3.2.2.2 Activity data

- Total quantity of wooden coal production/year = 784829 tons/year.
- Total annual releases of furans and dioxins into air resulting from

3.2.2.3 Emission factors

- Production of wooden coal/year = 784829x3x10^{-6} = 2.54 g TEQ/a.
- Total annual releases of dioxins and furans to water resulting from production of wood coal/year = 784829x0.06x10^{-6} = 0.05 g TEQ/a.

3.2.2.4 Result

Table (6) summarizes the wooden-charcoal producing regions.

Table (6): Production of wood charcoal in some coastal governorates and annual releases.

No	*Province*	*Production of wooden coal*	*Possible release route µg TEQ/a*		*Annual releases g TEQ/a*	
			Air	Water	Air	Water
1	Taiz	12960	3	0.06		
2	Hodaida	38880	3	0.06		
3	Lahj	38880	3	0.06		
4	Shabwa	170280	3	0.06		
5	Mukalla	340589	3	0.06		
6	Hajja	170280	3	0.06		
	Total	771869	3	0.06	2.54	0.05

3.2.2.5 Incomplete information

There is no incomplete data

3.2.3 Iron and steel production plants

3.2.3.1 General information

Dirty scrap, scrap preheating, limited controls.

3.2.3.2 Result

Table (7) shows the iron foundries production and annual releases.

Table (7): Iron foundries production in some coastal governorates and annual releases.

No.	Plan	Province	Production	Potential release route µg TEQ/a		Annual release g TEQ/a	
			t/a	Air	Residues	Air	Residues
1	Diff. iron products factory	Hodaida	10500	10	15		
2	Diff. metal formation	Aden	12000	10	15		
3	Collection, pressing and export	Hodaida	36000	10	15		
4	Construction iron rods	Abyan	39000	10	15		
5	United Co. for metal industries	Aden	120000	10	15		
6	Agric. and metal Equipment	Aden	40500	10	15		
	Total		258000	10	15	2.35	3.87

3.2.3.3 Incomplete information

There is no incomplete data

3.2.4 Copper production

3.2.4.1 General information

A factory for producing electrical cables was observed in Abyan governorate, located on the Gulf of Aden and another in the governorate of Taiz. Table (8) shows the production of cables plants and copper wires and annual releases.

3.2.4.2 Activity data

- Total production = 61970 t/a.
- Total annual releases of furans and dioxins into the air resulting from

3.2.4.3 Emission factors

- production of electrical cables/year = $61970 \times 800 \times 10^{-6}$ = 49.58 g TEQ/a.
- Total annual releases of furans and dioxins to residues resulting from production of electrical cables/year = $61970 \times 630 \times 10^{-6}$ = 39.04 g TEQ/a.

3.2.4.4 Result

Table (8): Production of cables plants and copper wires in some coastal governorates and annual releases.

No.	Plant	Province	Production t/a	Potential Release Route (µg TEQ/t)		Annual release g TEQ/a	
				Air	Residue	Air	Residue
1	Electric cables	Abyan	26100	800	630	20.88	16.40
2	Yemen cable & wire	Taiz	35870	800	630	28.97	22.60
	Total		61970	800	630	49.58	39.04

3.2.4.5 Incomplete data

There is no incomplete data

3.2.5 Aluminum production

3.2.5.1 General information

Processing scrap aluminum is characterized by minimal treatment of inputs, simple dust removal and extrusion production:

Over ten factories were found engaged in the production and formation of ready aluminum metal, recycled and imported. At the same time, these aluminum-recycling plants collect and reproduce it locally.

3.2.5.2 Activity data

- Quantity collected from scrap aluminum is about 500 tons/year.

3.2.5.3 Emission factors

- Total annual releases of dioxins and furans to the air resulting from the production of recycled aluminum/year = $500x150x10^{-6}$ = 0.08 g TEQ/a.
- Total annual releases of dioxins and furans resulting to remnants of minerals recovered from wire/year = $500x200x10^{-6}$ = 0.10 g TEQ/a.

3.5.6 Lead production:

3.5.6.1 General information

There are two factories outside Hodaida in the direction of Hodaida-Taiz road. They are extracting lead from scrap car batteries containing (PVC). Table (9) summarizes the production of secondary lead scrap containing PVC in Hodaida Governorate, and annual releases to air.

3.2.6.2 Activity data

- Total quantity of secondary lead produced from scrap containing PVC in the province of Hodaida = 284473 tons/year.

3.2.6.3 Emission factors

- Total annual releases of dioxins and furans into air resulting from the secondary lead produced from scrap, containing PVC in the province of Hodaida are $284473 \times 80 \times 10^{-6} = 22.76$ g TEQ/a.

3.2.6.4 Result

Table (9): Production of secondary lead scrap containing PVC in Hodaida Governorate, and annual releases to air.

No.	*Plant*	*Production t/a*	*Potential Release Route (µg TEQ/t)*	*Annual release g TEQ/a*
			Air	Air
1	Factory (1)	170683.8	80	13.66
2	Factory (2)	113789.2	80	9.10
	Total	284473	80	22.76

3.2.6.4 Incomplete information

There is no incomplete data

3.2.7 Zinc production:

3.2.7.1 General information

Kiln with no dust control. Table (10) shows the zinc production in Hodaida plant and annual releases to air.

3.2.7.2 Result

Table (10): Zinc production in Hodaida plant and annual releases to air.

Province	*Annual production t/a*	*Potential release route (µg TEQ/t)*	*Annual release g TEQ/a*
		Air	Air
Hodaida zinc national factory	3600	1000	3.60

3.2.8 Brass and bronze production*:* Not monitored

3.2.9 Magnesium production*:* Not monitored.

3.2.10 Thermal non-ferrous mental production: Not monitored

3.2.11 Shredders: Not monitored

3.2.12 Thermal wire reclamation:

Open burning of cable.

Nine sites were monitored in the coastal areas, in the Governorates of Taiz, Hodaida, Hadhramout coast (Mukalla), Shabwa, Lahj, Al-Mahra, Hajja and Abyan.

3.2.12.2 Hebron metals trading company (16 km):

3.2.12.2.1 General information

This company is located in the region of kilometer 16 at Hodaida. It is the largest company specializing in collection of metals and wires. The huge fenced ground pool metals and wires, as well as outside the ground. Significant amounts of minerals have been removed from associated materials such as plastic by burning inside the campus of the company. Fumes are seen rising from the inside every day and in very large quantities. Estimated quantities burned are more than one ton per day. Table (11) shows the restoration of metal wires, and annual releases to air.

Activity data

Total quantity of minerals recovered from wire = 8167 tons/year.

Emission factors

Total annual releases of dioxins and furans to air resulting from minerals recovered from wire/year = $8167 \times 5000 \times 10^{-6}$ = 40.84 g TEQ/a.

Result

Table (11): Restoration of metal wires in some coastal governorates and annual releases to air.

No.	*Province*	*Production t/a*	*Potential release route (µg TEQ/t)*	*Annual release g TEQ/a*
			Air	Air
1	Aden	576	5000	
2	Taiz	540	5000	
3	Hodaida	3600	5000	
4	Shabwa	2160	5000	
5	Mukalla	390	5000	
6	Lahj	250	5000	
7	Abyan	269	5000	
8	Hajja	195	5000	
9	Al-Mahra	187	5000	
	Total	8167	5000	40.84

3.2.12.2.5 Incomplete information

There is no incomplete data

3.3 MAIN CATEGORY NO 3 – HEAT AND POWER GENERATION

3.3.1 Fossil fuel power plants

3.3.1.1 Fossil fuel energy boilers and common waste incineration

3.3.1.1.1 General information

Table (12) shows the consumption of waste oils in some scattered plants in some governorates 2004 and annual releases.

3.3.1.1.2 Activity data

1 ton of waste oil = 1 ton of oil equivalent = 42 Gj.

3.3.1.1.3 Emission factors

Waste oil 35 to air. Cement factories fuel oil 2.5 to air

3.3.1.1.4 Result

Table (12): Consumption of waste oils in scattered plants in some coastal governorates in 2004 and annual releases.

No	*Province*	*Type of use*	*Waste t/a*	*Energy Tj*	*Potential release route (g TEQ/Tj)*	*Annual release (µg TEQ/Tj)*
1	Hodaida	Bajil cement (waste lube)	1566		35	
2	Mukalla	Lime production (waste lube)	777.6		35	
Total			2344	98.5		0.0003

3.3.1.2 Heavy fuel energy boilers

3.3.1.2.1 Activity data

- Total quantity of waste oil consumed in 2008 = 2344x42Gj = 98448Gj = 98.5 Tj
- Total annual releases of dioxins and furans into air resulting from waste oil = $35x10^{-6}x98.5 = 0.0003 = 0.0003$ g TEQ/a.

- Quantity of fuel oil consumed in cement factories = 78687396 liters/year in 2008.
- Quantity in liters x 0.00097 = quantity in tons

- Quantity of fuel oil consumed = 76327 tons/year = 76327x40 Gj = 3053 Tj.
- Quantity of fuel oil consumed in power stations = 1074992725 liters/year in 2008.
- Quantity of fuel oil consumed in power stations and cement factories = 104274 + 76327 tons/year = (104274+76327) x 40 Gj = 4170960 Gj = 4171 + 3053 Tj = 7224 Tj

3.3.1.2.2 Emission factors

- Annual releases to air of dioxins and furans from power stations and cement factories = 72210x 2.5x 4^{-6} = 0.02 g TEQ/a.

3.3.1.2.3 Result

- Total air releases from heavy fuels = 0.0003 + 0.02 = 0.02 g TEQ/a.

1 ton of heavy fuel oil equivalent to 40 Gj

3.3.1.2.4 Incomplete information

There is no incomplete data

3.3.1.3 Light fuel and natural gas boilers

3.3.1.3.1 Activity data

- Quantity of diesel consumed by electric power stations = 734410207 liters /year.
- Quantity of diesel consumed by electric power stations = 624249 tons/year = 624249 x 43 Gj = 26843 Tj.
- Quantity in liters x 0.00085 = quantity in tons.
- Amount of energy produced = 3149129.345 Mega Watt /year.
- Annual releases of dioxins and furans to air = 26843x0.5x10^{-6} = 0.01 g TEQ/a.

- Consumption of diesel by plants scattered in the governorates in 2008 = 6413310 liters.
- Consumption of diesel by plants scattered in the governorates = 5451 tons/year = 5451x43 Gj = 234 Tj.

3.3.1.3.2 Emission factors

- Annual releases to air of dioxins and furans = 234 x0.5x10^{-6} = 0.00011 g TEQ/a.

3.3.1.3.3 Result

- Total annual releases of dioxins and furans to air from diesel = + 0.01 0.00 = 0.01 gTEQ/a .

Diesel 43 Gj/ton. 0.5 to air in case of diesel

3.3.1.4 Incomplete information

There is no incomplete data

3.3.2 Biomass in Lime Production

3.3.2.1 General information

Table (13) summarizes the amount of consumption of biomass (clean wood) in lime production facilities in the governorate of Hadramawt coast, and the annual releases.

3.3.2.2 Activity data

1 Ton of fuel wood = 0.3215 toe = 41.868 x 0.3215 Gj = 13.461 Gj/ton

- Consumption of biomass (clean wood) in lime production facilities in Hadramawt coast = 468828 tons/year = 468828x13.46 Gj = 7032 Tj.

3.3.2.3 Emission factors

- Annual releases of dioxins and furans to air = $7032x50x10^{-6}$ =0.352 g TEQ/a.
- Annual releases of dioxins and furans to residues = $7032x15x10^{-6}$ =0.095 = 0.1 g TEQ/a.

3.3.2.4 Result

Table (13): Amount of consumption of biomass (clean wood) in lime production facilities in governorate of Hadramawt coast, and annual releases.

No	*Type of use*	*Quantity t/a*	*Energy Tj*	*Potential release route (g TEQ/a) air*	*Potential release route (g TEQ/a) residue*	*Annual release (µg TEQ/a) air*	*Annual release (µg TEQ/Tj) Residues*
1	Lime production (wood)	466560		50	15		
2	Lime production (palm leaves)	2268		50	15		
Total		468828	7032			0.352	0.1

3.3.2.5 Incomplete information

There is no incomplete data

3.3.3 Landfill and biogas combustion: Not monitored

3.3.4 Household heat and cooking – biomass

3.3.4.1 General information

Table (14) shows the amount of biomass (wood) used in cooking in coastal governorates, and annual releases. Stoves 100 to air, 10 to residues.

3.3.4.2 Activity data

- Quantity of wood consumed in Soso restaurants throughout the governorates = 671362 tons/year x 13.46 Gj = 9037 Tj.

3.3.4.3 Emission factors

- Annual releases to air of dioxins and furans = $9037 \times 10 \times 10^{-6}$ = 0.105 g TEQ/a.

3.3.4.4 Result

Table (14): Amount of biomass (wood) used in cooking in some coastal governorates, and annual releases.

No.	*Province*	*Biomass t/a*	*Potential release route (µg TEQ/t)*		*Annual release g TEQ/a*	
			Air	*Residue*	*Air*	*Residue*
1	Aden	21100	100	10		
2	Taiz	30000	100	10		
3	Hodaida	89762	100	10		
4	Lahj	42200	100	10		
5	Abyan	42200	100	10		
6	Shabwa	21100	100	10		
7	Al-Mahra	42200	100	10		
8	Mukalla	340600	100	10		
9	Hajja	42200	100	10		
	Total	671362 (9037 Tj)	100	10	1.039	

3.3.4.5 Incomplete information

There is no incomplete data

3.3.5 Domestic heating – fossil fuels: not monitored

3.4 MAIN CATEGORY NO 4 PRODUCTION OF MINERAL PRODUCTION

3.4.1 Cement production

3.4.1.1 Cement plants:

There are four cement factories in Yemen. They are distributed among four districts; however we will deal with only three at the coastal provinces, as follows:

3.4.1.1.1 Taiz Governorate:

3.4.1.1.1.1 General information

There is a cement factory in Albarh working on the dry process, where the flowing is 3400 cubic meters/minute.

3.4.1.1.1.2 Activity data

- Quantity of cement production of Albarh plant = 487125 tons/year.

3.4.1.1.1.3 Emission factors

- Annual releases of dioxins and furans resulting from production of cement = 0.024 g TEQ/a.

3.4.1.1.2 Lahj

3.4.1.1.2.1 General information

There is a cement factory working on the wet process at Almsaimeer, Lahj Governorate.

3.4.1.1.2.2 Activity factors

- Quantity of cement production of Lahj cement factory = 1,600,000 tons/year.

3.4.1.1.2.3 Emission factors

- Annual releases of dioxins and furans resulting from production of cement from Lahj cement plant = 0.08 g TEQ/a.

3.4.1.1.3 Hodaida

3.4.1.1.3.1 General information

There is a cement factory working on the wet process at Bajil.

3.4.1.1.3.2 Activity data

- Quantity of cement production of Hodaida cement factory = 270000 tons/year.

3.4.1.1.3.3 Emission factors

- Annual releases of dioxins and furans resulting from production of cement from Hodaida cement plant = 1.35 g TEQ/a.
- Annual releases of dioxins and furans resulting from the production of the three cement factories = 1.45 g TEQ/a.

3.4.1.1.4 Result

Table (15) summarizes the production of cement and way of emission and annual releases.

Table (15): Production of cement, way of emission and annual releases.

No.	*Factory*	*Production t/a*	*Potential release route (µg TEQ/t)*	*Annual release g TEQ/a*
			Air	Air
1	Bajil cement	270000	5	1.35
2	Al-Barh cement	487125	0.05	0.0244
٣	Lahj Cement	1600000	0.05	0.08
	Total	2357125	-	1.45

3.4.1.1.5 Incomplete data

There is no incomplete data

3.4.2 Production of lime

3.4.2.1 General information

There are (36) incinerators (Keer) for production of lime in Hadramawt coast. Seventeen of them are operating in Shamosha, and seven in Boish. The rest of incinerators are temporarily not functioning: (6) incinerator in Boish and (6) in Sheher.

3.4.2.3 Materials used in combustion:

White stones.

3.4.2.4 Main fuel:

The main fuel used is timber, tires, waste lube oils, and sometimes using animal dung and saw dust. The fuel used in Shamosa is timber and mostly not waste lube oils, while in Boish waste lube oil is used.

3.4.2.5 Types of operation:

Burning dry fuel varies according to lime (Alnorah) required. The quality is relative to the use of wood: if dry, the quality is excellent. In the event of the use of waste lube oils the quality is poor because of the fats resulting from the waste oil.

3.4.2.6 Incineration period

3.4.2.6.1 General information

Table (16) summarizes production of lime in Hadhramout and annual releases.

3.4.2.6.2 Activity factors

- Incinerators continue to burn for (12) hours/day.
- The burning process continues for one week at a rate ranging from 3-4 burns per month. Large incinerators remain burning for two weeks,.
- An average burning time of 8 days is experienced for the production, namely 24 day/month.
- Number of days per year = burns on 24 daysx12 months = 288 days/year.
- Quantity of production: 4000 sacks/bags containing 25 kg = 100 tons.
- Production quantity of lime = 494190 tons/year.

3.4.2.6.3 Emission factors

- Annual releases of dioxins and furans to air resulting from the production of lime = $494190 \times 10 \times 10^{-6} = 4.94$ g TEQ/a.

3.4.2.6.4 Result

Table (16): Production of lime in Hadhramout and the annual releases.

No.	*Province*	*Annual production t/a*	*Potential release route (µg TEQ/t)*	*Annual release g TEQ/a*
			Air	Air
1	Mukalla	494190	10	4.94

3.4.2.6.5 Incomplete data

There is no incomplete data

3.4.3 Production of red bricks:

3.4.3.1 General information

The steps of making red brick are as follows:

1. Mud is mixed with animal dung then divided into cubes.

2. The cubes are left to dry in the sun for 1 to 2 days.

3. The dry mud is introduced to an incineration furnace. The furnace-burning incinerator is built of bricks in the form of pillars.

4. There is a pit filled with wood. Diesel is poured on wood for flaring.

5. After completion of burning of firewood, the animal dung component of the brick is burnt. The brick is left burning inside the furnace for a period of 7 to10 days. It is noted that heavy smoke escalated resulting from the process of burning.

6. Bricks are left for 7 to 10 days in the incinerator until cold.

7. Finally, the bricks are removed from the furnace.

Important note:

- There are two sizes of the red brick.
- Small red bricks weight = 0.50 kg.
- Large red bricks weight = 1.25 kg.
- Average weight = 0.50 + 1.25 = 1.75/2 kg = 0.875 kg / red brick.

The quantity of production varies. Four incinerators produce weekly and another produces biweekly. There are other four incinerators that produced every ten days. Only one red brick incinerator is noticed in Hadramaut coast (Mukalla).

Table (17) summarizes the production of red bricks, all possible emissions and annual releases.

3.4.3.2 Activity data

- Quantity of production of red bricks = 38687569 tons/year.

3.4.3.3 Emission factors

- Annual releases of dioxins and furans resulting from production of red bricks = 7.74 g TEQ/a.

3.4.3.4 Result

Table (17): Production of red bricks, potential release routes and annual releases.

No.	Province	Production quantity t/a	Potential release route (µg TEQ/t)	Annual release g TEQ/a
			Air	Air
1	Mukalla	38687569	0.2	7. 74

3.4.3.5 Incomplete information

There is no incomplete data

3.4.4 Glass: Not monitored.

3.4.5 Ceramics: Not monitored

3.4.6 Asphalt Mixing:

3.4.6.1 General information

Table (18) shows the amount of asphalt production in some governorates of Yemen and annual releases

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3.4.6.2 Activity data

- Quantity of production of asphalt in coastal governorates = 9074400 tons/year.

3.4.6.3 Emission factors

- Annual air releases of dioxins and furans from asphalt = $9074400 \times 0.07 \times 10^{-6} = 0.64$ g TEQ/a.

3.4.6.4 Result

Table (18): Asphalt production in some coastal governorates and annual releases.

No.	Province	Quantity t/a	Potential release route (µg TEQ/t) to air	Annual release (g TEQ/a) to air
		864000	0.07	
1	Hodeida	864000	0.07	
		864000	0.07	
		864000	0.07	
2	Aden	124800	0.07	
		153.6	0.07	
٣	Taiz	144000	0.07	
		57600	0.07	
4	Mukalla	864000	0.07	
		864000	0.07	
5	Almahrah	864000	0.07	
6	Lahj	864000	0.07	
		864000	0.07	
7	Shabwa	8000	0.07	
		100000	0.07	
8	Abyan	864000	0.07	
	Total	9074400	0.07	0.64

3.4.6.5 Incomplete information

There is no incomplete information

3.5 MAIN CATEGORY NO 5 – TRANSPORT

Production of Marib and Aden refinery of leaded and lead-free gasoline is 801118 tons in 2008. A quantity of 395527 tons gasoline is imported. The total amount of gasoline consumed in Yemen is 1196645 metric tons. This quantity is distributed to meet the needs of the transport sector as often mixed with Aden Refinery and imported leaded gasoline. The octane number rate in the different types of regular gasoline is around 83. Super gasoline was present in 2008 and 533091 liters (395 ton/year) were sold in the Yemeni market. This type of fuel is used in the presence of catalytic converters besides that the quantity used is small hence it will be neglected. In fact its air releases in presence of a catalytic converter is zero. The total quantity of unleaded gasoline produced in Marib Refinery in 2008 is 155692 tons. The rest can be considered leaded gasoline because its use is allowed in Yemen.

Diesel is the biggest consumed fuel in the various economic sectors, especially transport, energy and industrial sectors. On the other hand, diesel is the most financially supported fuel. The government spent about 12 billion riyals per year to support the prices of diesel due to economic and social benefits. The two refineries produced 931396 tons but 2190419 tons were imported to fulfill the market needs. The total consumption of diesel in 2008 was 3121815 tons.

For fuel oil the total consumption in 2008 was 1652639 tons to cover the needs of the industrial and productive sectors, of which 453324 was produced locally and 1199315 tons was imported. There are two types of fuel oil; the type that contains 1% sulfur, and a lower quality second type that contains about 3.5% sulfur.

In 2008, 465395 tons of kerosene was produced locally in Aden refinery, to cover local consumption.

3.5.1 4-Stroke engines

3.5.1.1 General information

Table (19) summarizes the number of four-stroke vehicles, quantity of leaded gasoline consumption, and annual releases.

4.5.1.2 Activity data

- Number of four-stroke vehicles in Yemen using leaded gasoline = 275267.
- Quantity of leaded gasoline consumption = 1040953 tons/year.
- Annual air releases of dioxins and furans = $1040953 \times 2.2 \times 10^{-6} = 2.29$ g TEQ/a.
- Quantity of unleaded gasoline consumption = 155692 tons/year.

3.5.1.3 Emission factors

- Annual air releases of dioxins and furans = $155692 \times 0.1 \times 10^{-6} = 0.016$ g TEQ/a.

- Total annual air releases of dioxins and furans from gasoline = 2.29 + 0.016 = 2.31 g TEQ/a.

3.5.1.4 Result

Table (19): Number of four-stroke vehicles, quantity of leaded gasoline consumption, and annual releases.

No.	Prov.	gasoline Vehicles/ a	Gasoline consumption l/a	Conversion factor	Gasoline consumed t/a	Potential release route (µg TEQ/t) to air	Annual release (g TEQ/a) to air
1	Aden	37271		0.00074		2.2	
2	Taiz	63518		0.00074		2.2	
3	Hodaida	36150		0.00074		2.2	
4	Lahj	7476		0.00074		2.2	
5	Abyan	10253		0.00074		2.2	
6	Shabwa	9900		0.00074		2.2	
7	Mahra	5940		0.00074		2.2	
8	Mukalla	80600		0.00074		2.2	
9	Hajja	12831		0.00074		2.2	
	Total	263939	1406693000	0.00074	1040953	2.2	2.29

3.5.2 2-stroke engines

3.5.2.1 General information

Table (20) shows the number of double stroke vehicles, quantity of gasoline consumption, and annual releases.

3.5.2.2 Activity data

- Number of double stroke vehicles in some governorates using leaded gasoline = 93218.
- Quantity of gasoline consumption in all the governorates after conversion = 292892.6 tons/year.

3.5.2.3 Emission factors

- Annual air releases of dioxins and furans = $259686 \times 3.5 \times 10^{-6} = 0.91$ g TEQ/a.

3.5.2.4 Resul

Table (20): Number of double stroke vehicles, quantity of gasoline consumption, and annual releases.

No	Prov.	No of vehicles/a	Gasoline consump. l/a	Conv. factor	Gasoline consumed t/a	Potential release route (µg TEQ/t)	Annual release (g TEQ/a) to air
1	Aden	2811	8995200	0.00074	6656.448	3.5	
2	Taiz	2785	10165.250	0.00074	7.522285	3.5	
3	Hodaida	13100	41920000	0.00074	31020.8	3.5	
4	Lahj	498	1434000	0.00074	1061.16	3.5	
5	Abyan	998	3193600	0.00074	2363.264	3.5	
6	Shabwa	821	2855792	0.00074	2113.286	3.5	
7	Mahra	2935	9392000	0.00074	6950.08	3.5	
8	Mukalla	8530	277296000	0.00074	205199	3.5	
9	Hajja	600	1095000	0.00074	810.3	3.5	
	Total	34478	350926592	0.00074	259686	3.5	0.91

3.5.2.5 Incomplete information

There is no incomplete data

3.5.3 Diesel engines

3.5.3.1 General information

Table (21) shows the number of four-stroke diesel vehicles, quantity of diesel consumption, and annual releases.

3.5.3.2 Activity data

- Number of four-stroke vehicles using diesel = 107583 vehicles.
- Quantity of diesel consumption = 3121815 tons/year

3.5.3.3 Emission Factors

- Annual air releases of dioxins and furans = $3121815 \times 0.1 \times 10^{-6} = 0.31$ g TEQ/a.

3.5.3.4 Result

Table (21): Number of four-stroke diesel vehicles, quantity of diesel consumption, and annual releases.

No.	*Prov.*	*No. diesel Vehicles/ a*	*Diesel consumed Lt/a*	*Conversion factor*	*Diesel consumed t/a*	*Potential release route (µg TEQ/t) air*	*Annual release (g TEQ/a) to air*
1	Aden	13425		0.00085		0.1	
2	Taiz	7818		0.00085		0.1	
3	Hodaida	2334		0.00085		0.1	
4	Lahj	3122		0.00085		0.1	
5	Abyan	3800		0.00085		0.1	
6	Shabwa	9210		0.00085		0.1	
7	Mahra	2858		0.00085		0.1	
8	Mukalla	14335		0.00085		0.1	
9	Hajja	2500		0.00085		0.1	
Total		59402	3672724000	0.00085	3121815	0.1	0.31

3.5.3.5 Incomplete information

There is no incomplete data

3.5.4 Heavy oil fired engines

3.5.4.1 General information

Table (22) summarizes the number of four-stroke vehicles, quantity of heavy oil (fuel oil) consumption, and annual releases.

3.5.4.2 Activity data

- Quantity of heavy oil consumption of some governorates = 88631 tons/year.

3.5.4.3 Emission factors

- Annual air releases of dioxins and furans = $84165 \times 4 \times 10^{-6} = 0.34$ g TEQ/a.

3.5.4.4 Result

Table (22): Number of four-stroke vehicles, quantity of heavy oil (fuel oil) consumption, and annual releases.

No	*Prov.*	*No of vehicles/a*	*Fuel oil consump. l/a*	*Conv. factor*	*Fuel oil consumed t/a*	*Potential release route (µg TEQ/t)*	*Annual release (g TEQ/a) to air*
1	Aden	5743	25521710	0.00097	24756.06	4	
2	Hodaida	4762	21160833	0.00097	20526.01	4	
3	Mahra	52	223500	0.00097	216.80	4	
4	Mukalla	8969	39861800	0.00097	38665.95	4	
	Total	19526	86767843	0.00097	88631	4	0.355

3.5.4.5 Incomplete information

There is no incomplete data

3.6 MAIN CATEGORY NO 6 – OPEN BURNING PROCESSED

3.6.1 Fires /burning and biomass

3.6.1.1 Fires of grasslands and marshes:

3.6.1.1.1 Activity data

- A quantity of herbal grass plant spread in the mountains of scattered areas in the provinces of Hajja, Taiz and other coastal areas is burnt yearly. The burning happens in the winter in a rate of 5 hectares in each area = 5 x 4 x 8 = 160 tons/year.
- Annual quantity of burning of grasslands and marshes in Aden = 192 tons/year.

3.6.1.1.2 Emission factors

- Total annual releases of dioxins and furans to air resulting from the burning of grasslands and marshes in Aden and some provinces annually = (160 + 192) x 5 x 10^{-6} = 0.0018 g TEQ/a.
- Total annual releases of dioxins and furans to earth resulting from the burning of grasslands and marshes in Aden and other provinces annually = (160 + 192) x 4 x 10^{-6} = 0.0014 g TEQ/a.

3.6.1.2 Burning of agricultural staked residues (in the field*)*

3.6.1.2.1 General information

This is limited to poor combustion conditions. The investment region in Al-Jarr Valley, Abs Directorate, Hajja Governorate, contains more than (350) Mango and Palm Farms with 960000 Mango trees and 170000 Palm trees.

3.6.1.2.2 Activity data

- Sick and infected branches are burnt at a rate of 0.5 kg /year/Mango tree.
- Quantity of badly burned branches, in the open field, once a year from mango trees = 960000x0.5 = 480000 Kg/year.
- Sick and infected branches are burnt at a rate of 0.5 kg /year/palm tree.
- Quantity of badly burned branches, in the open field, once a year from palm trees = 170000x0.5 = 85000 Kg/year.
- Quantity of badly burned branches, in the open field, once a year from the palm trees and mangoes = 480000 + 85000 = 565000 Kg/year = 565 ton/year.

3.6.1.2.3 Emission factors

- Total annual releases of furans and dioxins into the air resulting from the burning branches of the mango and palm trees in Al-Jarr valley, Abs Directorate, Hajja Governorate annually = $565 \times 0.50 \times 10^{-6}$ = 0.000 g TEQ/a.
- Total annual releases of dioxins and furans to earth resulting from the burning branches of the mango and palm trees in Al-Jarr valley, Abs Directorate, Hajja Governorate annually = $565 \times 10 \times 10^{-6}$ = 0.006 g TEQ/a.
-

3.6.2 Landfill fires

3.6.2.1 General information

Table (23): Amount of domestic waste generated from coastal governorates, ratio of the amount of burning, and annual releases.

3.6.2.2 Activity data

- Amount of household waste produced in some governorates = 609601 tons/year.
- Amount of household waste being burnt in some governorates = 355237 tons/year.
-

3.6.2.3 Emission Factors

- Annual air releases of dioxins and furans = $355237 \times 300 \times 10^{-6}$ = 106.571 g TEQ/a.
- Annual releases of dioxins and furans to remnants = $355237 \times 600 \times 10^{-6}$ = 213.142 g TEQ/a.

3.6.2.4 Result

Table (23) shows the incidents of fires in homes and factories (per incident) in a number of governorates, and annual releases

No.	Province	Waste quantity t/a	Waste quantity		Qty burned	Qty burned	Release route (µg TEQ/t)		Annual release g TEQ/a	
			landfill	t/a	%	t/a	Air	Land	Air	Land
1	Mahra	25704	A	5400	21.5	1161				
				5040	18	907.2				
				4320	15	648				
				4140	14	579.6				
				3600	13	468				
				3204	11	352.44				
				Total		4116.24				
2	Shabwa	20709.5	1	12775	65	8303.75				
			2	6913	80	5530				
			3	1022	75	766.5				
				Total		14600.2				
3	Hajja	33215	1	16425	85	13961.25				
			2	5475	85	4653.75				
			3	4380	85	3723				
			4	3285	87	2857.95				
			5	1825	93	1697.25				
			6	1825	95	1733.75				
				Total		28626.9				
4	Abyan	51049	Jaar	26304	45	11836.8				
			Zanjibar	14014	45	6306.3				
			Loder	10731	45	4828.95				
				Total		22972.1				
5	Aden	182900	1	182900	65	118885				
				Total		118885				
6	Taiz	287520	1	143760	50	71880				
			2	143760	50	71880				
				Total		143760				
7	Mukalla	24455	Sheher	18980	80	15184				
			Ghail	5475	50	2737				
			Mukalla	39361	50	19681				
				Total		37502				
Grand total		**630311**				**355237**	**300**	**600**	**106.571**	**213.142**

Table (24): Incidents of fires in homes and factories (per incident) in some coastal governorates, and annual releases.

No.	Province	House fires No./a	Release route (µg TEQ/t)			Annual release g TEQ/a		
			Air	Water	Residue	Air	Water	Residue
1	Abyan	112	400	400	400			
2	Shabwa	205	400	400	400			
3	Mahra	90	400	400	400			
4	Mukalla	165	400	400	400			
5	Hajja	118	400	400	400			
Total		690	400	400	400	0.28	0.28	0.28

3.6.2.2 Accidental fires in vehicles (per vehicle):

3.6.2.2.1 Activity data

- Number of incidents of fires in vehicles (per incident) in a number of governorates /year = 249.

3.6.2.2.2 Emission factors

- Annual releases of dioxins and furans to air resulting from the number of incidents of fires in vehicles (per incident) in a number of governorates = $249 \times 94 \times 10^{-6} = 0.023$ g TEQ/a.
- Annual releases of dioxins and furans to residues resulting from the number of fire incidents in vehicles (per incident) in a number of governorates/year = $249 \times 18 \times 10^{-6} = 0.004$ g TEQ/a.
- A similar value was noted for the water release too 0.004 g TEQ/a.

3.6.2.2.3 Result

Table (25) shows the incidents of fires in vehicles (per incident) in a number of governorates, and annual releases.

Table (25): Incidents of fires in vehicles (per incident) in a number of coastal governorates, and annual releases.

No.	Province	House fires No./a	Release route (µg TEQ/t)			Annual release g TEQ/a		
			Air	Water	Residue	Air	Water	Residue
1	Abyan	85	94	18	18	0.00047	0.00009	0.00009
2	Shabwa	72	94	18	18	0.006768	0.001296	0.001296
3	Mahra	44	94	18	18	0.000188	0.000036	0.000036
4	Mukalla	48	94	18	18	0.001222	0.000234	0.000234

Total	249	-	-	-	0.023	0.004	0.004

3.6.2.2.4 Incomplete information

There is no incomplete information

3.6.2.3 Industrial fires: not mointored

3.6.2.4 Waste buring: not monitored

3.7 MAIN CATEGORY NO 7 – PORDUCTION OF CHEMICALS AND CONSUMER GOODS

3.7.1 Paper and pulp*:* Not monitored.

3.7.2 Chemical industries: Polychlorinated biphenyls, PCBs: Not monitored.

3.7.3 Petroleum refineries

3.7.3.1 Activity data

- Conversion factor barrel to cubic meter = 6.2898
- Quantity of crude oil refined in Aden Oil Refinery in 2008 = 27696356/6.2898 = 4403376.26 tons/year.
- Quantity of crude oil refined in Marib/year 2008 = 3080280/6.2898 = 489726.22 tons/year.
- Total quantity of the total production of petroleum products from the oil refinery Aden and Marib = 4403376.26 + 489726.22 = 4893102.48 tons/year.

3.7.4 Textile factory

3.7.4.1 General information

There are three factories one of them follows the public sector, while the other two manufacturers are owned by private sector.

3.7.4.2 Activity data

Production 3037000 meter in 2008 = 2277 ton

- Quantity of textile produced annually upper limit = 2277 tons/year.

3.7.4.3 Emission factors

Quantity of dioxins and furans releases lower limit for the products/year = $2277x0.1x10^{-6}$ = 0.0002 g TEQ/a.

3.7.5 Leather plant

3.7.5.1 General information

There are three tanneries in Hodaida. They are all owned by the private sector.

3.7.5.2 Activity data

Leather production in 2008 =17006000 meter = 3400 ton.

3.7.5.3 Emission factors

- Quantity of dioxins and furans releases lower limit for the products/year = $3400x10x10^{-6}$ = 0.034 g TEQ/

3.7.5.4 Incomplete information

There is no incomplete information

3.8 MAIN CATEGORY NO 8 MISCELLANEOUS

3.8.1 Drying of biomass

3.8.1.1Heavy tissues, treatment with pentachlorophenol etc

3.8.1.1.1 General information

Table (26) shows the number of heavy dry-cleaning labs, quantity, and annual releases.

The number of dry cleaning labs that use heavy tissues treatment with pentachlorophenol in some governorates of the republic = 20 lab.

3.8.1.1.2 Activity data

- Total quantity consumed/year = 63.6 tons/year.

3.8.1.1.3 Emission factors

- Quantity of dioxin emissions and furans the number remaining/year = $3000x10^{-6}$x 63.86 = 0.18 g TEQ/a.

3.8.1.1.4 Result

Table (26): Number of heavy dry-cleaning labs, quantity, and annual releases.

No.	*Province*	*No. of plants*	*Quantity t/a*	*Potential release route (µg TEQ/t)*	*Annual release g TEQ/a*
				Residue	Residue
1	Shabwa	6	55.68	3000	
2	Aden	1	3.95	3000	
3	Taiz	7	4.23	3000	
Total		20	63.86	3000	0.18

3.8.1.2 Normal tissues

3.8.1.2.1 General information

Table (27) summarizes the number of dry-cleaning labs (light), quantity, and the annual releases.

The number of labs that use dry cleaning tissues lightly, in some coastal governorates of Yemen = 20.

3.8.1.2.2 Activity data

- Total quantity consumed/year = 67.60 tons / year.

3.8.1.2.3 Emission factors

- Quantity of dioxin and furans emissions and the number remaining/year 67.6 x50x10^{-6} = 0.0034 g TEQ/a.
- Total amount of dioxin and furans emissions to remnants/year = dry cleaning (heavy tissue) + dry cleaning (light tissue) = total annual releases g TEQ/a.
- Total amount of dioxins and furans emissions and the number remaining/year = 0.18 + 0.003 = 0.18 g TEQ/a.

3.8.1.2.4 Result

Table (27): Number of dry-cleaning labs (light), quantity, and annual releases.

No.	*Province*	*No. of plants*	*Quantity t/a*	*Potential release route (µg TEQ/t)*	*Annual release g TEQ/a*
				Residue	Residue
1	Shabwa	6	60.15	50	
2	Aden	1	1.89	50	
٣	Taiz	7	5.49	50	
	Total	20	67.6	50	0.003

3.8.1.3 Incomplete information

There is no incomplete information

3.8.2 Crematoria: Not monitored

3.8.3 Smoke houses: Not monitored

3.8.4 Dry cleaning residues: Not monitored

3.8.5 Tobacco Smoking

Table (28) summarizes the area and quantity of tobacco production for the consumer hubble-bubble in some coastal governorates and annual releases.

3.8.5.1 Taiz:

3.8.5.1.1 General information

There is a factory owned by the private sector:

- Production quantity of cigarettes per day = 28618056 cigarettes.
- Production quantity of cigarettes a week = 1.72E+08 cigarettes.
- Production quantity of cigarettes per month = 6.87E+08 cigarettes.
- Production quantity of cigarettes / year = 8.24E+09 cigarettes.
- The rate of weight cigarette unit = 1.5625 gm.

3.8.5.1.2 Ctivity data

- The total quantity of cigarettes produced by the Taiz plant annually = 8242000000 x1.5625/1000 = 12878125 kg/year. = 12878 tons/year.

3.8.5.1.3 Emission factors

Emission factor for cigarettes smoking is based on number of cigarettes not their weight! 0.1 pg TEQ/cigarette. 0.3 pg TEQ /cigar = hubble bubble as an estimation.

Total cigarette produced and smoked = 8.242 + 1.5 + 5.1 billion = 14.842 billion cigarettes.

3.8.5.1.4 Result

Air releases = $14.842 \times 10^{9} \times 0.1 \times 10^{-12} = 0.0015$ g TEQ/a.

3.8. 5.2 Aden:

3.8.5.2.1 General information

There is a factory owned by the public sector:

- Production quantity of cigarettes per day = 6250000 cigarettes.
- Production quantity of cigarettes a week = 31250000 cigarettes.
- Production quantity of cigarettes per month = 125000000 cigarettes.
- Production quantity of cigarettes per year = 1500000000 cigarettes.
- Rate of weight cigarette unit = 1.5625 gm.

3.8.5.2.2 Activity data

- Total quantity of cigarettes produced by the Aden plant annually = 1500000000x1.5625/1000 = 1500000 kg/year = 1500 tons/year.

3.8.5.3 Hodaida:

3.8.5.3.1 General information

There is a factory owned by the mixed sector which produces the following quantity:

- Number of cigarettes produced per day = 17000000 cigarettes.
- Number of cigarettes produced per week = 102000000 cigarettes.
- Number of cigarettes produced monthly = 425000000 cigarettes
- Number of cigarettes produced yearly = 5100000000 cigarettes
- Rate of weight cigarette unit = 1.5625 gm.

3.8.5.3.2 Activity data

- Total quantity of cigarettes produced by the Aden plant annually = 5100000000x1.5625/1000 = 7968750 kg/year. = 7969 tons/year.

- Total quantity of cigarettes produced from the three factories = 12878 + 1500 7969 = 22347 tons/year.
- Total amount of dioxins and furans emissions resulting from the total quantity of cigarettes produced from the three factories annually = $22347 \times 0.1 \times 10^{-6}$ = 0.0022 g TEQ/a.
- Tobacco production area = 609 ha/year.
- Quantity of tobacco production = 1747 tons/year.

3.8.5.3.3 Emission factors

- Annual releases of furans and dioxins into the air resulting from the production and consumption of tobacco = $1747 \times 0.3 \times 10^{-6}$ = 0.0006 g TEQ/a.

3.8.5.3.4 Result

Table (28): Area and quantity of tobacco production for the consumer hubble-bubble in coastal governorates and annual releases**.**

No.	*Province*	*Production* *Hictar/t/a*	*Area of tobacco production* *Hictar/a*	*Potential release route µg TEQ/t* *Air*	*Annual release g TEQ/a* *Air*
1	Aden	22	35	0.3	
2	Lahj	36	68	0.3	
3	Abyan	39	61	0.3	
4	Shabwa	59	113	0.3	
5	Mahra	69	95	0.3	
6	Mukalla	355	1350	0.3	
	Total	594	1747	0.3	0

3.8.5.4 Imported tobacco (molasses tobacco) in some provinces:

3.8.5.4.1 Activity data

- Quantity of tobacco flavor (molasses tobacco) imported = 44467tons/year.

3.8.5.4.2 Emission factors

- Annual releases of furans and dioxins into air resulting from the consumption of tobacco (molasses tobacco) = $44467 \times 0.1 \times 10^{-6}$ = 0.004 g TEQ/a.

Molasses = cigar = 50 g

44467 ton x 1000000g x 2 x 10^{-2} x 0.3 x 10^{-} 0.000267 = ^{12}g TEQ/a.

Tobacco produced 1747 ton

Hubble bubble = cigar = 50 gm

1747 ton x 1000000g x 2 x 10^{-2} x 0.3 x 10^{-} 0.00001 = ^{12}g TEQ/a.

3.8.5.4.3 Result

Table (29): Quantity of imported tobacco flavor (molasses tobacco) for the purposes of hubble-bubble and annual releases.

No.	*Province*	*Quantity of molasses tobacco*	*Potential release route µg TEQ/t*	*Annual release g TEQ/a*
			Air	Air
1	Abyan	6	0.1	
2	Taiz	206	0.1	
3	Shabwa	4.75	0.1	
4	Mukalla	44250	0.1	
	Total	44467	0.1	0.00

3.8.5.5 Incomplete information

There is no incomplete informati

3.9 MAIN CATEGORY NO 9 – Disposal

3.9.1 Landfill Leachate:

3.9.1.1 Hazardous waste:

3.9.1.1.1 General information

Some hazardous medical and industrial waste is buried in the landfills. Table (30) illustrates the amount of medical waste generated from some coastal governorates, ratio of the amount of burial, and annual releases. Table (31) summarizes the amount of industrial waste generated from some coastal governorates, ratio of the amount of burial, and annual releases.

3.9.1.1.2 Activity data

- Quantity of hazardous medicinal waste generated = 20364 tons/year.

  Quantity of hazardous medicinal waste buried = 12386 tons/year

- Quantity of hazardous industrial waste generated = 37036 tons/year.
- Quantity of hazardous industrial waste buried = 20568 tons/year.
- Total quantity of hazardous wastes generated = 20364 + 37036 =57400 tons/year.
- Total quantity of hazardous waste buried = 12386 + 20568 = 32954 tons/year.

3.9.1.1.3 Emission factors

- Annual releases of furans and dioxins into water resulting from hazardous waste buried = $32954 \times 0.2 \times 10^{-6} = 0.0066$ g TEQ/a.
- Annual releases of furans and dioxins into residues resulting from hazardous waste buried = $32954 \times 50 \times 10^{-6} = 1.65$ g TEQ/a.

3.9.1.1.4 Result

Table (30): Amount of medical waste generated from coastal governorates, ratio of the amount of burial, and annual releases.

No.	*Province*	*Waste quantity t/a*	*Waste quantity*		*% buried*	*Quantity buried*	*Release route (µg TEQ/t)*	*Release route (µg TEQ/t)*
			landfill	*t/a*	*%*	*t/a*	*Water*	*Water*
1	Mahra	3168	1	1080	78.5	848	200	
			2	720	82	590	200	
			3	540	85	459	200	
			4	360	86	310	200	
			5	288	87	251	200	
			6	180	89	160	200	
				Total		2618	200	0.52
2	Shabwa	316	1	183	35	64	200	
			2	61	20	12	200	

No.	Province	Waste quantity t/a	Waste quantity		% buried	Quantity buried	Release route (µg TEQ/t)	Release route (µg TEQ/t)
			landfill	t/a	%	t/a	Water	Water
			3	73	25	18	200	
				Total		94	200	0.02
			1	4	85	3	200	
			2	3	85	3	200	
			3	2	85	1.7	200	
3	Hajja	11	4	1	87	0.87	200	
			5	0.5	93	0.47	200	
			6	0.5	95	0.48	200	
				Total		10	200	0.002
			Jaar	2484	45	1118		
			Zanjibar	1872	45	842		
4	Abyan	4860	Loder	504	45	227		
				Total		2187		
5	Aden	9125	1	9125	65	5931		
				Total		5931		
			1	730	50	365		
6	Taiz	2555	2	1825	50	913		
				Total		1278		
			Al-Ghail	91	50	46		
7	Mukalla	91		Total		46		
Grand total		20364				12382	0.2	0.61

Table (31): Amount of industrial waste generated from some coastal governorates, ratio of the amount of burial, and annual releases.

No.	Province	Waste quantity t/a	Waste quantity		% buried	Quantity buried	Release route(µg TEQ/t)	Annual release g TEQ/a
			landfill	t/a	%	t/a	water	water
			Sheher	4380	20	3504		
1	Mukalla	4563	Al-Ghail	182.5	50	91.25		
				Total		3595		
			1	5625	50	2812.5		
2	Taiz	11250	2	5625	50	2812.5		
				Total		5625		
			1	949	35	332.15		
3	Shabwa	1351	2	292	20	58.4		
			3	109.5	25	27.375		
				Total		418		
			Jaar	11664	55	6415.2		
4	Abyan	19872	Zanjibar	6840	55	3762		
			Loder	1368	55	752.4		
				Total		10930		
Grand total		37036				20568	50	1.03

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3.9.1.2 Non-hazardous waste

3.9.1.2.1 General information

Quantity of leachate should be assessed and used for calculation. It was very low due to lack of precipitation. In fact the burned quantity is used to calculate the buried from which, the leachate can be calculated.

3.9.1.2.2 Activity data

- Amount of household waste generated = 609601 tons/year.
- Amount of household waste buried = 275071 tons/year.

3.9.1.2.3 Emission factors

- Annual releases of furans and dioxins into water resulting from household waste buried = $275071 \times 0.03 \times 10^{-6} = 0.0083$ g TEQ/a.
- Annual releases of furans and dioxins into residues resulting from household waste buried = $275071 \times 6 \times 10^{-6} = 1.65$ g TEQ/a.

3.9.1.2.4 Result

Table (32): Amount of household waste generated from some coastal governorates, ratio of the amount of burial, and annual releases.

No.	*Province*	*Waste quantity t/a*	*Waste quantity*		*% buried*	*Quantity buried*	*Release route (µg TEQ/t)*	
			landfill	*t/a*	*%*	*t/a*	*water*	*water*
1	Mahra	25704	1	5400	78.5	4239		
			2	5040	82	4133		
			3	4320	85	3672		
			4	4140	86	3560		
			5	3600	87	3132		
			6	3204	89	2852		
				Total		21588		
2	Shabwa	7934.5	1	12775	35	4471		
			2	6913	20	1382		
			3	1022	25	256		
				Total		6109		
3	Hajja	33215	1	16425	15	2464		
			2	5475	15	821		
			3	4380	15	657		
			4	3285	13	427		
			5	1825	7	128		
			6	1825	5	91		
				Total		4587		
4	Abyan	51049	Jaar	26304	55	14467		
			Zanjibar	14014	55	7708		
			Loder	10731	55	5902		
				Total		28076		
5	Aden	182900	1	182900	35	64015		
				Total		64015		
6	Taiz	287520	1	143760	50	71880		
				Total		71880x2		
7	Mukalla		Sheher	18980	20	143760		
			Al-Ghail	5475	50	3796		
				Total		6534		
Grand total		609601				275071	0.0083	1.65 res

3.9.1.3 Incomplete information

There is no incomplete information

3.9.2 Sewage and sewage treatment:

3.9.2.1 Urban and remote sewage

3.9.2.1.1 Without removing sludge

3.9.2.1.1.1 General information

Water treatment is mostly remote and residential. Sludge not removed thus calculations are made at 0.002 for water and 100 for residue. Yemen is all rural or urban environment and no signs of real industrial activity while when available it is too primitive to affect the water quality.

3.9.2.1.1.2 Activity data

- Total amount resulting from the treatment plants without removing sludge = 57814 tons/year.

3.9.2.1.1.3 Emission

- Total annual releases of dioxins and furans to water resulting from treatment plants without removing sludge = $57814 \times 0.002 \times 10^{-6} = 0.000$ g TEQ/a.
- Total annual releases of dioxins and furans to residues resulting from treatment plants without removing sludge = $57814 \times 100 \times 10^{-6} = 5.78$ g TEQ/a.

3.9 .2.1.1.4 Result

Table (33) summarizes the amount of treated water produced by treatment plants without removing sludge, and annual releases.

No.	*Province*	*Sludge quantity t/a*	*Release route (µg TEQ/t)*		*Annual release g TEQ/a*	
			Water	*Residue*	*Water*	*Residue*
1	Aden	10000				
2	Taiz	7542				
3	Hodaida	7919				
4	Lahj	1800				
5	Abyan	1000				
6	Shabwa	7800				
7	Hajja	401				
8	Aden refinery	21352				
Grand total		57814	0.002	100	0.000	5.78

3.9.2.1.1.5 Incomplete information

There is no incomplete information

3.9.3 Open waters dumping

3.9.3.1 Remote and urban household sewage

3.9.3.1.1 General information

Table (34) summarizes the amount of treated water produced by treatment plants, sewage, and the annual releases. In fact this can be considered remote or mostly urban environments thus 0.0002 for water not 0.5.

3.9.3.1.2 Activity data

- Total quantity of water resulting from treatment plants = 31970195 tons/year.
-

3.9.3.1.3 Emission factors

- Total annual releases of dioxins and furans to residues resulting from urban, no sludge removal treatment plants of water/year = $31970195 \times 0.0002 \times 10^{-6} = 0.0064$ g TEQ/a.

As far as we know there is no lube recycling in Yemen. The information collected did not show its presence.

3.9.3.1.4 Result

Table (34): Amount of treated urban water produced by treatment plants, sewage, and annual releases.

No.	*Province*	*Unit*	*Sludge quantity t/a*	*Release route (µg TEQ/t)*	*Annual release g TEQ/a*
				Water	*Water*
1	Aden	1	5910445		
		2	4663970		
		Total	10574415		
2	Taiz	1	1095		
		Total	2477560		
3	Hodaida	1	1460		
		Total	7127990		
4	Lahj	1	1825		
		Total	5913000		
5	Abyan	1	2190		
		Total	328500		
6	Shabwa	1	1314000		
		2	1248300		
		Total	2562300		
7	Hajja	1	438000		
		2	87600		
		3	88330		
		Total	613930		
8	Aden refinery	1	2372500		
		Total	2372500		
	Grand total		31970195	0.0002	0.0064

3.9.3.1.5 Incomplete information

There is no incomplete information

3.9.4 Composting

3.9.4.1 General information

All organic materials are composted to fertilizers in Hadramawt coast towns: Sheher and Ghail Bawazier. The composted materials include the following:

- Fish.
- Remnants of the kitchen.
- Remnants of the garden.
- Remnants of farms.
- Remnants of household organic waste. This does not exist in Yemen. If happens it is very rarely.

3.9.4.2 Activity data

- Total quantity resulting from the process of conversion to fertilizer in Hadramawt coast (Sheher and Ghail Bawazier) kitchen waste/year = 24455 tons/year.

3.9.4.3 Emission factors

- Total annual releases of dioxins and furans to products resulting from the process of conversion to fertilizer in Hadramawt coast (Sheher and Ghail Bawazier) of all organic material/year = $24455 \times 15 \times 10^{-6} = 0.37$ g TEQ/a.

Compost emissions calculated as garden and kitchen waste i. e. 15 for products.

3.9.5 Waste oil disposal: Not monitored

3.10 MAIN CATOGERY NO 10 – IDENTIFICATION OF POTENTIAL HOTS SPOTS: Not monitored

4 ASSESSMENT OF THE INVENTORY RESULT

4.1 waste incienration

Table 35 summarizes the emissions released from waste incineration. The releases were noted to air and residues only. The two main emissions monitored originated from medicinal waste incineration and wood waste and waste biomass incineration. These two items have to be addressed for correction immediately.

Table 35: Subcategory of the Inventory Matrix – Main Category 1

			Potential Release Route				
No		Subcategories of Main Category					
1		Waste Incineration	Air	Water	Land	Product	Residue
	a	Waste Incineration Municipal	-				-
	c	Medical Waste Incineration	13.74	-			5.19
	d	Light Fraction Waste Incineration	0.73	-			-
	f	Waste Wood and waste biomass Incineration	2.5	-			25
		Total	16،969	0،000	0،000	0،000	30،188

4.2 Ferrous and non ferrous metal production

Table 36 summarizes the emissions released from ferrous and non-ferrous metal production. The releases were noticed to air and residues together with minor quantity to water. The three major emissions monitored originated from copper production, lead production and thermal wire reclamation. These three items have to be addressed for correction.

Table 36: Subcategory of the Inventory Matrix – Main Category 2

No		Subcategories of Main Category	Potential Release Route				
2		Ferrous -d NonFerrous an Metal Production	Air	Water	Land	Product	Residue
	a	Iron ore sintering	3.005				0.0005
	b	Coke production	2.354	0.05	-	-	-
	c	Iron and steel roduction and foundries	2.580				3.87
	d	Copper production	49.576				39.041
	e	onAluminium producti	0.075				0.10
	f	Lead productin	22.758				-
	g	Zinc production	3.600				-
	l	Thermal wire reclamation	40.835	-	-		-
		Total	124،783	0،000	0،000	0،000	43،012

4.3 Heat and Power Generation

Table 37 summarizes the emissions released from heat and power generation. The releases were noted to air and residues only. These emissions were too small to be considered for any correction.

Table 37: Subcategory of the Inventory Matrix – Main Category 3

No		Subcategories of Main Category	Potential Release Route				
3		Heat and Power Generation	Air	Water	Land	Product	Residue
	a	Fossil fuel power plants	0.051				-
	b	sBiomass power plant	0.352				0.1
	d	Household heating and (biomass)cooking	1.039		-		0.005
		Total	1،441	0،000	0،000	0،000	0،105

4.4 Production of mineral production

Table 38 summarizes the emissions released from production of mineral products. The releases were seen to air and residues only. The emissions monitored were too small to consider for further correction.

Table 38: Subcategory of the Inventory Matrix – Main Category 4

			Potential Release Route					
No		Subcategories of Main Category						
4		Production of Mineral Products	Air	Water	Land		Product	Residue
	a	Cement production	1.450					-
	b	production Lime	4.942					-
	c	Brick production	7.738					-
	f	Asphalt mixing	0.635				-	-
		Total	14.77	0،000	0،000	0		0،000

4.5 Transport

Table 39 summarizes the emissions released from transport. The releases were emitted to air only. The emissions monitored were too small to consider for further correction.

Table 39: Subcategory of the Inventory Matrix – Main Category 5

			Potential Release Route				
No		Subcategories of Main Category					
5		Transport	Air	Water	Land	Product	Residue
	a	Stroke engines-4	2.290				-
	b	Stroke engines-2	0.909				-
	c	Diesel engines	0.313				-
	d	Heavy oil fired engines	0.355				-
		Total	3،866	0،000	0،000	0،000	0،000

4.6 Open Burning Processes :6Subcategories of Main Category

Table 40 summarizes the emissions released from open burning processes. The releases were seen to air, water and residues. The most annoying emissions monitored originated from biomass burning, which caused about 60% of the entire emissions in Yemen. Immediate correction measures have to be addressed using BAT/BEP.

Table 40: Subcategory of the Inventory Matrix – Main Category 6

			Potential Release Route				
No		tegories of Main Subca Category					
6		Open Burning Processes	Air	Water	Land	Product	Residue
	a	Biomass Burning	0.019		0.007		0
	b	Waste burning and accidental fires	139.407	0	231.144		0
		Total	136،425	0،000	231،151	0،000	0،000

4.7 Production of chemicals and consumer goods

Table 41 summarizes the emissions released from production and use of chemicals and consumer goods. The releases noted to products only and were very tiny.

Table 41: Subcategory of the Inventory Matrix – Main Category 7

			Potential Release Route				
No		Subcategories of Main Category					
7		Production and Use of Chemicals and Consumer Goods	Air	Water	Land	Product	Residue
	a	Pulp and paper production	-	-		-	-
	b	yChemical industr	-	-	-	-	-
	c	Petroleum industry	-				-
	d	Textile production		-		0.000	
	e	Leather refining		-		0.034	
		Total	0،000	0،000	0،000	0،034	0،000

4.8 Miscellaneous

Table 42 summarizes the emissions released from miscellaneous. The releases were noted to air and residues only. The releases noted were very tiny.

Table 42: Subcategory of the Inventory Matrix – Main Category 8

			Potential Release Route				
No		Subcategories of Main Category					
8		Miscellaneous	Air	Water	Land	Product	Residue
	a	Drying of biomass	-			-	
	b	Creamtoria	-				-
	c	Smoke houses	0.00			-	-
	d	Dry cleaning		-		-	0.195
	e	Tobacco smoking	0.0005				
		Total	0،001	0،000	0،000	0،000	0،195

4.9 Disposal

Table 43 summarizes the emissions released from disposal. The releases were emitted to water, products and residues. The releases noted were very tiny.

Table 43: Subcategory of the Inventory Matrix – Main Category 9

			Potential Release Route				
No		Subcategories of Main Category					
9		Disposal	Air	Water	Land	Product	Residue
	a	Lanfills and waste dumps		0.015			3.298
	b	sewage treatment/Sewage	-	0.016	-	-	0.00
	c	Open water dumping		-			0.00
	d	composting		0.268	-	2.446	
	e	-non)Waste oil treatment (thermal	-	-	-	-	-
		Total	0،000	0،299	0،000	2،446	3،298

Table (44): Categories of primary sources, and annual releases in gram Total Equivalent/year (g TEQ/a).

o	Subcategories of Main Category	Potential Release Route				
		Air	Water	Land	Product	Residue
1	Waste Incineration	16،969	0،000	0،000	0،000	30،188
2	Ferrous Metal -Ferrous and Non Production	124،783	0،000	0،000	0،000	43،012
3	Heat and Power Generation	1،441	0،000	0،000	0،000	0،105
4	Production of Mineal Products	14.77	0،000	0،000	0	0،000
5	Transport	3،866	0،000	0،000	0،000	0،000
6	Open Burning Processes	136،425	0،000	231،151	0،000	0،000
7	Production and Use of Chemicals and Consumer Goods	0،000	0،000	0،000	0،034	0،000
8	Miscellaneous	0،001	0،000	0،000	0،000	0،195
9	Disposal	0،000	0،299	0،000	2،446	3،298
10	Identification of Potential Hot-Spots				0،000	0،000
	Total	**283،484**	**0،299**	**231،151**	**2،480**	**76،798**
	Grand Total					**594**

5 Criteria for Selecting the Priority Locations for BAT/PEB Implementations

The following are a few broad guidelines and criteria for selecting BAT/PEB implementation in Yemen:

1) The most dangerous locations have to be addressed first.
2) The more emitting processes are to be considered secondly.
3) The older technologies are to be substituted for better BAT/PEB technologies.
4) Copper production is responsible for 15% of Yemen emissions.
5) Lead production and thermal wire reclamation are two dangerous processes.
6) Open waste burning is responsible for about 60% of the emissions in Yemen.

Annexes

1 Assumption Techniques Used to Calculate the Activity Rates

1.1 Main category 1- Waste Incineration

1.1.1 Municipal solid waste incineration:

Currently there are no incinerators to burn municipal solid waste in Yemen.

1.1.2 Municipal solid waste incineration:

There are no incinerators to burn hazardous waste in Yemen.

1.1.3 Medical waste incineration:

This has been calculated using 40,000 for air potential releases under uncontrolled batch combustion and no APCS while the residues have been calculated at 200.

In case of controlled emissions of dioxins and furans to residues (ashes) 920 has been adopted.

For controlled batch combustion of dioxins and furans emission to air, potential releases of 525 have been used.

1.1.4 Light–fraction shredder waste incineration:

Light fraction shredder waste in Taiz is controlled and potential releases to air have been calculated at 50 and at 1000 for the non-controlled batch.

1.1.5 Waste wood and biomass incineration:

Old furnaces, with intermittent system, had no or only little use of air pollution control equipment.

Annual releases of dioxins and furans to air of waste wood and biomass in Taiz has been calculated at 100 g TEQ/a.

Annual releases of dioxins and furans to the remnants and volatile ashes resulting from burning of waste wood and biomass in Taiz has been calculated at 1000 g TEQ/a.

1.2 Main category 2 - Ferrous and Non-Ferrous Metal Production

1.2.1 Iron ore sintering

High waste recycling, including oil-contaminated materials

Total annual releases of furans and dioxins into the air resulting from the production of recycled iron are calculated as 20 g TEQ/a. Residues has been calculated at 0.003.

1.2.**2 Charcoal production*:*** No gas cleaning

Total annual releases of furans and dioxins into air resulting from production of wooden coal have been calculated at 3 g TEQ/a.

Total annual releases of dioxins and furans to water resulting from production of wood coal have been calculated at 0.06 g TEQ/a.

1.2.3 Iron and steel production plants

Dirty scrap, scrap preheating, limited controls.

Iron foundries production and annual releases emissions to air have been calculated at 10 and 15 for residues.

1.2.4 Copper production basic technology

Total annual releases of furans and dioxins into the air resulting from production of electrical cables have been calculated at 800 g TEQ/a.

Total annual releases of furans and dioxins to residues resulting from production of electrical cables have been calculated at 630 g TEQ/a.

1.2.5 Aluminum production

Processing scrap aluminum is characterized by minimal treatment of inputs, simple dust removal and extrusion production.

Total annual releases of dioxins and furans to the air resulting from the production of recycled aluminum have been calculated at 150 g TEQ/a.

Total annual releases of dioxins and furans to remnants resulting from minerals recovered from wire have been calculated at 200 g TEQ/a.

1.2.6 Lead production:

Total annual releases of dioxins and furans into the air resulting from the secondary lead produced from scrap containing PVC have been calculated at 80 g TEQ/a.

1.2.7 Zinc production:

Kiln with no dust control. The zinc production in Hodaida plant and annual releases to air has been calculated at 1000.

1.2.8 Magnesium production: Not monitored.

1.2.9 Thermal wire reclamation:

Open burning of cable.

Total annual releases of dioxins and furans to air resulting from minerals recovered from wire have been calculated at 5000 g TEQ/a.

1.3 Main Category 3 - Power Generation and Heating

1.3.1 Fossil fuel power plants

1.3.1.1 Fossil fuel energy boilers and common waste incineration

Releases to air have been calculated at 35 µg TEQ/Tj.

A ton of waste oil has been assumed to be equivalent to 1 ton of oil equivalent = 42 Gj.

1.3.1.2 Heavy fuel energy boilers

Cement factories fuel oil has been calculated at 2.5 µg TEQ/Tj to air. A ton of heavy fuel oil is assumed to be equivalent to 40 Gj

1.3.1.3 Light fuel and natural gas boilers

A ton of diesel is equivalent to 43 Gj/ton
Releases have been calculated at 0.5 µg TEQ/Tj to air.

1.3.1.4 Biomass in Lime Production

Clean wood

Releases have been calculated at 50 µg TEQ/Tj to air and 15 residues.

1 Ton of fuel wood = 0.3215 toe = 41.868 x 0.3215 Gj = 13.461 Gj/ton

1.3.1.5 Biomass and virgin wood stoves

Stoves virgin wood releases have been have been calculated at 100 ng TEQ/Tj to air and 10 to residues

1 Ton of fuel wood is equivalent to 0.3215 toe = 41.868 x 0.3215 Gj = 13.461 Gj/ton

1.4 Main category 4 – Mineral Products

1.4.0 Cement production

1.4.1 Cement plants:

Emission to air has been calculated at 5 for Bajil Cement Factory since it is applying the wet process and 0.05 for Lahj and Albarh Factories as the dry process is used.

1.4.2 Production of lime

Annual releases of dioxins and furans to air resulting from the production of lime have been calculated at 10 g TEQ/a.

1.4.3 Production of red bricks:

Annual releases of dioxins and furans to air resulting from the production of lime have been calculated at 0.2 g TEQ/a.

1.4.4 Production of asphalt:

Annual air releases of dioxins and furans from asphalt have been calculated at 0.07 g TEQ/a.

1.5 Main category 5 - transport

Annual air releases of dioxins and furans leaded gasoline has been calculated at 2.2 g TEQ/a.

Annual air releases of dioxins and furans unleaded gasoline has been calculated at 0.1 g TEQ/a.

Annual air releases of dioxins and furans diesel engines have been calculated at 0.1 g TEQ/a.

Annual air releases of dioxins and furans heavy oil (fuel oil) has been calculated at 4 g TEQ/a.

Annual air releases of dioxins and furans from double stroke vehicles in some governorates using leaded gasoline have been calculated at 3.5 g TEQ/a.

I have never heard about double stroke diesel engines. I do not know where this information came from. The numbers are small. The annual releases are zero anyway! This has been cancelled since no double stroke engines are known and emission is zero.

1.6 Main category 6 - Uncontrolled Combustion Processes

1.6.1 Fires and biomass burning

1.6.1.1 Fires of grasslands and marshes:

Total annual releases of dioxins and furans to air resulting from the burning of grasslands and marshes have been calculated at 5 g TEQ/a.

Total annual releases of dioxins and furans to earth resulting from the burning of grasslands and marshes have been calculated at 4 g TEQ/a.

1.6.1.2 Burning of agricultural staked residues (in the field)

Total annual releases of furans and dioxins into the air resulting from the burning branches of the mango and palm trees havv been calculated at 30 g TEQ/a.

Total annual releases of dioxins and furans to earth resulting from the burning branches of mango and palm trees have been calculated at 10 g TEQ/a.

1.6.2 Uncontrolled domestic waste burning

Annual air releases of dioxins and furans to air have been calculated at 300 g TEQ/a.

Annual releases of dioxins and furans to remnants have been calculated at 600 g TEQ/a.

1.6.3 Fires in garbage and waste burial pits

Hazardous medical and industrial has been calculated at 1000 to air

1.6.4 Incidents of fires in homes and factories (per incident)

Annual releases of dioxins and furans resulting from the number of incidents of fires in homes and factories (per incident) to air, water and residue has been calculated at 690 g TEQ/a.

1.6.5 Accidental fires in vehicles (per vehicle):

Annual releases of dioxins and furans to air resulting from the number of incidents of fires in vehicles (per incident) have been calculated at 94 g TEQ/a.

Annual releases of dioxins and furans to residues resulting from the number of fire incidents in vehicles (per incident) has been calculated at 18 g TEQ/a .

A similar value was noted for the water release has been calculated at 0.004 g TEQ/a.

1.7 Main category 7 - The production and Use of Chemicals and Consumer Goods

1.7.1 Petroleum industries

1 ton of oil = 42 Gj. Only gas that was flared should be used. It has not been estimated during the information collection! The production only is estimated. The two Yemeni refineries are rather small and little amount of oil is flared usually around 5% or less of total production. This has not been calculated or added to PCDD/F emissions in Yemen. It has been simply ignored. If added it would be around $4893102.48 \times 0.05 \times 8 \times 10^{-6}$ = 1.96 g TEQ/a.

1.7.2 Textile factory

Quantity of dioxins and furans releases as lower limit to the products has been calculated at 0.1 g TEQ/a.

1.7.3 Leather factories

Quantity of dioxins and furans releases as lower limit to the products has been calculated at 10 g TEQ/a.

1.8 Main category 8 - Miscellaneous

1.8.1 Remnants of dry cleaning:

1.8.1.1 Heavy tissues, treatment with pentachlorophenol etc:

Total quantity consumed/year = 63.6 tons/year.

Quantity of dioxin emissions and furans has been calculated at 3000 g TEQ/a.

The amount of residue that stays after distillation has to be used for calculations; not weight of dry cleaning chemical! This has not been assessed or estimated during information collection. In fact, I was not happy with all these numbers of labs. I think

we have many more that has never been included in the inventory. The numbers are left as found to compensate for the missed ones. The quantity of material imported is much more than that observed here.

1.8.1.2 Normal tissues:

Quantity of dioxin and furans emissions has been calculated at 50 g TEQ/a.

Same argument in 12.8.1.1 above applies here.

1.8.2 Tobacco Smoking

Emission factor for cigarettes smoking should be based on number of cigarettes not their weight at 0.1 pg TEQ/cigarette and 0.3 pg TEQ /cigar = hubble bubble!

Total cigarette produced and smoked = 8.242 + 1.5 + 5.1 billion = 14.842 billion cigarettes.

Air releases has been calculated at = $14.842 \times 10^{9} \times 0.1 \times 10^{-12} = 0.0015$ g TEQ/a.

1.8.3 Imported tobacco (molasses tobacco) in some provinces:

Molasses = cigar = 50 g

44467 ton x 1000000g x 2 x 10^{-2} x 0.3 x 10^{-} 0.000267 = ^{12}g TEQ/a.

Tobacco produced 1747 ton. Hubble bubble = cigar = 50 gm

Releases have been calculated at = 1747 ton x 1000000g x 2 x 10^{-2} x 0.3 x 10^{-} 0.00001 = ^{12}g TEQ/a.

1.9 Main category 9 - Disposal/Landfill

1.9.1 Filtrate or leachate from waste dumps:

1.9.1.1 Non-hazardous waste:

Quantity of leachate should be assessed and used for calculation! It would be very low due to lack of precipitation. In fact, the burned quantity is used to calculate the buried from which, the leachate can be calculated. The quantities of buried waste have not been changed. The buried waste has been calculated and from which then releases in non-hazardous waste has been calculated at 0.03 in water and at 6 for residues.

1.9.1.2 Hazardous waste:

Annual releases of furans and dioxins into water resulting from hazardous waste buried have been calculated at 0.2 g TEQ/a.

Annual releases of furans and dioxins into residues resulting from hazardous waste buried have been calculated at 50 g TEQ/a.

1.9.2 Sewage and sewage treatment:

12.9.2.1 Urban and remote sewage

1.9.**2.1.1Without removing sludge**

Water treatment is mostly remote and residential. Sludge not removed and calculations were made at 0.002 for water and 100 for residue. Yemen is all rural or urban environments with no signs of real industrial activity while when available it is too primitive to affect the water quality.

1.9.3 Open waters dumping

1.9.3.1 Remote and urban household sewage

In fact, this can be considered remote or mostly urban environments thus 0.0002 for water, not 0.5 applies.

With regard to lube oil, as far as we know, there is no lube recycling in Yemen. We are exporting our used lube oil to Saudi Arabia and using small quantities in cement factories, washing houses and lime production. The information collected did not show its presence. There was a project started by Yemen Economic Corporation in 2002 but was not successful.

1.9.4 Composting

All organic materials are composted to fertilizers in Hadramawt coast towns: Sheher and Ghail Bawazier. The composted materials include fish, remnants of the kitchen, remnants of the garden, remnants of farms, but mainly fish remnants. Remnants of household organic waste do not exist in Yemen. If happens, it is very rarely. Thus total annual releases of dioxins and furans to products resulting from the process of conversion of fish remnants to fertilizer in Hadramawt coast has been calculated at 15 g TEQ/a.

2 Incomplete Information

There are many incomplete data in this report. There are several reasons:

1) Some industries do not exist in Yemen, so they were not found and hence not reported. This is a poor non-industrialized country.
2) The time span given to collect information was not adequate.
3) The nature of Yemeni managers and management is another obstacle. You have to visit them more than once to collect the right information. Honestly, none of the forms sent was received in a complete satisfactory manner.
4) The supervision of the inventory process was not strict.

In fact, I suggest that some information in this inventory be reconsidered during BAT/PEB process to get the right correct information.

3. Recommendations

.The following recommendations are necessary at the end of this study

1) The most annoying emissions monitored originated from biomass burning, which caused about 60% of the entire emissions in Yemen. Immediate correction measures have to be addressed using BAT/BEP. These are scattered all over the country and coastal provinces.

2) Sludge was not studied because of lack of information. Information has to be collected and action taken.

3) Leaching was studied in a brief approximate manner. This is a serious threat endangering the surface, wells and underground waters. A deeper consideration is required.

4) Medical remnants and guidelines to deal with the POPs security and how to get rid of remnants of research and medical labs, which is not less dangerous than the remnants of hospitals, is crucial. **Disposal** of hazardous materials and remnants of the hospitals, using cement kilns for the final disposal as waste incineration has to be studied carefully as a cheap available option.

5) Industrial and medical waste burning should be addressed carefully. Suitable equipment and incinerators have to be installed where appropriate, provided with spare parts and well trained technicians.

6) BAT/PEB technologies for improvement of plastics recycling, besides recycling of metals would improve dioxin and furan emissions.

7) Copper production is responsible for more than 15 % of the emissions released in Yemen. A BAT/PEB process has to be adopted as soon as possible.

8) Lead production together with thermal wire reclamation is another BAT/PEB recommended sector. I am afraid we saw only the head of the iceberg.

9) Focusing on modernization of industry, and supporting cleaner production mechanisms in old and new factories through BAT/PEB technologies is a must.

10) Awareness is very important. Action to raise awareness of environmental POPs issues should be motivated by all means.

11) Promotion of scientific research in the universities to find the best alternatives to POPs with the performance of economic and environmental studies of the use of such alternatives.

4References

1) Standard Toolkit for Identification and Quantification of Dioxin and Furan .2005Releases
2) .2006Yemen Inventory for dioxins and furans
3) .2006 ,Yemen National Chemical Profile
4) Evaluation of the Inventory of Persistent Organic Pollutants in the Republic of .2006 ,Yemen
5) .2008 ,Yemen Statistical Data

5 MAIN EXCEl SHEET

Cat.	Source Categories	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	16,969	0,000	0,000	0,000	30,188
2	Ferrous and Non-Ferrous Metal Production	124,783	0,000	0,000	0,000	43,012
3	Heat and Power Generation	1,441	0,000	0,000	0,000	0,105
4	Production of Mineral Products	14.77	0,000	0,000	0,000	0,000
5	Transportation	3,866	0,000	0,000	0,000	0,000
6	Open Burning Processes	136,425	0,000	231,151	0,000	0,000
7	Production of Chemicals and Consumer Goods	0,000	0,000	0,000	0,034	0,000
8	Miscellaneous	0,001	0,000	0,000	0,000	0,195
9	Disposal	0,000	0,299	0,000	2,446	3,298
10	Identification of Potential Hot-Spots				0,000	0,000
1-9	**Total**	**283,484**	**0,299**	**231,151**	**2,480**	**76,798**
	Grand Total			**594**		

1Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t)						Production t/a	Annual release					
				Air	Water	Land	Product	Residue: Fly Ash	Residue: Bottom Ash		g TEQ/a Air	g TEQ/a Water	g TEQ/a Land	g TEQ/a Product	g TEQ/a Fly ash	g TEQ/a Bottom Ash
1			**Waste incineration**													
	a		**Municipal solid waste incineration**							**0,000**	**0,000**	**0**	**0**	**0**	**0,000**	**0,000**
		1	Low technol. combustion, no APCS	3,500		NA	NA	0	75		**0,000**				**0,000**	**0,000**
		2	Controlled comb., minimal APCS	350		NA	NA	500	15		**0,000**				**0,000**	**0,000**
		3	Controlled comb., good APCS	30		NA	NA	200	7		**0,000**				**0,000**	**0,000**
		4	High tech. combustion, sophisticated APCS	0,5		NA	NA	15	1,5		**0,000**				**0,000**	**0,000**
	b		**Hazardous waste incineration**							**0,000**	**0,000**	**0**	**0**	**0**	**0,000**	**0,000**
		1	Low technol. combustion, no APCS	35,000		NA	NA	9,000			**0,000**				**0,000**	**0,000**
		2	Controlled comb., minimal APCS	350		NA	NA	900			**0,000**				**0,000**	**0,000**
		3	Controlled comb., good APCS	10		NA	NA	450			**0,000**				**0,000**	**0,000**
		4	High tech. combustion, sophisticated APCS	0,75		NA	NA	30			**0,0000**				**0,000**	**0,000**
	c		**Medical waste incineration**							**5850,240**	**13,739**	**0**	**0**	**0**	**5,134**	**0,054**
		1	Uncontrolled batch combustion, no APCS	40,000		NA	NA		200	270,240	**10,810**				**0,000**	**0,054**
		2	Controlled, batch, no or minimal APCS	3,000		NA	NA		20		**0,000**				**0,000**	**0,000**
		3	Controlled, batch comb., good APCS	525		NA	NA	920	ND	5580,000	**2,930**				**5,134**	
		4	High tech, continuous, sophisticated APCS	1		NA	NA	150			**0,000**				**0,000**	**0,000**

	d		**Light fraction shredder waste incineration**							**2432.000**	**0.730**	**0**	**0**	**0**	**0.000**	**0.000**
		1	Uncontrolled batch comb., no APCS	1.000		NA	NA	ND	ND	640.000	**0.640**					
		2	Controlled, batch, no or minimal APCS	50		NA	NA	ND	ND	1792.000	**0.090**					
		3	High tech, continuous, sophisticated APCS	1		NA	NA	150			**0.000**				**0.000**	**0.000**
	e		**Sewage sludge incineration**							**0.000**	**0.000**	**0**	**0**	**0**	**0.000**	**0.000**
		1	Old furnaces, batch, no/little APCS	50		NA	NA	23			**0.000**				**0.000**	**0.000**
		2	Updated, continuously, some APCS	4		NA	NA	0.5			**0.000**				**0.000**	**0.000**
		3	State-of-the-art, full APCS	0.4		NA	NA	0.5			**0.000**				**0.000**	**0.000**
	f		**Waste wood and waste biomass incineration**							**25000.000**	**2.500**	**0**	**0**	**0**	**25.000**	**0.000**
		1	Old furnaces, batch, no/little APCS	100		NA	NA	1.000		25000.000	**2.500**				**25.000**	**0.000**
		2	Updated, continuously, some APCS	10		NA	NA	10			**0.000**				**0.000**	**0.000**
		3	State-of-the-art, full APCS	1		NA	NA	0.2			**0.000**				**0.000**	**0.000**
	g		**Animal carcasses burning**							**0.000**	**0.000**	**0**	**0**	**0**	**0.000**	**0.000**
		1	Old furnaces, batch, no/little APCS	500		NA	NA		ND		**0.000**				**0.000**	
		2	Updated, continuously, some APCS	50		NA	NA		ND		**0.000**				**0.000**	
		3	State-of-the-art, full APCS	5		NA	NA		ND		**0.000**				**0.000**	
1			**Waste Incineration**								**16.969**	**0**	**0**	**0**	**30.134**	**0.054**
															30.2	

2Category

Cat,.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t)					Production	Annual release				
				Air	Water	Land	Product	Residue	t/a	g TEQ/a	g TEQ/a	g TEQ/a	g TEQ/a	g TEQ/a
2			**Ferrous and Non-Ferrous Metal Production**							**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**Iron ore sintering**						**150.225**	**3.005**	**0**	**0**	**0**	**0.0**
		1	High waste recycling, incl. oil contamin. materials	20	ND	ND	ND	0.003	150.225	**3.005**				**0.000**
		2	Low waste use, well controlled plant	5	ND	ND	ND	0.003		**0.000**				**0.000**
		3	High technology, emission reduction	0.3	ND	ND	ND	0.003		**0.000**				**0.000**
	b		**Coke production**						**784.829**	**2.354**	**1.41269E-07**	**0**	**0**	**0**
		1	No gas cleaning	3	0.06	ND	ND	ND	784.829	**2.354**	**1.41269E-07**			
		2	Afterburner/ dust removal	0.3	0.06	ND	ND	ND		**0.000**	**0**			
	c		**Iron and steel production plants and foundries**						**258.000**	**3**	**0**	**0**	**0**	**4**
			Iron and steel plants						*258.000*	*3*	*0*	*0*	*0*	*3.870*
		1	Dirty scrap, scrap preheating, limited controls	10	ND	ND	NA	15	258.000	**2.580**				**3.870**
		2	Clean scrap/virgin iron, afterburner, fabric filter	3	ND	ND	NA	15		**0.000**				**0.000**
		3	Clean scrap/virgin iron, BOS furnaces	0.1	ND	ND	NA	1.5		**0.000**				**0.000**

		4	Blast furnaces with APC	0.01	ND	ND	NA	ND		0.000				
			Foundries						***0***	***0.000***	***0***	***0***	***0***	***0.0***
		1	Cold air cupola or rotary drum, no APCS	10	ND	ND	NA	ND		0.000				
		2	Rotary drum - fabric filter	4.3	ND	ND	NA	0.2		0.000				0.000
		3	Cold air cupola, fabric filter	1	ND	ND	NA	8		0.000				0.000
		4	Hot air cupola or induction furnace, fabric filter	0.03	ND	ND	NA	0.5		0.000				0.000
			Hot-dip galvanizing plants						**0**	**0.000**	**0**	**0**	**0**	**0.0**
		1	Facilities without APCS	0.06	NA	NA	NA	ND		0.000				
		2	Facilties without degreasing step, good APCS	0.05	NA	NA	NA	2.000		0.000				0.000
		3	Facilities with degreasing step, good APCS	0.02	NA	NA	NA	1.000		0.000				0.000
	d		**Copper production**						**61.970**	**49.576**	**0**	**0**	**0**	**39.0**
		1	Sec. Cu - Basic technology	800	ND	NA	NA	630	61.970	**49.576**				**39.041**
		2	Sec. Cu - Well controlled	50	ND	NA	NA	630		0.000				0.000
		3	Sec. Cu - Optimized for PCDD/PCDF control	5	ND	NA	NA	300		0.000				0.000
		4	Smelting and casting of Cu/Cu alloys	0.03	ND	NA	NA	ND		0.000				
		5	Prim. Cu, well-controlled, with some secondary feed materials	0.01	ND	NA	NA	ND		0.000				
		6	Pure prim. Cu smelters with no secondary feed	ND	ND	NA	NA	NA						
	e		**Aluminum production**						**500.0**	**0.075**	**0**	**0**	**0**	**0.1**
		1	Processing scrap Al, minimal treatment of inputs, simple dust removal	150	ND	NA	NA	200	500.0	**0.075**				**0.100**
		2	Scrap treatment, well controlled, good APCS	35	ND	NA	NA	400		0.000				0.000
		3	Scrap treatment, well-controlled, fabric filter, lime injection	5	ND	NA	NA	100		0.000				0.000
		4	Optimized proces for PCDD/PPCDF abatement	0.5	ND	NA	NA	100		0.000				0.000
		5	Shavings/turnings drying (simple plants)	5.0	NA	NA	NA	NA		0.000				
		6	Thermal de-oiling, rotary furnaces, afterburners, fabric filters	0.3	NA	NA	NA	NA		0.000				
		7	Pure primary Al plants	ND	NA	NA	NA	ND						
	f		**Lead production**						**284.473**	**22.758**	**0**	**0**	**0**	**0.0**
		1	Sec. lead from scrap, PVC battery separators	80	ND	NA	NA	ND	284.473	**22.758**				
		2	Sec. from PVC/Cl2 free scrap, some APCS	8	ND	NA	NA	5		0.000				0.000
		3	Sec. Lead, PVC/Cl2 free scrap in modern furnaces, with scrubber	0.5	ND	NA	NA	ND		0.000				
		4	Pure primary lead production	0.5	ND	NA	NA	ND		0.000				
	g		**Zinc production**						**3.600**	**3.600**	**0**	**0**	**0**	**0**
		1	Kiln with no dust control	1.000	ND	NA	NA	ND	3.600	**3.600**				
		2	Hot briquetting/rotarry furnaces, basic control	100	ND	NA	NA	ND		0.000				
		3	Comprehensive control	5	ND	NA	NA	ND		0.000				
		4	Melting (only)	0.3	ND	NA	NA	ND		0.000				
		5	Pure primary zinc production	ND	ND	NA	NA	ND						
	h		**Brass and bronze production**						**0**	**0.000**	**0**	**0**	**0**	**0.0**
		1	Thermal de-oiling of turnings	2.5	NA	NA	NA	NA		0.000				
		2	Simple melting furnaces	10	NA	NA	NA	ND		0.000				
		3	Mixed scarp, induction furnace, bagfilter	3.5	ND	NA	NA	125		0.000				0.000

		4	Sophisticated equipment, clean inputs, good APCS	0.1	ND	NA	NA	ND		**0.000**				
	i		**Magnesium production**						**0**	**0.000**	**0.0**	**0.0**	**0.0**	**0.0**
		1	Using MgO/C thermal treatment in Cl2, no effluent treatment, poor APCS	250	9000	NA	ND	0		**0.000**	**0.000**			
		2	Using MgO/C thermal treatment in Cl2, comprehensive pollution control	50	24	NA	ND	9000		**0.000**	**0.000**			**0.000**
		3	Thermal reduction process	3	ND	NA	NA	ND		**0.000**				
	j		**Thermal Non-ferrous metal production (e.g., Ni)**						**0**	**0.000**	**0**	**0**	**0**	**0**
		1	Contaminated scrap, simple or no APCS	100	ND	ND	ND	ND		**0.000**				
		2	Clean scrap, good APCS	2	ND	ND	ND	ND		**0.000**				
	l		**Shredders**						**0**	**0.000**	**0**	**0**	**0**	**0**
		1	Metal shredding plants	0.2	NA	NA	ND	ND		**0.000**				
	m		**Thermal wire reclamation**						**8167**	**40.835**	**0**	**0**	**0**	**0**
		1	Open burning of cable	5000	ND	ND	ND	ND	8167	**40.835**				
		2	Basic furnace with after burner, wet scrubber	40	ND	NA	ND	ND		**0.000**				
		3	Burning electric motors, brake shoes, etc., afterburner	3.3	ND	NA	ND	ND		**0.000**				
2			**Ferrous and Non-Ferrous Metal Production**							**124.783**	**0.000**	**0.000**	**0.000**	**43.012**

3Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/TJ) Air	Water	Land	Product	Residue	Production TJ/a	Annual release g TEQ/a	g TEQ/a Air	g TEQ/a Water	g TEQ/a Land	g TEQ/a Product	g TEQ/a Residue
3			**Heat and Power Generation**								**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**Fossil fuel power plants**						**35776**	**0.051**	**0**	**0**	**0**	**0.0**
		1	Fossil fuel/waste co-fired power boilers	35	ND	NA	NA	ND	530	**0.019**				
		2	Coal fired power boilers	10	ND	NA	NA	14		**0.000**				**0.000**
		3	Heavy fuel fired power boilers	2.5	ND	NA	NA	ND	7224	**0.018**				
		4	Shale oil fired power plants	1.5	ND	NA	NA	ND		**0.000**				
		5	Light fuel oil/natural gas fired power boilers	0.5	ND	NA	NA	ND	28022	**0.014**				
	b		**Biomass power plants**						**7032**	**0.352**	**0**	**0**	**0**	**0.1**
		1	1. Mixed biomass fired power boilers	500	ND	NA	NA	ND		**0.000**				
		2	2. Clean wood fired power boilers	50	ND	NA	NA	15	7032	**0.352**				**0.105**
	c		**Landfill and biogas combustion**						**0**	**0.000**	**0**	**0**	**0**	**0.0**
		1	Biogas-/landfill gas fired boilers, motors/turbines and flaring	8	ND	NA	NA	NA		**0.000**				
	d		**Household heating and cooking - Biomass**					µg TEQ/t Ash	**10387**	**1.039**	**0**	**0**	**0**	**0.0**
		1	Contaminated wood/biomass fired	1500	ND	NA	NA	1000		**0.000**				**0.000**

			stoves											
		2	Virgin wood/biomass fired stoves	100	ND	NA	NA	10	10,387	**1,039**				**0,000**
	e		**Domesting heating - Fossil fuels**					µg TEQ/t Ash	**0**	**0,000**	**0**	**0**	**0**	**0,0**
		1	High-chlorine coal fired stoves	12,000	ND	NA	NA	30,000		**0,000**				**0,000**
		2	Coal fired stoves	100	ND	NA	NA	5,000		**0,000**				**0,000**
		3	Oil fired stoves	10	ND	NA	NA	NA		**0,000**				
		4	Natural gas fired stoves	1,5	ND	NA	NA	NA	0	**0,000**				
3			**Heat and Power Generation**							**1,441**	**0**	**0**	**0**	**0,1**

4Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t)					**Production**	**Annual release**				
				Air	Water	Land	Product	Residue	**t/a**	**g TEQ/a**	**g TEQ/a**	**g TEQ/a**	**g TEQ/a**	**g TEQ/a**
4			**Production of Mineral Products**							**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**Cement kilns**						**2,357,125**	**1.45**	**0**	**0**	**0**	**0**
		1	Shaft kilns	5	NA	NA	ND	ND	270,000	**1,350**				
		2	Old wet kilns, ESP temperature >300 °C	5	NA	ND	ND	NA	0.00	**0.000**				
		3	Wet kilns, ESP/FF temperature 200 to 300 °C	0,6	NA	ND	ND	NA		**0,000**				
		4	Wet kilns, ESP/FF temperature <200 °C and all types of dry kilns with preheater/precalciner, T<200 °C	0,05	NA	ND	ND	NA		**0.1**				
									2,087,125					
	b		**Lime**						**494,190**	**4,942**	**0**	**0**	**0**	**0**
		1	Cyclone/no dust control, contaminated or poor fuels	10	ND	ND	ND	ND	494,190	**4,942**				
		2	Good dust abatement	0,07	ND	ND	ND	ND		**0,000**				
	c		**Brick**						**38,687,569**	**7,738**	**0**	**0**	**0**	**0**
		1	Cyclone/no dust control, contaminated or poor fuels	0,2	NA	ND	ND	ND	38,687,569	**7,738**				
		2	Good dust abatement	0,02	NA	ND	ND	ND		**0,000**				
	d		**Glass**						**0**	**0,000**	**0**	**0**	**0**	**0**
		1	Cyclone/no dust control, contaminated or poor fuels	0,2	NA	ND	ND	ND		**0,000**				
		2	Good dust abatement	0,015	NA	ND	ND	ND		**0,000**				
	e		**Ceramics**						**0**	**0,000**	**0**	**0**	**0**	**0**
		1	Cyclone/no dust control, contaminated or poor fuels	0,2	NA	ND	ND	ND		**0,000**				
		2	Good dust abatement	0,02	NA	ND	ND	ND		**0,000**				
	f		**Asphalt mixing**						**9,074,400**	**0,635**	**0**	**0**	**0**	**0,000**

		1	Mixing plant with no gas cleaning	0،07	NA	ND	ND	ND	9،074،400	**0،635**				
		2	Mixing plant with fabric filter, wet scrubber	0،007	NA	ND	ND	0،06		**0.000**				**0.000**
	g		**Oil shale processing**						**0**	**0.000**	**0**	**0**	**0**	**0.000**
		1	Thermal fractionation	ND	ND	ND	ND	ND						
		2	Oil shale pyrolysis	0،003	NA	ND	0،07	2		**0.000**			**0.000**	**0.000**
4			**Production of Mineral Products**							**14.77**	**0**	**0**	**0**	**0.000**

5Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t) Air	Water	Land	Product	Residue	Consumption t/a *	Annual release g TEQ/a Air	g TEQ/a Water	g TEQ/a Land	g TEQ/a Product	g TEQ/a Residue
5			**Transport**							**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**4-Stroke engines**						**1،040،953**	**2،290**	**0**	**0**	**0**	**0**
		1	Leaded fuel	2،2	NA	NA	NA	NA	1،040،953	**2،290**				
		2	Unleaded fuel without catalyst	0،1	NA	NA	NA	NA		**0.000**				
		3	Unleaded fuel with catalyst	0،00	NA	NA	NA	NA		**0.000**				
	b		**2-Stroke engines**						**259،686**	**0.909**		**0**	**0**	**0**
		1	Leaded fuel	3،5	NA	NA	NA	NA	259،686	**0.909**				
		2	Unleaded fuel without catalyst	2،5	NA	NA	NA	NA		**0.000**				
	c		**Diesel engines**						**3،125،108**	**0.313**	**0**	**0**	**0**	**0**
		1	Diesel engines	0،1	NA	NA	NA	ND	3،125،108	**0.313**				
	d		**Heavy oil fired engines**						**88،631**	**0.355**	**0**	**0**	**0**	**0**
		1	All types	4	NA	NA	NA	ND	88،631	**0.355**				
5			**Transport**							**3،866**	**0**	**0**	**0**	**0**

6Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t) Air	Water	Land	Product	Residue	Production t/a	Annual release g TEQ/a Air	g TEQ/a Water	g TEQ/a Land	g TEQ/a Product	g TEQ/a Residue
6			**Open Burning Processes**							**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**Fires/burnings - biomass**						**917**	**0.019**	**0**	**0.007**	**0**	**0**
		1	Forest fires	5	ND	4	NA	ND		**0.000**		**0.000**		
		2	Grassland and moor fires	5	ND	4	NA	ND	352	**0.002**		**0.001**		
		3	Agricultural residue burning (in field), impacted, poor combustion conditions	30	ND	10	NA	ND	565	**0.017**		**0.006**		
		4	Agricultural residue burning (in field), not impacted	0،5	ND	10	NA	ND		**0.000**		**0.000**		
	b		**Fires, waste burning, landfill fires, industrial fires, accidental fires**						**385،712**	**136،407**	**0**	**231،144**	**0**	**0**

		1	Landfill fires	1,000	ND	600	NA	600	29,536	**29,536**		**17,722**		
		2	Accidental fires in houses, factories	400	ND	400	NA	400	690	**0.276**		**0.276**		
		3	Uncontrolled domestic waste burning	300	ND	600	NA	600	355,237	**106,571**		**213,142**		
		4	Accidental fires in vehicles (per vehicle)	94	ND	18	NA	18	249	**0.023**		**0.004**		
		5	Open burning of wood (construction/demolition)	60	ND	10	NA	10		**0.000**		**0.000**		
6			**Open Burning Processes**							**136,425**	**0**	**231,151**	**0**	**0.000**

7Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t)					Production	Annual release				
				Air	Water	Land	Product	Residue	t/a	g TEQ/a	g TEQ/a	g TEQ/a	g TEQ/a	g TEQ/a
7			**Production and Use of Chemicals and Consumer Goods**							**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**Pulp and paper mills ***							**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
			Boilers (per ton of pulp)						**0**	**0.000**	**0**	**0**	**0**	**0.000**
		1	Black liquor boilers, burning of sludges, wood	0.07				NA		**0.000**				
		2	Bark boilers only	0.2				50		**0.000**				**0.000**
			Acqueous discharges and products						0		**0.000**		**0.000**	**0.000**
		1	Kraft process, Cl2 gas, non-wood fibers, impacted		ND		30	ND					**0.000**	
		2	Kraft process, old technology (Cl2)		4.5		8	4.5			**0.000**		**0.000**	**0.000**
		3	Kraft process, mixed technology		1.0		3	1.5			**0.000**		**0.000**	**0.000**
		4	Sulfite pulp/papers, old technology		ND		1	ND					**0.000**	
		5	Kraft process, modern technology (ClO2)		0.06		0.5	0.2			**0.000**		**0.000**	**0.000**
		6	Sulfite papers, new technology (ClO2, TCF)		ND		0.1	ND					**0.000**	
		7	TMP pulp		ND		1.0	ND					**0.000**	
		8	Recycling papers from contaminated waste papers		ND		10						**0.000**	
		9	Recycling pulp/paper from modern papers		ND		3	ND					**0.000**	
	b		**Chemical industry**							**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
			PCP						0	**0**	**0**	**0**	**0.000**	**0**
		1	European, American production (chlorination of phenol with Cl2)				2.000.000						**0.000**	
		2	Chinese production (thermolysis of HCH)				800.000						**0.000**	
		3	PCP-Na				500						**0.000**	
			PCB						0	**0**	**0**	**0**	**0.0**	**0**
		1	Low chlorinated, e.g., Clophen A30, Aroclor 1242				15.000							
		2	Medium chlorinated, e.g., Clophen A40, Aroclor 1248				70.000						**0.000**	
		3	Medium chlorinated, e.g., Clophen A50, Aroclor 1254				300.000						**0.000**	
		4	High chlorinated, e.g., Clophen A60, Aroclor 1260				1.500.000						**0.000**	
			Chlorinated Pesticides						0	**0**	**0**	**0**	**0.000**	**0**
		1	Pure 2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)				7.000						**0.000**	
		2	2,4,6-Trichlorophenol (2,4,6-PCPh)				700						**0.000**	
		3	Dichlorprop				1.000						**0.000**	
		4	2,4-Dichlorophenoxy acetic acid (2,4-D)				700						**0.000**	
		5	2,4,6-Trichlorophenyl-4'-nitrophenyl ether (CNP = chloronitrofen)						*0*	*0*	*0*	*0*	*0.000*	*0*
			Old technology				300.000						**0.000**	
			New technology				400						**0.000**	
			Chloranil						0	**0**	**0.0**	**0.0**	**0.000**	**0**
		1	*p*-chloranil *via* chlorination of phenol				400.000						**0.000**	
		2	*p*-chloranil *via* hydrochinone				100						**0.000**	
		3	Dyestuffs on chloranil basis (old process, Class 1)				1.200						**0.000**	
		4	*o*-chloranil *via* chlorination of phenol				60.000						**0.000**	

			Chlorobenzenes						0	**0**	**0**	**0**	**0**	**0**
		1	*p*-Dichlorobenzene	ND	NA	NA	39	ND					**0.000**	
		2	*o*-Dichlorobenzene	ND	NA	NA	0	ND					**0.000**	
		3	1,2,4-Trichlorobenzene	ND	NA	MA	0	3.000					**0.000**	**0**
			Chlorine/chloralkali production						0	**0**	**0**	**0**	**0**	**0**
			Chloralkali production using graphite anodes	NA	NA	NA	NA	1.000						**0**
			ECD/VCM/PVC						0	**0.0**	**0.0**		**0.000**	**0**
		1	Old technology, EDC/VCM, PVC		1	NA		ND			**0**			
		2	Modern plants, EDC/VCM or EDC/VCM/PVC	0.4	0.5	NA	0.03	10		**0**	**0.000**		**0.000**	**0**
		3	PVC only	0.0003	0.03	NA	0.1	0.2		**0**	**0**		**0.000**	**0.0**
	c		**Petroleum refineries**						**0**	**0.0**	**0**	**0**	**0**	**0**
		1	All types (flares) (µg TEQ/TJ) **	8	NA	NA	NA	ND		**0**				
	d		**Textile plants**						**2.277**	**0**	**0**	**0**	**0.0002 277**	**0**
		1	Upper limit	NA	ND	NA	100	ND					**0**	
		2	Lower limit	NA	ND	NA	0.1	ND	2.277				**0.0002 277**	
	e		**Leather plants**						**3.400**	**0**	**0**	**0**	**0.034**	**0**
		1	Upper limit	NA	ND	NA	1.000	ND					**0**	
		2	Lower limit	NA	ND	NA	10	ND	3.400				**0.034**	
7			**All Main Sectors**							**0.000**	**0.000**	**0.000**	**0.034**	**0**

8Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t)					**Production**	**Annual release**				
				Air	Water	Land	Product	Residue	**t/a**	**g TEQ/a**	**g TEQ/a**	**g TEQ/a**	**g TEQ/a**	**g TEQ/a**
8			**Miscellaneous**							**Air**	**Water**	**Land**	**Product**	**Residue**
	a		**Drying of biomass**						**0**	**0.000**	**0**	**0**	**0.000**	**0**
		1	Clean wood	0.007	NA	ND	0.1	ND		**0.000**			**0.000**	
		2	Green fodder	0.1	NA	ND	0.1	ND		**0.000**			**0.000**	
		3	PCP- or otherwise treated biomass	10	NA	ND	0.5	ND		**0.000**			**0.000**	
	b		**Crematoria**						**0**	**0.000**	**0**	**0**	**0**	**0.000**
		1	No control (per cremation)	90	NA	NA	NA	ND		**0.000**				
		2	Medium control (per cremation)	10	NA	NA	NA	2.5		**0.000**				**0.000**
		3	Optimal control (per cremation)	0.4	NA	NA	NA	2.5		**0.000**				**0.000**
	c		**Smoke houses**						**0**	**0.000**	**0**	**0**	**0**	**0.000**
		1	Treated wood, waste fuels used as fuel	50	NA	ND	ND	2.000		**0.000**				**0.000**
		2	Clean fuel, no afterburner	6	NA	ND	ND	20		**0.000**				**0.000**
		3	Clean fuel, afterburner	0.6	NA	ND	ND	20		**0.000**				**0.000**
	d		**Dry cleaning residues**						**131**	**0**	**0**	**0**	**0**	**0.195**
		1	Heavy textiles, PCP-treated, etc.	NA	NA	NA	NA	3.000	64					**0.192**
		2	Normal textiles	NA	NA	NA	NA	50	68					**0.003**
	e		**Tobacco smoking**						**5.100.000.000**	**0.0005**	**0**	**0**	**0**	**0**
		1	Cigar (per item)	0.3	NA	NA	NA	NA		**0.0000**				
		2	Cigarette (per item)	0.1	Na	NA	NA	NA	5.100.000.000	**0.0005**				
8			**Miscellaneous**							**0.001**	**0**	**0**	**0.000**	**0.195**

9Category

Cat.	Subcat.	Class	Sub-categories	Potential Release Route (µg TEQ/t) Air	Water	Land	Product	Residue	Production	Annual release g TEQ/a Air	g TEQ/a Water	g TEQ/a Land	g TEQ/a Product	g TEQ/a Residue
9			**Disposal**		µg TEQ/m³			µg TEQ/m³						
	a		**Landfill leachate**						**308‹021**	**0**	**0‹015**	**0**	**0**	**3‹297926**
		1	Hazardous waste *	NA	0‹2	NA	NA	50	32‹950		**0‹007**			**1‹6475**
		2	Non-hazardous waste *	NA	0‹03	NA	NA	6	275‹071		**0‹008**		**0**	**1‹650426**
	b		**Sewage/sewage treatment**						**32‹028‹009**		**0‹016**	**0**	**0**	**0‹000**
		1	Industrial, mixed domestic with chlorine relevance	NA					*57‹814*		*0‹000*	*0*	*0*	*0‹000*
			No sludge removal	NA	0‹005	NA	NA	1‹000	57‹814		**0‹000**			**0‹000**
			With sludge removal	NA	0‹0005	NA	NA	1‹000			**0‹000**			**0‹000**
		2	Urban environments	NA					*31‹970‹195*		*0‹016*	*0*	*0*	*0‹000*
			No sludge removal	NA	0‹002	NA	NA	100			**0‹000**			**0‹000**
			With sludge removal	NA	0‹0005	NA	NA	100	31‹970‹195		**0‹016**			**0‹000**
		3	Remote and residential or modern treatment plant	NA	0‹0001	NA	NA	10			**0‹000**			**0‹000**
	c		**Open water dumping**						**53‹654‹306**	**0**	**0‹268**	**0**	**0**	**0**
		1	Mixed domestic and industrial inputs	NA	0‹005	NA	NA	NA	53‹654‹306		**0‹268**			
		2	Urban environments	NA	0‹0002	NA	NA	NA			**0‹000**			
		3	Remote environments or input control	NA	0‹0001	NA	NA	NA			**0‹000**			
	d		**Composting**						**24‹455**	**0**	**0**	**0**	**2‹446**	**0**
		1	All organic fraction	NA	ND	NA	100	NA	24‹455				**2‹446**	
		2	Garden, kitchen wastes	NA	ND	NA	15	NA					**0‹000**	
		3	Green materials,not impacted environments	NA	ND	NA	5	NA					**0‹000**	
	e		**Waste oil disposal**						**0**	**0**	**0**	**0**	**0**	**0**
		1	All fractions	ND	ND	ND	ND	ND						
9			**Disposal/Landfill**							**0‹000**	**0‹299**	**0**	**2‹446**	**3‹297926**

10Category

Cat.	Subcat.	Class	Sub-categories	Product (µg TEQ/t)	Occurrence (t)	g TEQ identified Air	Water	Land	Product	Residue
10			**Identification of Hot Spots**			x indicates need for site-specific evaluation				
	a		**Production sites of chlorinated organics**							
		1	Chlorophenols and derivatives or PCB				x	x		
		2	Other chlorinated organics					x		
	b		**Production sites of chlorine**							

		1	with graphite electrodes				x	x		
		2	without graphite electrodes				x	x		
	c		**Formulation of chlorinated phenols/pesticides**				x	x		
	d		**Application sites of dioxin-contaminated pesticides**					x		
	e		**Timber manufacture**							
		1	Using pentachlorophenol, other dioxin-containing preservatives				x	x		
		2	No use of PCP, not open to the environment				x	x		
	f		**PCB containing equipment**		**0**				**0**	
			Low chlorinated, e.g., Clophen A30, Aroclor 1242	15‹000					**0**	
			Medium chlorinated, e.g., Clophen A40, Aroclor 1248	70‹000					**0**	
			Medium chlorinated, e.g., Clophen A50, Aroclor 1254	300‹00 0					**0**	
			High chlorinated, e.g., Clophen A60, Aroclor 1260	1‹500‹ 000					**0**	
		1	Leaching				x	x		
		2	Not leaching				x	x		
	g		**Dumps of waste/residues from categories 1-9**				x	x		
	h		**Sites of relevant accidents**				x	x		
	i		**Dredging of sediments**				x	x		
10			**Hot spots**						**0**	**0**