United Kingdom

Description of surveyed documents

After publication of individual estimations on the national PCDD/F emissions during the recent past ‹1›, ‹2› the United Kingdom has presented a comprehensive inventory in 1995 ‹3›. This study considers almost all relevant emission sources. Concerning the sectors waste incineration, sintering plants, combustion of tyres and cement production it is based on measurement results; however, in most cases estimations are derived from statistical data and emission factors taken from the scientific literature.

The UK inventory covers only air emissions of dioxins and furans; for the major part of the considered emission sources it presents probable emission ranges. For the European Dioxin Inventory the data from the UK inventory were re-evaluated in order to assess the uncertainty ranges using the chosen index-system. Naturally, the new ranges differ from those reported in the UK inventory (560-1100 g I-TEQ/a, c.f. the following table). Actually, the maximum value given in the UK inventory is more than doubled. This mainly results due to the large uncertainty index of „4“ attributed to the sector of non ferrous metal production. In the UK inventory this sector is assessed as a whole; one activity rate without differentiation according to specific production processes is used in connection with emission factors taken from foreign publications. Disregarding the contribution of this industrial sector would lead to a decrease of the maximum estimate to about 1271 g I-TEQ/a which is comparable to the upper emission estimate proposed in the UK report.

CORINAIR SNAP	ITEM	Emission estimates g I-TEQ/a		
		typ	min	max
	SUM	702.0	559.4	2561.0
01	Combustion in Energy Production and Energy Transformation	10.7	3.4	33.7
02	Combustion in Commercial, Residential...	32.0	22.7	45.2
03	Combustion in Industry	82.7	35.7	1643.2
04	Production Processes	12.84	2.8	115.1
05	Extraction and Distribution of Fossil Fuels	nd	nd	nd
06	Solvent and Other Product USE	0.3	0.1	1.0
07	Road Transport	6.1	0.6	60.7
08	Other Mobile Sources and Machinery	nd	nd	nd
09	Waste Treatment and Disposal	568.4	498.9	675.1
10	Agriculture, Forestry, Land use change	nd	nd	nd
11	Nature	2.2	0.2	21.9
12	Fires	nd	nd	nd

UK: Annual PCDD/F air emissions (nd: no data available)

01 01
Public power

General Remark:

Here only combustion of fossil fuels for public power generation is considered; for industrial combustion of other fuels see also 03 01; for co-combustion of sewage sludge see 09 02 05

Considered pathways/media:

Atmosphere.

Measurements:

In the UK measurements were carried out at 4 power generating plants all using coal as primary energy source, the measurement results were not reported. Measurements at plants using other primary energy sources for public power generation were not reported.

Plant data:

The UK report contains information on the number and capacity of the investigated plants and it mentions the kind of coal employed (e.g. bituminous coal). Power generation plants use coal as pulverised fuel.

National activity rates:

Data on the annual coal consumption by power generation plants and industrial/ comercial furnaces are supplied for the UK for the year 1992.

Year	**1992**
public power [kt/a]	77,000

UK: Public power; activity rates

01 01

Public power

Emission factors:

The emission factors applied to power generation are based on English values published in the literature ‹4,5›. These emission factors are used to calculate the emissions by power plants and industrial/comercial plants.

Public power	**Emission factor [µg I-TEQ/t]**
minimal	0.06
maximal	0.32
geom. mean	0.14
arithmetric mean	0.19

UK: Public power; emission factors in [µg I-TEQ/t]

Estimation of uncertainty:

For the estimation of uncertainty the evaluation method of the Belgian Dioxin inventory is used. The activity rates are considered to be precise (index: 0). For the emission factors of power plants the uncertainty margin is one decade (index 1).

Public power	
activity rates	0
emission factors	1
total uncertainty	**1**

UK: Public power; indices of uncertainty

Emission estimation:

In the UK dioxin inventory the emissions into the atmosphere caused by the use of coal for power generation is being estimated with the emission factors and activity rates above:

Public power	**g I-TEQ/a**
annual emission	10.7
margin of uncertainty	3.4 - 33.7

UK: Public power; annual PCDD/F emissions

02 01 / 02 03
03 01 01 - 03
Commercial and institutional plants / plants in agriculture, forestry and fishing
Combustion plants (boilers)

General Remark:

Here only commercial and industrial combustion of coal is considered; for industrial combustion of other fuels see also 03 01; for co-combustion of sewage sludge see 09 02 05

Considered pathways/media:

Atmosphere.

Measurements:

In the UK measurements were carried out at 19 industrial/commercial plants all using coal as primary energy source. The measurement results were not reported.

Plant data:

The UK report contains information on the number and capacity of the investigated plants and it mentions the kind of coal employed (e.g. bituminous coal, anthracite).

National activity rates:

Data on the annual coal consumption by industrial / comercial boilers are supplied from the UK for the year 1992.

Year	**1992**
industry / comercial [kt/a]	8,800

UK: Commercial and institutional plants / plants in agriculture, forestry and fishing Combustion plants (boilers); activity rates

02 01 / 02 03
03 01 01 - 03

Commercial and institutional plants / plants in agriculture, forestry and fishing Combustion plants (boilers)

Emission factors:

Emission factors applied to power generation (based on English values published in the literature see 01 01) are used to calculate the emissions by industrial and comercial plants.

Industrial/ comercial plants	**Emission factor [µg I-TEQ/t]**
minimal	0.04
maximal	4.8
geom. mean	0.44
arithmetric mean	2.42

UK: Commercial and institutional plants / plants in agriculture, forestry and fishing Combustion plants (boilers); emission factors

Estimation of uncertainty:

For the estimation of uncertainty the evaluation method of the Belgian Dioxin inventory was used (see 01 01). The activity rates are considered to be precise (index: 0). For industrial / comercial plants an uncertainty margin of two decades (index 2) is obtained.

Industrial / comercial plants	
activity rates	0
emission factors	2
total uncertainty	**2**

UK: Commercial and institutional plants / plants in agriculture, forestry and fishing Combustion plants (boilers); indices of uncertainty

Emission estimation:

In the UK dioxin inventory the emissions into the atmosphere caused by the use of coal in industrial and commercial boilers is being estimated with the emission factors and activity rates above:

Industrial/comercial plants	**g I-TEQ/a**
annual emission	3.9
margin of uncertainty	0.4 - 38.6

UK: Commercial and institutional plants / plants in agriculture, forestry and fishing Combustion plants (boilers);
annual PCDD/F emissions

02 02
Residential plants

General Remark:

The UK dioxin inventory gives a report on dioxin emissions out of domestic fireplaces using wood and coal or lignite.

Considered pathways/media:

Atmosphere.

Measurements:

The UK report does not supply results of measurements, though studies are quoted performed in the UK and other countries.

Plant data:

No information on the number or type of heating systems or fireplaces is provided.

National activity rates:

For the consumption of coal, statistic data for the year 1992 are provided. For wood consumption an estimate of the Department of Trade and Industry (DTI) is cited ‹6›.It is assumed that 1/9 of the total wood consumed comprises treated wood. For obtaining an estimate of the emissions the various types of fuels are combined into 5 groups:

1. clean wood,
2. treated wood,
3. anthracite,
4. bituminous coal and
5. smokeless fuel

For the above groups following consumption data are given:

fuel	1992	1994
clean wood	-	800
treated wood	-	100
anthracite	1,303	-
bituminous coal	2,853	-
smokeless fuel	1,090	-

UK: Residential plants; consumption of fuels [kt/a]

Emission factors:

The emission factors for domestic wood combustion rely on studies performed in the UK and other countries ‹7, 8, 9, 10›. The emission factors for domestic coal combustion rely on reported test results of CRE ‹11, 12›. The factors and their means are presented in the 5 tables following:

Parameter Residential plants	wood clean	wood, treated	bituminous coal	smokeless fuel	anthracite
minimal	1	10	5.7	0.7	
maximal	29	50	9.3	4.7	
geom. mean	5.39	22.36	7.28	1.81	
arith. mean	15.00	30.00	7.50	2.70	2,1

UK: Residential plants; emission factors [µg I-TEQ/t]

Estimation of uncertainty:

The activity rates and emission factors are considered to be rather precise (index 0 or 1). Considering combustion of treated wood it has to be kept in mind that aktivity rates and emission factors are rough estimates therefore the uncertainty index ”1” was applied. According to the data mentioned above the following indices were set up for coal and wood burning:

	clean wood	treated wood	anthracite	bitum.coal	smokel. fuel
Activity rates	0	1	0	0	0
emission factors	1	1	0	0	1
total uncertainty	**1**	**2**	**0**	**0**	**1**

UK: Residential plants; indices of uncertainty

If the uncertainty indices are weighted by the contributions of the various fuel classes to the total emissions (for 1992/94 the ratios of clean wood to treated wood, anthracite,

bituminous coal and to smokeless fuel are = 8 : 1 : 13 : 28.5 : 10.9), the following overall uncertainty index is obtained:

Year	**1992/94**
Total index	0.3

UK: Residential plants; uncertainty index weighted by fuel contribution

Estimation of annual emission:

With the above data the following annual emissions are obtained:

Fuel	**1992/94**
clean wood	4.31
treated wood	2.24
anthracite	2.74
bituminous coal	20.77
smokeless fuel	1.97
total	32.03
margin of uncertainty	23 - 45

UK: Residential plants; annual PCDD/PCDF emissions [g I-TEQ]

Comment:

The UK inventory reports a margin of uncertainty of 22 to 52 g I-TEQ per year, which is in good agreement with the recalculation of this report.

03 01
Combustion in boilers, gas turbines and stationary engines

General Remark:

For the combustion of coal in industry see 02 01 / 02 03 / 03 01 01 - 03. Under this CORINAIR code the industrial combustion of wood, straw, tyres and of gases emitted by landfills in the UK is considered. For flared and escaping landfill gas see 09 02 06 and 09 10 04 respectively. The combustion of waste oil is treated under 09 02 08.

Considered pathways/media:

Atmosphere.

Measurements:

In the UK inventory measurement results of the UK are reported for the combustion of tyres and landfill gas‹13,14,15›. In addition measurement results from other countries are quoted for the combustion of straw and landfill gas ‹9,13,16›. The next table presents the measurement results from the UK:

Fuel	1991	1993/94
combustion of tyres	-	0.8 - 4.6
combustion of landfill gas (exhaust)	-	0.078 - 0.097
combustion of landfill gas (raw gas)	-	0.32 - 0.36
combustion of landfill gas (exhaust)	1.2	-

UK: Combustion in boilers, gas turbines and stationary engines; measurement results from the UK; PCDD/PCDF emissions [ng I-TEQ/m^{-3}]

Plant data:

The UK report quotes 3 plants (one of them closed some time ago) and their capacities for tyres combustion. For the calculations in this report only the two plants still running were taken into account. No information on the number and capacity of plants for wood, straw and landfill gas combustion is given.

03 01

Combustion in boilers, gas turbines and stationary engines

National activity rates:

According to the UK report 94,000 t of tyres are combusted every year. For the consumption of wood and straw an estimate of the Energy Technology Support Unit is cited ‹13›. For landfill gas an estimate of the Department of the Environment is given ‹17›.To obtain an estimate of the total emissions the various types of fuels are combined into 5 groups:

1. untreated wood
2. treated wood
3. straw,
4. tyres,
5. landfill gas,

For the above groups following consumption data are given:

fuel	1994
untreated wood	50
treated wood	150
straw	200
tyres	94
landfill gas	308

UK: Combustion in boilers, gas turbines and stationary engines; consumption of fuels [kt/a] (except landfill gas in [Mm³/a])

Emission factors:

From the emission factors for wood combustion quoted in publications only values for the combustion of untreated and treated wood (without PCP) were considered in the UK report ‹8,9,10›. No explanation is given why values for the combustion of treated wood (with PCP, comprising concentrations of 25 to 168 µg I-TEQ/t‹7,9›) were ignored. The emission factors for the combustion of straw relay on a few values from Sweden and the UK ‹8,16›. As in the UK both operating plants for the combustion of tyres are ”Part A” processes, and therefor have to restrict dioxin emissions to below 1 ng I-TEQ/Nm³ ie 18 µg I-TEQ/t, this value was taken for the UK inventory and for this report. The emission factor for the combustion of landfill gas is derived from results

obtained in the Netherlands, Germany and the UK ‹9,14,15,18›. The factors and their means are presented in the 5 tables following:

Parameter	**wood clean**	**wood treated**	**straw**	**landfill gas**	**tyres**
	[µg I-TEQ/t]	[µg I-TEQ/t]	[µg I-TEQ/t]	[µg I-TEQ/t]	[ng I-TEQ/m^3]
minimal	1	9	17	0.006	14
maximal	2	19	50	1.2	228
geom. mean	1.41	13.08	29.15	0.08	18 (typical)
arith. mean	1.50	14.00	33.50	0.60	

UK: Combustion in boilers, gas turbines and stationary engines; emission factors

Estimation of uncertainty:

The activity rates and emission factors are considered to be precise for tyres and fairly precise for straw (index 0). Considering combustion of wood it has to be kept in mind that aktivity rates and emission factors (particularly for treated wood) are rough estimates therefore the uncertainty indices ”1 or 2” were applied, the same goes for landfill gas combustion (indices ”1 and 3”). According to the data mentioned above the following indices were set up:

	clean wood	treated wood	straw	tyres	landfill gas
Activity rates	1	1	0	0	1
emission factors	0	2	1	1	3
total uncertainty	**1**	**3**	**1**	**1**	**4**

UK: Combustion in boilers, gas turbines and stationary engines; indices of uncertainty

If the uncertainty indices are weighted by the contributions of the various fuel classes to the total emissions (for 1994 the ratios of clean wood, treated wood, straw, tyres and landfill gas are = 5 : 15 : 20 : 9.4 : 30.8), the following overall uncertainty index is obtained:

Year	**1992/94**
Total index	2.5

UK: Combustion in boilers, gas turbines and stationary engines; uncertainty index weighted by fuel contribution

Estimation of annual emission:

With the above data the following annual emissions are obtained:

Fuel	1992/94
untreated wood	0.07
treated wood	1.96
straw	5.83
tyres	1.69
landfill gas	0.02
total	9.57
margin of uncertainty	0.54 - 170.18

UK: Combustion in boilers, gas turbines and stationary engines; annual PCDD/PCDF emissions [g I-TEQ]

03 03 01
Sinter plants

Considered pathways/media:

Atmosphere

Measurements:

In the UK report measurement results of five sinter plants are specified.

Sinter plant	1995
Scunthorpe	0.6 - 1.0
Port Talbot	0.6 - 1.6
Llanwern B	2.0 - 3.4
Llanwern C	1.4 - 2.4
Redcar	1.0 - 1.7

UK: Sinter plants; measurement results from the UK; PCDD/PCDF emissions [ng I-TEQ/m^{-3}]

Plant data:

The UK report gives information on production capacities and on waste gas volumes (in Nm^3/t) for every British sinter plant.

National activity rates:

The figures on total production of sinter material in 1994 are taken from a personal communication of HMIP, the values for each sinter plant were provided by British Steel ‹19›:

Year	1994
Scunthorp	5,191
Port Talbot	3,587
Llanwern B	1,387
Llanwern C	1,472
Redcar	3,459
Production (total) [kt]	15,100

UK: Sinter plants; annual production in kt/a

03 03 01

Sinter plants

Emission factors:

As the UK report contains detailed data on production capacities, waste gas volumes and emission concentrations for every sinter plant, emission factors and annual emissions can be calculated directly. The results are paralleled with the outcome of the calculations using the given emission factor range of

1.2 - 9.0 µg/t.

The results are presented in the table following:

	Emission factors [µg I-TEQ/t]					
	Scunthorpe	Port Talbot	Llanwern B	Llanwern C	Redcar	all plants
minimal	1.20	1.35	5.31	3.16	1.73	1.2
maximal	1.99	3.60	9.02	5.42	2.94	9.0
geom. mean	1.55	2.20	6.92	4.14	2.26	3.29
arith. mean	1.60	2.48	7.16	4.29	2.34	5.10

UK: Sinter plants; emission factors

Estimation of uncertainty:

The emission factors and the activity rates are both considered to be precise (index 0), so a total index of "0" is obtained. However, in order to obtain an estimate of the emissions the mentioned lowest and highest emission factors were used.

Activity rates	0
emission factors	0
total uncertainty	**0**

UK: Sinter plants; indices of uncertainty

Estimation of annual emission:

	Scunthorpe	**Port Talbot**	**Llanwern B**	**Llanwern C**	**Redcar**	**all plants**
annual emission	8.05	7.89	9.60	6.09	7.82	39.5
Margin of Uncertainty	6.23 -10.33	4.84 -12.91	7.36 -12.51	4.65 -7.98	5.98 -10.17	29 -54

UK: Sinter plants; annual PCDD/PCDF emissions [g I-TEQ]/a

03 03 04
Primary lead production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 05
Primary zinc production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 06
Primary copper production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 07
Secondary lead production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 08
Secondary zinc production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 09
Secondary copper production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 10
Secondary aluminium production

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 11
Cement

Considered pathways/media:

AIR

Measurements:

Up to now there are only limited British data about dioxin emissions from cement kilns but trials are going on to asses the burnig of waste solvents in cement and lime kilns. A range of measurement results apparently obtained by the British Cement Association (BCA) at plants not specified is cited; with 0.01 to 0.35 ng I-TEQ/m³ (at stack conditions).

Plant data:

No informations on the plants existing in the UK are provided.

National activity rates:

The UK cement production is reported as follows‹20›:

Year	**1993**
production rate [kt/a]	9,800

UK: Cement; production rates

Emission factors:

In the UK study a common emission factor of 0.02 to 1.08 µg/t was assumed for cement and lime kilns. This represents the the extreme ends of the range of emissions expected from cement kilns in the UK. The emission factor refers to reported data of the British Cement Association concerning plants with supplementary fuels (no further details provided) ‹21›.

Cement	Emission factor [µg I-TEQ/t]
Cement, minimal	0.02
Cement, maximal	1.08
Cement, geom. mean	0.15
Cement, arith. mean	0.55

UK: Cement; emission factors

Estimation of uncertainty:

While the activity rates are considered to be precise, the emission factors are characterised by the uncertainty index 2.

Activity rates	0
emission factors	2
total uncertainty	**2**

UK: Cement; indices of uncertainty

Estimation of annual emission:

With the estimates described above the following values are obtained:

	1993
Annual emission	1.4
Margin of uncertainty	0.1 - 14.4

UK: Cement; annual PCDD/PCDF emissions [g I-TEQ/a]

03 03 12
Lime (including iron and steel and paper pulp industries)

Considered pathways/media:

AIR

Measurements:

No British measurements are reported.

Plant data:

No informations on the plants existing in the UK are provided.

National activity rates:

Year	**1993**
production rate [kt/a]	2,000

UK: Lime (including iron and steel and paper pulp industries); activity rates

Emission factors:

In the UK study a common emission factor of 0.02 to 1.08 µg/t was assumed for lime kilns. This represents the the extreme ends of the range of emissions expected from lime kilns in the UK. (see 03 03 11)

Lime	**Emission factor [µg I-TEQ/t]**
Lime, minimal	0.02
Lime, maximal	1.08
Lime, geom. mean	0.15
Lime, arith. mean	0.55

UK: Lime (including iron and steel and paper pulp industries); emission factors

Estimation of uncertainty:

While the activity rates are considered to be precise, the emission factors are characterised by the uncertainty index 2.

Activity rates	0
emission factors	2
total uncertainty	**2**

UK: Lime (including iron and steel and paper pulp industries); indices of uncertainty

Estimation of annual emission:

With the estimates described above the following values are obtained:

	1993
Annual emission	0.3
Margin of uncertainty	0.03 - 2.9

UK: Lime (including iron and steel and paper pulp industries); annual PCDD/PCDF emissions [g I-TEQ/a]

03 03 13
Asphalt concrete plants

General remark:

No data are presented in the UK report; reference is made of the Dutch inventory.

Considered pathways/media:

AIR

Measurements:

No British measurements are reported.

Plant data:

No informations on the plants existing in the UK are provided.

National activity rates:

The national activity rates were taken from production statistics of the ”Institute of Asphalt Technology” ‹22›.

Year	**1992**
production rate [kt/a]	33,000

UK: Asphalt concrete plants; activity rates

Emission factors:

For the UK study the Dutch emission factor of 0.047 µg/t was used ‹9›.

Asphalt	**Emission factor [µg I-TEQ/t]**
Asphalt, mean	0.047

UK: Asphalt concrete plants; emission factor

Estimation of uncertainty:

While the activity rate is considered to be precise, the emission factor is characterised to be uncertain at least one order of magnitude (index 1) as it is not a genuine British value.

Activity rate	0
emission factor	1
total uncertainty	**1**

UK: Asphalt concrete plants; indices of uncertainty

Estimation of annual emission:

With the estimates described above the following values are obtained:

	1993
Annual emission	1.6
Margin of uncertainty	0.5 - 4.9

UK: Asphalt concrete plants; annual PCDD/PCDF emissions [g I-TEQ/a]

03 03 14/15/17
Flat, container and other glass

Considered pathways/media:

AIR

Measurements:

No information is available on emissions of PCDD/F from this industrial branch. The authors of the UK study assume a similar potential to that in cement and lime manufacture due to the use of similar fuel.

Plant data:

No informations on the plants existing in the UK are provided.

National activity rates:

The following production rate of various glass products is reported ‹23›:

Year	**1993**
Total glass	2,500

UK: Flat, container and other glass; activity rates [kt/a]

Emission factors:

For the estimation of the emission factors the everage energy consumption for glass manufacture (7 GJ/t) was compared with the primary energy consumption for cement and lime (3.3 and 3.5 GJ/t) ‹18›. Assuming the energy consumption is the same order of magnitude and oil and gas are the primary fuels an emissions factor range of 0.002 to 0.005 µg I-TEQ/t is attained.

Flat, container and other glass	**Emission factor [µg I-TEQ/t]**
Flat, container and other glass, minimal	0.002
Flat, container and other glass, maximal	0.005
Flat, container and other glass, geom. mean	0.003
Flat, container and other glass, arith. mean	0.004

UK: Flat, container and other glass; emission factors

Estimation of uncertainty:

The activity rate is considered to be precise, the emission factor might be uncertain at least one order of magnitude (index 1).

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Flat, container and other glass; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Total glass	0.008
Margin of uncertainty	0.003 - 0.025

UK: Flat, container and other glass; annual PCDD/F emissions [g I-TEQ/a]

03 03 19
Bricks and tiles

Considered pathways/media:

AIR

Measurements:

None.

Plant data:

None.

National activity rates:

Production figures are quoted for heavy clay ceramics for the year 1993 ‹20›.

Year	**1993**
production rate [kt/a]	7,100

UK: Bricks and tiles; production rates [kt/a]

Emission factors:

For bricks and tiles the same emission factor was used as for glass production (see 03 03 14/15/17).

Bricks and tiles	**Emission factor [µg I-TEQ/t]**
Bricks and tiles, minimal	0.002
Bricks and tiles, maximal	0.005
Bricks and tiles, geom. mean	0.003
Bricks and tiles, arith. mean	0.004

UK: Bricks and tiles; emission factors

Estimation of uncertainty:

The activity rate is considered to be precise, the emission factor might be uncertain at least one order of magnitude (index 1).

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Bricks and tiles; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Bricks and tiles	0.022
Margin of uncertainty	0.007 - 0.071

UK: Bricks and tiles; annual PCDD/F emissions [g I-TEQ/a]

03 03 20
Fine ceramic materials

Considered pathways/media:

AIR

Measurements:

None.

Plant data:

None.

National activity rates:

Production figures are quoted for fine ceramic materials for the year 1993 ‹20›.

Year	**1993**
production rate [kt/a]	4,000

UK: Fine ceramic materials; production rates [kt/a]

Emission factors:

For fine ceramic materials the same emission factor was used as for glass production (see 03 03 14/15/17).

Fine ceramic materials	**Emission factor [µg I-TEQ/t]**
Fine ceramic materials, minimal	0.002
Fine ceramic materials, maximal	0.005
Fine ceramic mat., geom. mean	0.003
Fine ceramic mat., arith. mean	0.004

UK: Fine ceramic materials; emission factors

Estimation of uncertainty:

The activity rate is considered to be precise, the emission factor might be uncertain at least one order of magnitude (index 1).

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Fine ceramic materials; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Bricks and tiles emission	0.013
Margin of uncertainty	0.004 - 0.040

UK: Fine ceramic materials; annual PCDD/F emissions [g I-TEQ/a]

03 03 24
Nickel production (thermal process)

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented under this SNAP code. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

03 03 26
Other - non ferrous metals production

General Remark:

The sector of non ferrous metals production is considered as a whole in the UK inventory. Hence no specific data are presented for the various metals covered by the SNAP codes 03 03 04 - 03 03 10 and 03 03 24. The estimate of the emission from the non ferrous metal industry is presented under this CORINAIR code.

Considered pathways/media:

AIR.

Measurements:

In the UK only limited emission testing had been carried out by site operators and by HMIP. The few HMIP measurements on secondary metals furnaces indicate emission PCDD/F concentrations ranging from 0.01 to 2.2 ng I-TEQ/m³.

Plant data:

No informations on the plants existing in the UK are provided.

National activity rates:

The UK report quotes only an overall value for the entire non-ferrous metal industry ie lead, brass, copper/bronze, aluminium and others. According to the ”UK Minerals Yearbook 1993” approximately 1 M tonnes of non-ferrous metals were produced (primary and secondary production), 50 % of this production being unter ”Part A” control. The total amount of primary lead produced is not determinable.

Product	**1993**
Total, non ferrous metals	1,000

UK: Non-ferrous metals production; annual production estimates [kt/a]

03 03 26

Other - non ferrous metals production

Emission factors:

For the UK report a common emission factor of 5 to 35 µg/t was assumed for the non-ferrous metal industry. The given emission factor is based on Dutch data‹9›.

Non-ferrous metals (total)	**Emission factor [µg I-TEQ/t]**
Non-ferrous metals, minimal	5
Non-ferrous metals, maximal	35
Non-ferrous metals, geom. mean	13.23
Non-ferrous metals, arith. mean	20.00

UK: Non-ferrous metals production; emission factors

Estimation of uncertainty:

As the activity rates are approximately known index ”1” was assigned to the uncertainty of this information. The common emission factor is considered to be quite uncertain (index ”3”) due to the few measurement results obtained up to now in the UK.

Activity rates (total)	1
emission factors (total)	3
total uncertainty	**4**

UK: Non-ferrous metals production; Indices of uncertainty

Estimation of annual emission:

With the mentioned data the following annual emissions are obtained:

	1993
Annual emission	13.23
Margin of Uncertainty	0.13 - 1323

UK: Non-ferrous metals production;
annual PCDD/PCDF emission [g I-TEQ/a]

Comment:

The uncertainty assessments for the entire non-ferrous metal industries definitely need to be narrowed. The emission factors are highly uncertain.

04 02 01
Coke oven (door leakage and extinction)

Considered pathways/media:

AIR

Measurements:

None

Plant data:

None

National activity rates:

The national activity rates were taken from production statistics ‹24›.

Year	**1993**
production rate [kt/a]	6,400

UK: Coke oven (door leakage and extinction); production rates

Emission factors:

The emission factor is based on a value from the Dutch inventory ‹9›:

Coke oven	**Emission factor [µg I-TEQ/t]**
Coke oven (mean):	0.3

UK: Coke oven (door leakage and extinction); emission factors

04 02 01

Coke oven (door leakage and extinction)

Estimation of uncertainty:

The activity rate is presumably rather precise; the emission factor might be uncertain up to one order of magnitude (index 1) as it was transferred from a another country with a possibly different industrial technique:

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Coke oven (door leakage and extinction); indices of uncertainty

Estimation of annual emission:

Year	**1993**
Coke oven	1.92
Margin of uncertainty	0.61 - 6.17

UK: Coke oven (door leakage and extinction); annual PCDD/PCDF emissions [g I-TEQ/a]

04 02 07
Electric furnace steel plant

Considered pathways/media:

Air

Measurements:

No measurement results are cited in the UK report.

Plant data:

None

National activity rates:

The national activity rates were taken from statistics of the "International Iron and Steel Institute from 1993 ‹25›.

Year	**1993**
production rate [kt/a]	4,120

UK: Electric furnace steel plant; production rates

Emission factors:

The UK study refers to several emission factors published in other European Countries ‹26,27,28,29›. According to the quoted data an emission factor range from 0.02 to 20 µg I-TEQ/t had been estimated depending on operational conditions. For the UK study an emission factor range from 0.7 to 10 µg I-TEQ/t was considered, representing operational conditions with "no chlorine" and with "high chlorine" amount.

Electric furnace steel plant	**Emission factor [µg I-TEQ/t]**
Electric furnace steel plant, minimal	0.7
Electric furnace steel plant, maximal	10.0
Electric furnace steel plant, geom. mean	2.65
Electric furnace steel plant, arith. mean	5.35

UK: Electric furnace steel plant; emission factors

04 02 07

Electric furnace steel plant

Estimation of uncertainty:

The activity rate is quite precise (index ”0”); the emission factor is uncertain up to two orders of magnitude (index 2):

Activity rates	0
emission factors	2
total uncertainty	**2**

UK: Electric furnace steel plant; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Electric furnace steel plant	10.9
Margin of uncertainty	1.1 - 109

UK: Electric furnace steel plant; annual PCDD/PCDF emissions [g I-TEQ/a]

04 03 01
Aluminium production (electrolysis)

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented under this SNAP code. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

04 03 02
Ferro alloys

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented under this SNAP code. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

04 03 09
Other - non ferrous metal foundries

General Remark:

The sector of non ferrous metal production is considered as a whole in the UK inventory. Hence no specific data are presented under this SNAP code. The estimate of the emission from the non ferrous metal industry is presented under 03 03 26.

04 05 24
Halogenated hydrocarbons production

Considered pathways/media:

AIR

Measurements:

No measurement results are cited for the UK; German data (0.053 ng I-TEQ/m³) are quoted instead‹30›.

Plant data:

None

National activity rates:

As no data regarding production statistics were available, an estimate of the total sales per year of all halogenated compounds produced was taken out of the ”Business Monitor ” ‹31›. A division of this figure by the average import/export prices per tonne gives approximately the amount of halogenated compounds produced every year.

Year	**1993**
production rate [kt/a]	800

UK: Halogenated hydrocarbons production; production rates

Emission factors:

For determinig the emission factor reference of the literature is made. On the basis that 500 m³ of gas is generated per tonne of product ‹18› and with the German measurement results (see above) a table value is calculated roughly applying to the UK as well:

Halogenated hydrocarbons	**Emission factor [µg I-TEQ/t]**
Halogenated hydrocarbons (mean)	0.025

UK: Halogenated hydrocarbons production; emission factor

Estimation of uncertainty:

The activity rate is presumably precise; the emission factor might be uncertain up to one order of magnitude (index 1) as it was transferred from a another country with a possibly different industrial technique:

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Halogenated hydrocarbons production; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Halogenated hydrocarbons	0.02
Margin of uncertainty	0.01 - 0.1

UK: Halogenated hydrocarbons production; annual PCDD/PCDF emissions [g I-TEQ/a]

04 05 25
Pesticide production

Considered pathways/media:

AIR

Measurements:

No measurement results are cited for the UK; Dutch data (0.02-0.05 ng I-TEQ/m³) are quoted instead‹9›.

Plant data:

None

National activity rates:

As no data regarding production statistics were available, an estimate of the total sales per year of all pesticides produced was taken out of the ”Business Monitor ” ‹31›. However, the quantity produced has not been reported. For estimating a national activity rate the total sales of all pesticides in 1991 (25 900 tonnes) were considered. Assuming that 50 % of this quantity comprises halogenated pesticides half of this figure approximately represents the amount of halogenated pesticides produced every year.

Year	**1993**
production rate [kt/a]	12.95

UK: Pesticide production; production rates

Emission factors:

For determinig the emission factor reference of the literature is made. On the basis that 500 m³ of gas is generated per tonne of product ‹18› and with the Dutch measurement results (see above) the table values are calculated roughly applying to the UK as well:

Pesticide production	Emission factor [µg I-TEQ/t]
Pesticide production, minimal	0.01
Pesticide production, maximal	0.025
Pesticide production, geom. mean	0.02
Pesticide production, arith. mean	0.02

UK: Pesticide production; emission factor

Estimation of uncertainty:

The uncertainty of the activity rate is somewhat higher than for halogenated hydrocarbons, due to the lack of more precise data on the quantities produced. The emission factor can be uncertain up to one order of magnitude (index 1) as it was transferred from a another country with a possibly different industrial technique:

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Pesticide production; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Pesticide production	0.0002
Margin of uncertainty	0.00006 - 0.0006

UK: Pesticide production; annual PCDD/PCDF emissions [g I-TEQ/a]

06 04 06
Preservation of wood

General remark:

The emissions of PCDD/Fs in this process category relate to the use of pentachlorophenol and and its salts as wood preservatives in the British timber industry.

Considered pathways/media:

AIR

Measurements:

No measurement results quoted.

Plant data:

None

National activity rates:

Data regarding the application of wood preserving agents (PCP) were taken from a publication of the HMIP ‹32›.

Year	**1992**
application rate [t/a]	250

UK: Preservation of wood; application rate

Emission factors:

For the determination of the emission factors German results from 1987 were applied ‹33›. According to Eitzer and Hites it can be assumed that 0.1 % of the PCDD/F content would volatilise ‹34›. On the basis of this assumption the table values are attained:

Preservation of wood	Emission factor [µg I-TEQ/t]
Preservation of wood, minimal	700
Preservation of wood, maximal	2500
Preservation of wood, geom. mean	1323
Preservation of wood, arith. mean	1600

UK: Preservation of wood; emission factor

Estimation of uncertainty:

The activity rate is considered to be rather precise. The emission factor is uncertain up to one order of magnitude (index 1):

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Preservation of wood; indices of uncertainty

Estimation of annual emission:

Year	**1993**
Preservation of wood	0.33
Margin of uncertainty	0.10 - 1.0

UK: Preservation of wood; annual PCDD/PCDF emissions [g I-TEQ/a]

07 01 01/02/03
Passenger cars

Considered pathways/media:

AIR

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

National activity rates:

The report contains a detailed table in billion kilometres per year considering separately the kind of fuel and the kind of vehicle ‹35›.

Passenger cars	**1992**
leaded fuel	163.2
unleaded fuel (no cat)	134
unleaded fuel	10.8
diesel fuel	27
total	335

UK: Passenger cars; vehicle distances per year [10^9km/a]

Emission factors:

The listed minimum and maximum emission factors in the UK study (see below) represent the lowest and highest values found in the literature ‹36,37,38,39›.

Passenger cars	**Emission factors [pg/km]**			
	min	max	arith. m.	geo. m.
leaded fuel	1.1	220	15.56	110.55
unleaded fuel (no cat)	0.36	21	2.75	10.68
unleaded fuel	0.36	13	2.16	6.68
diesel fuel	0.65	10	2.55	5.33

UK: Passenger cars; emission factors

Estimation of uncertainty:

The activity rates are termed to be rather precise while the emission factors are of quite low accuracy:

Activity rates	0
emis. factor, leaded fuel	2
emis. factor, unleaded fuel (no cat)	2
emis. factor, unleaded fuel	2
emis. factor, diesel fuel	2

UK: Passenger cars; indices of uncertainty

Estimation of annual emission:

For calculating the the margin of uncertainty the total uncertainty factor "2" for all kinds of fuels was applied.

Type of fuel	**1992**
leaded fuel	2.54
unleaded fuel (no cat)	0.37
unleaded fuel	0.02
diesel fuel	0.07
total	3.00
Margin of uncertainty	0.3 - 30

UK: Passenger cars; annual PCDD/PCDF emissions [g I-TEQ/a]

07 02 01/02/03
Light duty vehicles < 3.5 t

Considered pathways/media:

AIR

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

National activity rates:

The UK report contains a detailed table in billion kilometres per year considering separately the kind of fuel and the kind of vehicle (see 07 01 01/02/03).

Light duty vehicles < 3.5 t	1992
leaded fuel	19.4
diesel fuel	18.0
total	37.4

UK: Light duty vehicles < 3.5 t; vehicle distances per year [10^9km/a]

Emission factors:

The listed minimum and maximum emission factors in the UK study represent the lowest and highest values found in the literature (see 07 02 01/02/03).

Light duty vehicles < 3.5 t	Emission factor [pg/km]			
	min	max	arith. m.	geo. m.
leaded fuel	1.1	220	15.56	110.55
diesel fuel	0.65	10	2.55	5.33

UK: Light duty vehicles < 3.5 t; emission factors

Estimation of uncertainty:

The activity rates are considered to be rather precise while the emission factors are of low accuracy:

Activity rates	0
emis. factor, leaded fuel	2
emis. factor, diesel fuel	2

UK: Light duty vehicles < 3.5 t; indices of uncertainty

Estimation of annual emission:

For calculating the the margin of uncertainty the total uncertainty factor "2" for all kinds of fuels was applied.

Type of fuel	**1992**
leaded fuel	0.30
diesel fuel	0.05
TOTAL	0.35
Margin of uncertainty	0.04 - 3.5

UK: Light duty vehicles < 3.5 t; annual PCDD/PCDF emissions [g I-TEQ/a]

07 03 01/02/03
Heavy duty vehicles > 3.5 t and buses

Considered pathways/media:

AIR

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

National activity rates:

The report contains a detailed table in billion kilometres per year considering separately the kind of fuel and the kind of vehicle (see 07 01 01/02/03).

Heavy duty vehicles > 3.5 t and buses	**1992**
petrol	1.5
diesel fuel	24.8
diesel fuel (buses)	3.68
total	29.98

UK: Heavy duty vehicles > 3.5 t and buses; vehicle distances per year [10^9km/a]

Emission factors:

The listed minimum and maximum emission factors in the UK study represent the lowest and highest values found in the literature (see 07 01 01/02/03).

Heavy duty vehicles > 3.5 t and buses	**Emission factor [pg/km]**			
	min	max	arith. m.	geo. m.
petrol	1.1	220	15.56	110.55
diesel fuel	26	37	31.02	31.50
diesel fuel (buses)	26	37	31.02	31.50

UK: Heavy duty vehicles > 3.5 t and buses; emission factors

Estimation of uncertainty:

The activity rates are termed to be rather precise; the emission factor for petrol is of low accuracy. The emission factor range for diesel fuel is quite narrow; however, in view of the few and old results quoted the values are questionable.

Activity rates	0
emis. factor petrol	2
emis. factor diesel fuel	2
emis. factor diesel fuel (buses)	2

UK: Heavy duty vehicles > 3.5 t and buses; indices of uncertainty

Estimation of annual emission:

Type of fuel	**1992**
petrol	0.03
diesel fuel	0.77
diesel fuel (buses)	0.11
TOTAL	0.91
Margin of uncertainty	0.09 - 9,1

UK: Heavy duty vehicles > 3.5 t and buses; annual PCDD/PCDF emissions [g I-TEQ/a]

07 04
07 05 01/02/03
Mopeds and Motorcycles < 50 cm³
Motorcycles > 50 cm³

Considered pathways/media:

AIR

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

National activity rates:

The report contains a detailed table in billion kilometres per year considering separately the kind of fuel and the kind of vehicle (see 07 01 01/02/03).

Mopeds and Motorcycles	**1992**
total	4.5

UK: Mopeds and Motorcycles < 50 cm³
Motorcycles > 50 cm³; vehicle distances per year [10^9km/a]

Emission factors:

The listed minimum and maximum emission factors in the UK study represent the lowest and highest values found in the literature (see 07 01 01/02/03).

Mopeds and Motorcycles	**Emission factor [pg/km]**			
	min	max	arith. m.	geo. m.
total	0.36	21	2.75	10.68

UK: Mopeds and Motorcycles < 50 cm³
Motorcycles > 50 cm³; emission factors

Estimation of uncertainty:

The activity rates is considered to be rather precise; the emission factor is of rather low accuracy:

Activity rates	0
emission factor	2
total uncertainty	**2**

UK: Mopeds and Motorcycles < 50 cm³ Motorcycles > 50 cm³; indices of uncertainty

Estimation of annual emission:

Mopeds and motorcycles	**1992**
TOTAL	0.012
Margin of uncertainty	0.001 - 0.12

UK: Mopeds and Motorcycles < 50 cm³ Motorcycles > 50 cm³; annual PCDD/PCDF emissions [g I-TEQ/a]

09 02 01
Incineration of domestic or municipal wastes

General remark:

In the UK about 8 % of municipal solid waste is incinerated. In the UK report old and new waste incinerators were divided into two categories: new plant (SELCHP at Lewisham) and old plants (all other incinerators); both considered separately.

Considered pathways/media:

AIR

Measurements:

The UK study cites measurement results for each British waste incinerator (at least one result per plant) exept for plants shut down in the mean time ‹40›.

09 02 01

Incineration of domestic or municipal wastes

Plant data:

About 30 waste incinerators were constructed in the 1960s and 1970s equipped with electrostatic precipitators for air pollution control but without energy recovery. These plants must either upgrade to meet the PCDD/F guide limit of 1 ng/Nm³ in Process Guidance Note IPR 5/3 by December 1996, or cease operation.

National activity rates:

In the UK about 2,920 kt of municipal and domestic waste is incinerated every year.

Incineration of domestic or municipal waste	**1995**
old plants [kt/a]	2,500
new plant (SELCHP) [kt/a]	420
total [kt/a]	2,920

UK: Incineration of domestic or municipal wastes; annually burned waste

Emission factors:

Separate emission factors are presented for each type of plant. For calculating emission factors out of measurement results a gas generation rate of 5,140 Nm³ per tonne of waste was assumed.

Incineration of domestic or municipal waste	**old plants**	**new plant**
old plants, minimum	184	
old plants, maximum	231	
old plants, geom. mean	206.16	
old plants, arith. mean	207.50	0.8

UK: Incineration of domestic or municipal wastes; emission factors for MSW incineration [µg I-TEQ/t]

Estimation of uncertainty:

Both the activity rates and the emission factors are considered to be precise:

Activity rates	0
emis. factors old plants	0
emis. factor new plants	0
total uncertainty	**0**

UK: Incineration of domestic or municipal wastes; indices of uncertainty

Estimation of annual emission:

By multiplying the mass of waste incinerated per year with the respective emission factors the following PCDD/PCDF emissions are obtained:

Incineration of domestic or municipal waste	**1995**
old plants	515.40
new plant (SELCHP)	0.34
TOTAL	515.74
Margin of uncertainty*)	460 - 577

UK: Incineration of domestic or municipal wastes; annual PCDD/PCDF emissions [g I-TEQ/a]

***) calculated from minimum and maximum emission factor**

Comment:

Due to the enforcement of Process Guidance Note IPR 5/3, the emissions of old plants are expected to be reduced by a factor 10 to 20 by 1996 and beyond than in 1995.

09 02 02
Incineration of industrial wastes (except flaring)

General remark:

The UK report consideres only the incineration of chemical wastes.

Considered pathways/media:

AIR

Measurements:

The ranges of measurement results at four commercial chemical waste incinerators are presented in the UK report ‹40›. Additionally the emission ranges of chemical waste incinerators from other European countries are reported ‹41›. No data were available for further 59 in-house facilities in England and Wales authorised under Part A. For the UK study a range of 0.5 to 3 ng I-TEQ/m³ was assumed covering all of the licensed facilities in the UK.

Plant data:

In the UK study four commercial plants are mentioned:

1. Rechem, Fawley;
2. Rechem, Pontypool;
3. Leigh, Killamarsh;
4. Cleanaway, Ellesmere Port.

National activity rates:

The total annual capacity for incineration of chemical waste in the UK is approximately 140,000 t. Another 150,000 t was assumed for in-house incineration, thus resulting in the table value below:

Incineration of industrial waste	**1995**
total [kt/a]	290

UK: Incineration of industrial wastes (except flaring); amount of burned waste

Emission factors:

For the calculation of the emission factors out of the measurement results (see above), a generation of 10,000 m³ waste gas per tonne of waste was assumed.

Incineration of industrial waste	**Emission factor [µg I-TEQ/t]**
Incineration of industrial waste, minimum	5
Incineration of industrial waste, maximum	30
Incineration of industrial waste, geom. mean	12.25
Incineration of industrial waste, arith. mean	17.50

UK: Incineration of industrial wastes (except flaring); emission factors

Estimation of uncertainty:

For the activity rate an uncertainty index of "0" was assumed while the emission factor is characterised with index "1" (see above):

Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Incineration of industrial wastes (except flaring); indices of uncertainty

Estimation of annual emission:

The emissions listed below were calculated on the activity rates and emission factors mentioned above.

Incineration of industrial waste	**1995**
Total	3.55
Margin of uncertainty	1.12 - 11.2

UK: Incineration of industrial wastes (except flaring); annual emissions [g I-TEQ/a]

09 02 05
Incineration of sludges from waste water treatment

Considered pathways/media:

AIR

Measurements:

The limited data for UK incinerators suggest an emission range of 0.04 to 0.85 ng I-TEQ/m³ for post-1985 plants and 7 ng I-TEQ/m³ for pre-1985 plants ‹40,42,43›. Based on these results a value of 0.8 ng I-TEQ/m³ for post-1985 (fluidised bed) plants and 7 ng I-TEQ/m³ for pre-1985 (multiple hearth) plants was selected for the UK study.

Plant data:

None

National activity rates:

The national activity rate was derived from data on the capacity of sewage sludge incinerators in 1992 taken from the British Department of the Environment ‹44›:

Incineration of sewage sludge	**1992**
total [kt/a]	77

UK: Incineration of sludges from waste water treatment; amount of annually burned sewage sludge

Emission factors:

The emission factors were calculated using the measurement results (see above). Assuming that per tonne of sewage sludge 11,000 Nm³ of gas are emitted the following table values are achieved:

Incineration of sludges from waste water treatment	Emission factor [µg I-TEQ/t]
Incineration of sewage sludge, minimum	9
Incineration of sewage sludge, maximum	77
Incineration of sewage sludge, geom. mean	26.32
Incineration of sewage sludge, arith. mean	43.00

UK: Incineration of sludges from waste water treatment; emission factors

Estimation of uncertainty:

The activity rate is deemed to be quite accurate, the emission factors are of lower precision:

Activity rate	0
emission factors	1
total uncertainty	**1**

UK: Incineration of sludges from waste water treatment; indices of uncertainty

Estimation of annual emission:

The emissions listed below were calculated on the activity rates and emission factors mentioned above.

Incineration of sewage sludge	1995
Total	2.03
Margin of uncertainty	0.64 - 6.42

UK: Incineration of sludges from waste water treatment; annual PCDD/PCDF emissions into the air [g I-TEQ/a]

09 02 06
Flaring in gas and oil extraction

General Remark:

As far as the combustion of fossil fuels is concerned see 01 01 - 03 01. For the combustion of landfill gas in engines see 03 01 and for escaping gas 09 10 04 respectively.

Considered pathways/media:

AIR

Measurements:

Measurement results from the Netherlands are quoted for flaring of landfill gas ‹9›:

Flaring in gas and oil extraction	**1994**
flared landfill gas	0.022

UK: Flaring in gas and oil extraction; PCDD/PCDF emissions [ng I-TEQ/m^{-3}]

Plant data:

None

National activity rates:

According to the UK report 10,039 Mm³ of landfill gas are flared every year. The presented value is an estimate of the Department of the Environment ‹17›.

Emission factors:

The emission factor for flaring of landfill gas is based on results obtained in the Netherlands ‹9›. The factor is presented in the following table:

Flaring in gas and oil extraction	**Emission factor [ng I-TEQ/m³]**
flared landfill gas, mean	0.022

UK: Flaring in gas and oil extraction; emission factors

Estimation of uncertainty:

Considering flaring of landfill gas index ”1” was applied. According to the data mentioned above the following indices were set up:

Activity rates	1
emission factors	1
total uncertainty	**2**

UK: Flaring in gas and oil extraction; indices of uncertainty

Estimation of annual emission:

With the above data the following annual emissions are obtained:

Flaring in gas and oil extraction	**1994**
flared landfill gas	0.22
margin of uncertainty	0.022 - 2.20

UK: Flaring in gas and oil extraction; annual PCDD/PCDF emissions [g I-TEQ]

09 02 07
Incineration of hospital wastes

General Remark:

As the UK study points out, the clinical waste incineration in the UK has undergone a period of rapid change following the introduction of the Environmental Protection Act in 1990. Old hospital-based incineration plants are being largely replaced by larger modern and centralised facilities, which will be better operated and controlled. The transition was deemed to be substantially completed by the end of 1995.

Considered pathways/media:

AIR

Measurements:

The UK study only quotes one measurement result from Germany ‹27›

Plant data:

None

National activity rates:

According to the British Department of the Environment 308,800 tonnes of clinical waste are produced in the UK every year ‹45›. It is assumed that approximately 260,000 tonnes of the total amount is incinerated. Of this total, it is assumed that 50 % is incinerated in old plants:

Incineration of hospital wastes	**1993**
in old plants	130
in new plants	130
total [kt/a]	260

UK: Incineration of hospital wastes;
amount of annually incinerated hospital waste

Emission factors:

The UK study applies a gas generation rate of 12,000 Nm³ per tonne of waste for old plants and 20,000 Nm³ per tonne for new plants for calculating emission factors ‹46›. Besides the UK study cites a British investigation published in 1993 ‹8›. However this investigation relays on measurements carried out in the pre-1990 period. The emission factors for modern rotary kiln plants were 3.4 to 6.5 µg I-TEQ/t, for old plants operating under poor combustion conditions 700 µg I-TEQ/t and the median for five plants was 130 µg I-TEQ/t. The emission factors in the two tables below are assumptions taking into concideration German, US and Britsh emission factors:

Incineration of hospital wastes, old plants	**Emission factor [ng I-TEQ/t]**	**Emission factor [ng I-TEQ/t]**
	old plants	new plants
Incineration of hospital wastes, minimum	120	20
Incineration of hospital wastes, maximum	480	200
Incineration of hospital wastes, geom. mean	240	63.25
Incineration of hospital wastes, arith. mean	300	110

UK: Incineration of hospital wastes; emission factors

Estimation of uncertainty:

The activity rates are characterised as being rather accurate, the emission factor for old plants seems to be quite accurate too, while for new plants the uncertainty index "1" was applied:

	old plants	new plants
Activity rates, old plants	0	0
emission factors, old plants	0	0
total uncertainty old plants	**0**	**1**

UK: Incineration of hospital wastes; indices of uncertainty

Estimation of annual emission:

The estimated PCDD/PCDF emissions are listed in the following table.

09 02 07

Incineration of hospital wastes

Incineration of hospital wastes	1993
Annual emission, old plants	31.20
Annual emission, new plants	8.22
Margin of uncertainty, new plants	2.60 - 25.99
Total annual emission	39.42
Margin of uncertainty	33.80 - 57.19

UK: Incineration of hospital wastes;
annual PCDD/PCDF emissions [g I-TEQ/a]

09 02 08
Incineration of waste oil

General Remark:

As far as the combustion of coal and other fossil fuels is concerned see 01 01 - 03 01.

Considered pathways/media:

Atmosphere.

Measurements:

No measurement results are presented for the UK.

Plant data:

None.

National activity rates:

The amount of waste oil combusted in the UK is derived from a publication of the Chemical and Oil Recycling Association‹47›.

Incineration of waste oil	**1994**
total	400

UK: Incineration of waste oil; consumption of fuels [kt/a]

Emission factors:

The emission factors for waste oil combustion rely on studies performed in the Netherlands ‹9›. The factors and their means are presented in the table following:

Incineration of waste oil	**Emission factor [µg I-TEQ/t]**
waste oil, minimal	2
waste oil, maximal	6
waste oil, geom. mean	3.46
waste oil, arith. mean	4.00

UK: Incineration of waste oil; emission factors

09 02 08

Incineration of waste oil

Estimation of uncertainty:

The activity rates and emission factors are considered to be fairly precise for waste oil (index 0). According to the data mentioned above the following indices were set up:

Activity rates	0
emission factors	0
total uncertainty	**0**

UK: Incineration of waste oil; indices of uncertainty

Estimation of annual emission:

With the above data the following annual emissions are obtained:

Incineration of waste oil	**1994**
waste oil	1.38

UK: Incineration of waste oil; annual PCDD/PCDF emissions [g I-TEQ]

09 09 01
Incineration of corpses

Considered pathways/media:

AIR

Measurements:

The UK study presents an emission range for old (41.93 to 71.31 ng I-TEQ/Nm³) and modified cremators (25.36 to 45.46 ng I-TEQ/Nm³) respectivly (both values related to 11 % oxygen). From these results a mean of 46 ng I-TEQ/Nm³ was derived.

Plant data:

There were approximately 700 cremators in the UK prior to the introduction of the Environmental Protection Act in 1990 ‹46›. About 240 to 270 cremators have subsequently been replaced or upgraded to meet the requirements in Process Guidance Note PG 5/2.

National activity rates:

The number of annual cremations for the UK study was taken from the Municipal Yearbook ‹48›:

Year	**1994**
Annual cremations	437,000

UK: Incineration of corpses; number of cremations per year

Emission factors:

Gas generation rates reported in the Netherlands were used for calculating the maximum emission factor out of the measurement results mentioned above ‹9›. The minimum emission factor was taken from the Dutch study too:

09 09 01

Incineration of corpses

Incineration of corpses	Emission factor [µg I-TEQ/Crem]
Incineration of corpses, minimal	2.4
Incineration of corpses, maximal	80
Incineration of corpses, geom. mean	13.86
Incineration of corpses, arith. mean	41.20

UK: Incineration of corpses; emission factors

Estimation of uncertainty:

The activity rate (number of cremations) is quite exact, for the emission factor index "1" was applied.

Incineration of corpses	
Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Incineration of corpses; indices of uncertainty

Estimation of annual emission:

The above mentioned data yield the following annual emissions:

Incineration of corpses	**1994**
Annual emission	6.1
Margin of uncertainty	1.9 - 19

UK: Incineration of corpses; annual PCDD/PCDF emissions [g I-TEQ/a]

Comment:

The UK report points out that discussions with UK cremator manufacturers suggest that the UK measurements might be elevated because the tested plants were not state of the art. Emissions from upgraded or replaced plants in the UK may well be lower, but emission data from such units are presently not available.

09 10 04
Land filling

General Remark:

Under this CORINAIR code only dioxins and furans emitted by escaping gas from landfill sites is considered. For the combustion of landfill gas in engines see 03 01 and for flaring of landfill gas 09 02 06 respectively.

Considered pathways/media:

Atmosphere.

Measurements:

Measurement results from the UK are quoted for dioxin and furan concentrations in landfill gas (raw gas) ‹14›:

Plant data:

None

National activity rates:

According to the UK report 4,384 Mm^3 of landfill gas escape from landfills every year. The presented value is an estimate of the Department of the Environment ‹17›.

Emission factors:

The emission factors for escaping landfill gas (raw gas) are based on results from the UK ‹14›. The factors are presented in the following table:

Land filling	**Emission factor [µg I-TEQ/m^3]**
escaping landfill gas, minimal	0.0032
escaping landfill gas, maximal	0.0036
escaping landfill gas, geom. mean	0.0034
escaping landfill gas, arith. mean	0.0034

UK: Land filling; emission factors

09 10 04

Land filling

Estimation of uncertainty:

Considering escaping landfill gas index ”0” was applied. According to the data mentioned above the following indices were set up:

Activity rates	0
emission factors	0
total uncertainty	**0**

UK: Land filling; indices of uncertainty

Estimation of annual emission:

With the above data the following annual emissions are obtained:

Land filling	**1994**
escaping landfill gas	0.0015

UK: Land filling; annual PCDD/PCDF emissions [g I-TEQ]

09 10 09
Other - regeneration of activated carbon

General remark:

This type of installation is not contained in the catalogue CORINAIR 94. Plants for regenerating activated carbon and catalysts of industrial chemical processes are mentioned as potential sources of dioxin.

Considered pathways/media:

AIR

Measurements:

The British study presents no measurement results from the UK.

Plant data:

None

National activity rates:

For the UK study the annual UK capacity was taken from a British publication ‹49›:

Regeneration of activated carbon	**1992**
Total [tonnes/a]	7,800

UK: Other - regeneration of activated carbon; amount of annually regenerated activated carbon

Emission factors:

Under the assumption the US EPA and the I-TEQ systems are equivalent, US measurement results in the region of 0.05 ng TEQ (US EPA)/m³ from 1988 were taken as the basis for the estimation ‹50›. This value and an assumed gas generation rate of 15,000 m³ per tonne of carbon treated were taken for calculating the emission factor:

Regeneration of activated carbon	**Emission factor [µg I-TEQ/t]**
Regeneration of activated carbon, mean	0.75

UK: Other - regeneration of activated carbon; emission factors

09 10 09

Other - regeneration of activated carbon

Estimation of uncertainty:

The activity rate is quite exact, for the emission factor index "1" was applied.

Regeneration of activated carbon	
Activity rates	0
emission factors	1
total uncertainty	**1**

UK: Other - regeneration of activated carbon; indices of uncertainty

Estimation of annual emission:

The above mentioned data yield the following annual emissions:

Regeneration of activated carbon	**1992**
Annual emission	0.006
Margin of uncertainty	0.002 - 0.019

UK: Other - regeneration of activated carbon; annual PCDD/PCDF emissions [g I-TEQ/a]

11 03
Forest fires

General remark:

The UK inventory considers natural fires (forests and moorlands).

Considered pathways/media:

AIR

Measurements:

None.

Plant data:

Not applicable.

National activity rates:

About 590 hectares of UK forests and approximately 50,000 hectares of moorland are consumed by natural fires every year ‹51›. It was assumed that these estimates are equivalent to a maximum burn of 13,500 tonnes of wood and a maximum of 400,000 tonnes of moorland heather per annum.

Emission factors:

Due to the limited data available on natural fires, the UK study made two different approaches to estimate emission factors for this dioxin and furan source. The first "open fire approach" uses emission factors for clean wood burning in open domestic fireplaces from the Netherlands and Germany ‹9,10›. The Dutch and German emission factors were combined giving the values in the following table:

11 03

Forest fires

Forest fires (including other natural fires), "open fire approach"	Emission factor [µg I-TEQ/t]
forest fires, minimal	1
forest fires, maximal	28
forest fires, geom. mean	5.29
forest fires, arith. mean	14.50

UK: Forest fires; emission factors

For the second "soot-based approach" emission factors from US EPA and from a publication of H. Thoma were combined and applied ‹52,53›.

Forest fires (including other natural fires), "soot-based approach"	Emission factor [µg I-TEQ/t]
forest fires, minimal	18
forest fires, maximal	1,125
forest fires, geom. mean	142.30
forest fires, arith. mean	571.50

UK: Forest fires; emission factors

Estimation of uncertainty:

Both, the activity rates and the emission factor from the "open fire approach" are considered to be uncertain (index "1"); while the emission factor from the "soot-based approach" was classified as very uncertain (index "2").

Forest fires "open fire approach"	
Activity rate emission factors total uncertainty	1 1 2
Forest fires "soot-based approach"	
Activity rate emission factors **total uncertainty**	1 2 **3**

UK: Forest fires; indices of uncertainty

Estimation of annual emission:

Based on the data mentioned above, the following emissions are calculated:

	Forest fires	Other natural fires	Total
Total "open fire approach"	0.07	2.12	2.19
Margin of uncertainty	0.01 - 0.7	0.21 - 21.2	0,21 - 21.9
Total "soot-based approach"	1.9	57	58.9
Margin of uncertainty	0.2 - 19	1.8 - 1,800	2 - 1,819

UK: Forest fires; annual PCDD/PCDF emissions [g I-TEQ/a]

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