Switzerland

Description of surveyed documents

Data on dioxin emissions in Switzerland have been provided by the Suiss EPA (BUWAL). They were derived from a database containing time series of activity rates and emission factors. Fortunately, this database uses the Corinair structure; thus, the submitted data could be used directly.

In particular, the provided data cover tables containing estimates of the annual PCDD/F emissions and emission factors for the years 1985, 1990 and 1995. With respect to the 1990 emission factors additional information could be taken from the „handbook emission factors for stationary sources 1990“ ‹1›. It appears that in many cases emission factors taken from foreign studies were used; for certain source types, reference is made to Suiss measurement reports and research studies. However, the data provided by this document are largly insufficient to assess the quality and the uncertainty of the emission factors applied. Therefore the min/max rows in the following table are indicated with „nd“ (no data).

CORINAIR SNAP	ITEM	Emission estimates g I-TEQ/a		
		Typ	min	max
	SUM	181.6	nd	nd
01	Combustion in Energy Production and Energy Transformation	0.8	nd	nd
02	Combustion in Commercial, Residential...	0.7	nd	nd
03	Combustion in Industry	2.7	nd	nd
04	Production Processes	10.6	nd	nd
05	Extraction and Distribution of Fossil Fuels	nd	nd	nd
06	Solvent and Other Product USE	2.7	nd	nd
07	Road Transport	0.8	nd	nd
08	Other Mobile Sources and Machinery	0.1	nd	nd
09	Waste Treatment and Disposal	154.0	nd	nd
10	Agriculture, Forestry, Land use change	nd	nd	nd
11	Nature	nd	nd	nd
12	Fires	9.1	nd	nd

CH: Annual PCDD/F air emissions 1995 (nd: no data available)

01 01
Public power

Considered pathways/media:

Atmosphere.

Measurements:

The Swiss report does not supply any results of measurements obtained in Switzerland.

National activity rates:

Not data provided.

Emission factors:

The emission factor applied for thermal power plants > 300 MW is assumed to be the same as the emission factor for industrial combustion furnaces (heating oil ”medium and heavy”) and is based on Swiss investigations ‹2›. For combustion plants run with heating oil EL emission factors were taken into account mainly derived from German and Austrian findings ‹3,4›. The same factor was applied to gas turbines combusting heating oil EL and to Diesel engines. The value for natural gas combustion (industrial, gas turbines and gas engines) goes back to Swiss and Austrian results ‹2,3›. For coal combustion an average emission factor was calculated taking into consideration measurement results from Germany and Austria ‹3,4,5›. The Swiss report partially cites strongly varying emission factors from other investigations which were not taken into account. No explanation is provided why certain values were selected and others not.

01 01

Public power

Public power	emission factors, 1985 [ng/GJ]	emission factors, 1990 [ng/GJ]	emission factors, 1995 [ng/GJ]
Power plants > 300 MW, heating oil "heavy"	2.5	2.5	2.5
Public power, heating oil EL		0.5	0.5
Public power, heating oil "medium and heavy"		2.5	2.5
Public power, natural gas		0.03	0.03
Public power, coal		230	230
Public power, gas turbines; heating oil EL		0.5	0.5
Public power, gas turbines; natural gas		0.03	0.03
Public power, diesel engines		0.5	0.5
Public power, gas engines		0.03	0.03

CH: Public power; emission factors in [ng/GJ]

Estimation of annual emission:

Public power	1985	1990	1995
Total	0.004	0.043	0.043
Margin of Uncertainty			-

CH: Public power; annual PCDD/PCDF emissions [g I-TEQ]/a

01 02
District heating plants

Considered pathways/media:

Atmosphere.

Measurements:

The Swiss report does not supply any results of measurements obtained in Switzerland.

National activity rates:

No data provided.

Emission factors:

In the Swiss report the emission factors for district heating plants are considered to be the same as for public power plants (see 01 01)

District heating plants	emission factors, 1990 [ng/GJ]	emission factors, 1995 [ng/GJ]
District heating, heating oil EL	0.5	0.5
District heating, heating oil "medium and heavy"	2.5	2.5
District heating, natural gas	0.03	0.03
District heating, coal	230	230
District heating, gas turbines; heating oil EL	0.5	0.5
District heating, gas turbines; natural gas	0.03	0.03
District heating, diesel engines	0.5	0.5
District heating, gas engines	0.03	0.03

CH: District heating plants; emission factors in [ng/GJ]

Estimation of annual emission:

District heating plants	1985	1990	1995
Total		0.088	0.087
Margin of Uncertainty			-

CH: District heating plants; annual PCDD/PCDF emissions [g I-TEQ]/a

02 01 / 02 03
Commercial and institutional plants;
Plants in agriculture, forestry and fishing

General remark:

Definition in Suiss report: Heating boilers in commercial and agricultural sector

Considered pathways/media:

Atmosphere.

Measurements:

The Swiss report does not supply any results of measurements obtained in Switzerland.

Plant data:

No data provided.

National activity rates:

No data provided.

Emission factors:

The emission factor for heating oil EL combustion is based on Austrian and German investigations ‹3,4›. The value for natural gas combustion goes back to Swiss and Austrian results ‹2,3›. For coal and wood combustion an average emission factor was calculated taking into consideration measurement results from Germany, Austria and Switzerland ‹2,3,4,5›. Here again the Swiss report partially cites strongly varying emission factors from other investigations which were not taken into account. No explanation is provided why certain values were selected and others not.

Commercial and institutional plants; Plants in agriculture, forestry and fishing	emission factors, 1985 [ng/GJ]	emission factors, 1990 [ng/GJ]	emission factors, 1995 [ng/GJ]
Commerc./agricult. sector, heating oil EL	0.5	0.5	0.5
Commerc./agricult. sector, natural gas	0.03	0.03	0.03
Commerc./agricult. sector, coal	230	230	230
Commerc./agricult. sector, wood	24	24	24
Commerc./agricult. sector, gas turbines; natural gas		0.03	0.03
Commerc./agricult. sector, diesel engines		0.5	0.5
Commerc./agricul. sector, gas engines		0.03	0.03

CH: Commercial and institutional plants; Plants in agriculture, forestry and fishing; emission factors in [ng/GJ]

Estimation of annual emission:

Commercial and agricultural sector	1985	1990	1995
Total	0.205	0.215	0.21
Margin of Uncertainty			-

CH: Commercial and institutional plants; Plants in agriculture, forestry and fishing; annual PCDD/PCDF emissions [g I-TEQ]/a

02 02
Residential plants

General remark:

Definition in Suiss report: Heating boilers in domestic sector

Considered pathways/media:

Atmosphere.

Measurements:

The Swiss report does not supply any results of measurements obtained in Switzerland.

Plant data:

No data provided.

National activity rates:

No data provided.

Emission factors:

The Swiss report considers the emission factors for residential heating boilers to be the same as for boiler in commercial and agricultural sector (see 02 01 / 02 03)

Residential plants	**emission factors, 1985 [ng/GJ]**	**emission factors, 1990 [ng/GJ]**	**emission factors, 1995 [ng/GJ]**
Heating oil EL	0.5	0.5	0.5
Natural gas	0.03	0.03	0.03
Coal	230	230	230
Wood	24	24	24
Diesel engines		0.5	0.5
Gas engines		0.03	0.03

CH: Residential plants; emission factors in [ng/GJ]

Estimation of annual emission:

Residential plants	**1985**	**1990**	**1995**
Total	0.875	0.565	0.5
Margin of Uncertainty			-

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

03 01
Combustion in boilers, gas turbines and stationary engines

General remark:

Here industrial combustion boilers, turbines and stationary engines are considered

Considered pathways/media:

Atmosphere.

Measurements:

The Swiss report does not supply any results of measurements obtained in Switzerland.

Plant data:

No data provided.

National activity rates:

No data provided.

Emission factors:

The emission factor for industrial wood combustion furnaces is a calculated mean based on Austrian, German and Swiss investigations ‹2,3,4›. The other emission factors are the same as for public power and district heating plants (see above).

Combustion in boilers, gas turbines and stationary engines	emission factors, 1985 [ng/GJ]	emission factors, 1990 [ng/GJ]	emission factors, 1995 [ng/GJ]
Industrial comb., heating oil EL	0.5	0.5	0.5
Industrial comb., heating oil "med. and heavy"	2.5	2.5	2.5
Industrial comb., natural gas	0.03	0.03	0.03
Industrial comb., coal	230	230	230
Industrial comb., wood	60	60	60
Industrial comb., gas turbines; heating oil EL		0.5	0.5
Industrial comb., gas turbines; natural gas		0.03	0.03
Industrial comb., diesel engines		0.5	0.5
Industrial comb., gas engines		0.03	0.03

CH: Combustion in boilers, gas turbines and stationary engines; emission factors in [ng/GJ]

Estimation of annual emission:

Combustion in boilers, gas turbines and stationary engines	**1985**	**1990**	**1995**
Total	1.39	0.613	0.713
Margin of Uncertainty			-

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

03 02 04
Plaster furnaces

Considered pathways/media:

Atmosphere.

Measurements:

None

Plant data:

No data provided.

National activity rates:

No data provided.

Emission factors:

Emission factors evaluated for industrial combustion furnaces are used and related to the amount of produced plaster considering the specific energy consumption and fuel mix

Plaster furnaces	**emission factor, 1985 [ng I-TEQ/t]**	**emission factor, 1990 [ng I-TEQ/t]**	**emission factor, 1995 [ng I-TEQ/t]**
estimated mean	1.6	1.6	1.6

CH: Plaster furnaces; emission factors in [ng/t]

Estimation of annual emission:

Plaster furnaces	**1985**	**1990**	**1995**
Total	< 0.001	< 0.001	< 0.001
Margin of Uncertainty			-

CH: Plaster furnaces; annual PCDD/PCDF emissions [g I-TEQ]/a

03 03 03
Gray iron foundries

General remark:

In the Suiss report data concerning iron and steel foundries are splitted into three subgroups (cupola ovens, electric furnace, other operation). Here these data are put together.

Considered pathways/media:

Atmosphere.

Measurements:

No measurement results quoted.

Activity rates:

From annual emissions and emission factors the following activity rates could be re-calculated:

Year	**1985**	**1990**	**1993**
[kt/a]	1725	90	85.7
	1443	90	85.7
	188	180	171.5

CH: Gray iron foundries; annual production in kt

Emission factors:

The 1990 emission factor for hot and cold wind cupola furnaces is based on Swiss measurement results from 1992 ‹6,7›. For electric furnaces an emission factor was applied, based on the emission factor for cupola ovens (3.5 µg I-TEQ/t in 1990). This value was rounded down due to an assumed lower chlorine content of input material (No employment of fuel!). Other operations comprise all emissions not generated by a furnace (e.g. core moulding casting etc.); the reported factor goes back to measurement results at a Swiss foundry in 1993 ‹8›.

03 03 03

Gray iron foundries

Gray iron foundries	emission factor, 1985 [µg I-TEQ/t]	emission factor, 1990 [µg I-TEQ/t]	emission factor, 1995 [µg I-TEQ/t]
Cupola furnace (mean?)	58.9	3.5	3.5
hot wind, filtered flew gas		1.5	
hot wind, unfiltered flew gas		1.5	
cold wind, filtered flew gas		7.0	
cold wind, unfiltered flew gas		7.0	
Electric furnace	50.5	3.0	3.0
Other operations	4.0	4.0	4.0

CH: Gray iron foundries; emission factors

Additionally the Swiss report presents annual emissions related to the number of employees in gray iron foundries:

Gray iron foundries	Dioxin [µg I-TEQ/ Empl.]
cupola furnaces, CH 1990	106
electric furnaces CH 1990	91
Other operations, CH 1990	120

CH: Gray iron foundries; emission factors per employee

Estimation of annual emission:

Cupola furnaces	1985	1990	1995
Total	6.04	0.315	0.3
Margin of Uncertainty			-
Electric furnaces	**1985**	**1990**	**1995**
Total	4.33	0.27	0.257
Margin of Uncertainty			-
Other operations	**1985**	**1990**	**1995**
Total	0.753	0.72	0.686
Margin of Uncertainty			-

CH: Gray iron foundries; annual PCDD/PCDF emissions [g I-TEQ]/a

03 03 10
Secondary aluminium production

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The emission factor for secondary aluminium production is based on Swiss measurement results from 1992 and data on annual production rates ‹9›.

Secondary aluminium production	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**
Applied value	33.2	19

CH: Secondary aluminium production; emission factors

Estimation of annual emission:

Secondary aluminium production	**1985**	**1990**	**1995**
Total	0.761	0.654	?
Margin of Uncertainty			-

CH: Secondary aluminium production;
annual PCDD/PCDF emissions [g I-TEQ]/a

03 03 11
Cement

Considered pathways/media:

Atmosphere.

Measurements:

Cement	1994
cement production (waste gas)	0,1

CH: Cement; measurement results from Switzerland; PCDD/PCDF emissions [ng I-TEQ/m^{-3}]

National activity rates:

No data provided.

Emission factors:

The emission factor in the Swiss report for cement was obtained from a personel communication of the Swiss cement industry ‹10›. Though the Swiss report cites an emission factor of 180 ng/t in the communication of the Swiss cement industry; this value was not taken into account. No explanation is provided why 160 ng/t was selected as table value.

Cement	emission factor, 1985 [µg I-TEQ/t]	emission factor, 1990 [µg I-TEQ/t]	emission factor, 1995 [µg I-TEQ/t]
Applied value	0.193	0.16	0.16

CH: Cement; emission factors

Estimation of annual emission:

Cement	1985	1990	1995
Total	0.841	0.832	0.672
Margin of Uncertainty			-

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

03 03 12
Lime (incl. iron/steel ind. and Paper pulp ind.)

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The applied emission factor for the Swiss inventory is a mean of 7 measurements at 2 plants in Germany from 1993 ‹11›.

Lime	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.097	0.08	0.08

CH: Lime (incl. iron/steel ind. and Paper pulp ind.); emission factors

Estimation of annual emission:

Lime (incl. iron/steel ind. and Paper pulp ind.)	**1985**	**1990**	**1995**
Total	0.011	0.009	0.008
Margin of Uncertainty			-

CH: Lime (incl. iron/steel ind. and Paper pulp ind.); annual PCDD/PCDF emissions [g I-TEQ]/a

03 03 13
Asphalt concrete plants

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The applied emission factor for the Swiss inventory is a mean (3.8 ng/t) of 3 measurements at one plant in Germany from 1993 ‹11›. The table value was rounded up.

Asphalt concrete plants	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.06	0.05	0.05
"new production"		0.05	
"remixing"		0.05	

CH: Asphalt concrete plants; emission factors

Estimation of annual emission:

Asphalt concrete plants	**1985**	**1990**	**1995**
Total	0.019	0.027	0.029
Margin of Uncertainty			-

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

03 03 19
Bricks and tiles

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The applied emission factor for the Swiss inventory is a mean (18 ng/t) derived from measurements in Germany from 1993 ‹11›. The table value was rounded up.

Bricks and tiles	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.023	0.02	0.019

CH: Bricks and tiles; emission factors

Estimation of annual emission:

Bricks and tiles	**1985**	**1990**	**1995**
Total	0.029	0.027	0.026
Margin of Uncertainty			-

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

03 03 20
Fine ceramic materials

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

For fine ceramic materials the emission factors of industrial combustion furnaces were applied taking into consideration the specific energy consumption and the fuels mix for the produced amount of fine ceramics.

Fine ceramic materials	emission factor, 1985 [µg I-TEQ/t]	emission factor, 1990 [µg I-TEQ/t]	emission factor, 1995 [µg I-TEQ/t]
Applied value	0.019	0.004	0.004

CH: Fine ceramic materials; emission factors

Estimation of annual emission:

Fine ceramic materials	1985	1990	1995
Total	0.001	< 0.001	< 0.001
Margin of Uncertainty			-

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

03 03 26
Other processes - metal reclamation from cables

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The Swiss report consideres the emissions through metal reclamation from cables to be comparable to waste incinerators (see 09 02 02). Assuming dioxin emissions are correlated to particulate emissions and chlorine concentrations in the waste gas; the dioxin emission factors in the Swiss report were calculated according to the following formula:

EF (dioxin) = 53 * EF (particulate emis.) * EF (HCl)

EF = emission factor

After entering the emission factors for particulate emissions and chlorine (both in kg/t) the results in the following table are achieved (in µg/t cable).

Metal reclamation from cables	**particulate emission, kg/t**	**HCl g/t**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.51	600	17	2340	17
Incine. in furnaces	0.51	600	17		
Open incineration	5.0	600	17		

CH: Metal reclamation from cables; emission factors

Estimation of annual emission:

Metal reclamation from cables	**1985**	**1990**	**1995**
Total	14.2	0.128	0
Margin of Uncertainty			-

CH: Metal reclamation from cables;
annual PCDD/PCDF emissions [g I-TEQ]/a

04 02 07
Electric furnace steel plant

General Remark:

For the dioxin estimation out of electric furnace steel plants the Swiss report considers stack and diffuse emissions.

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The factor in the Swiss report for stack emissions of electric furnace steel plants (5.7 µg/t steel) was obtained from measurements carried out in Switzerland in 1990 ‹12›. The Swiss report cites another emission factor from Germany (3.8 µg/t steel) which was not taken into account. No explanation is given why this value was disregarded.

With the emission factor for particulate stack emissions (0.14 kg/t steel) a dioxin concentration in particulate stack emissions of 41 ppb was calculated.

The emission factor for diffuse emissions was estimated under the following assumption:

The dioxin content in diffuse emitted particulate emissions is 10 times lower than in the clean gas of the stack emission; thus approximately 4.1 ppb are attained.

With the emission factor for diffuse particulate stack emissions (1.2 kg/t steel) an emission factor of 4.9 µg/t steel is obtained.

The table value is the rounded up sum of stack and diffuse dioxin emissions.

Electric furnace steel plant	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	12.7	11	11

CH: Electric furnace steel plant; emission factors

Estimation of annual emission:

Electric furnace steel plant	1985	1990	1995
Total	12.9	12.2	8.03
Margin of Uncertainty			-

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

04 02 10
Other processes - shredder installations

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The applied emission factor for the Swiss inventory goes back to German findings (415 ng/t) from 1993 ‹11›. The table shows a rounded down value.

Shredder installations	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.4	0.4	0.4

CH: Shredder installations; emission factors

Estimation of annual emission:

Shredder installations	**1985**	**1990**	**1995**
Total	0.116	0.145	0.169
Margin of Uncertainty			-

CH: Shredder installations; annual PCDD/PCDF emissions [g I-TEQ]/a

04 03 07
Galvanising

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

For the Swiss inventory the emission factor was acquired from results of 4 measurements carried out in Germany (mean: 0,623 µg/t product) in 1993 ‹11›. The table shows a rounded up value.

Galvanising	emission factor, 1985 [µg I-TEQ/t]	emission factor, 1990 [µg I-TEQ/t]	emission factor, 1995 [µg I-TEQ/t]
Applied value	3.85	0.7	0.7

CH: Galvanising; emission factors

Additionally the Swiss report presents annual emissions related to the number of employees in galvanising plants:

Galvanising	Dioxin [µg I-TEQ/Empl.]
CH 1990	5.51

CH: Galvanising; emission factor per employee

Estimation of annual emission:

Galvanising	1985	1990	1995
Total	0.418	0.071	0.071
Margin of Uncertainty			-

CH: Galvanising; annual PCDD/PCDF emissions [g I-TEQ]/a

04 03 09
Other processes - non ferrous metal foundries

General Remark:

Stack emissions of the furnace and other emissions (drying of shavings, diffuse emissions) are considered separately.

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The emission factors for stack emissions and other operations are based on Swiss measurements and communications ‹13,14,15›.

Dioxin emissions caused by drying of shavings are summarised under ”other operations”. Measurements at an installation without abatement measures resulted in an emission factor of about 365 µg I-TEQ/t of non ferrous metal. As no measurements were known the emission factor of installations with abatement facilities was assumed to be about 100 times lower ensuing 3 µg I-TEQ/t of non ferrous metal.

Foundries	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
stack emissions	147	30	30
other operations	87	87	4.9

CH: Non ferrous metal foundries; emission factors

Estimation of annual emission:

Foundries (stack emissions)	**1985**	**1990**	**1995**
Total	8.56	1.65	1.57
Margin of Uncertainty			-
Foundries (other operations)			
Total	5.08	4.79	0.257
Margin of Uncertainty			-

CH: Non ferrous metal foundries;
annual PCDD/PCDF emissions [g I-TEQ]/a

04 06 01
Chipboard

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

For the Swiss inventory the emission factor was acquired from results of 4 measurements carried out in Germany at drying installations (arithmetic mean: 0,12 ng/m³ related to 17 % O_2) in 1993 ‹11›. The table value was calculated considering the chipboard volumes, the specific waste gas volume and density and was rounded up finally.

Chipboard	emission factor, 1985 [µg I-TEQ/m³]	emission factor, 1990 [µg I-TEQ/m³]	emission factor, 1995 [µg I-TEQ/m³]
Applied value	0.3	0.3	0.3

CH: Chipboard; emission factors

Estimation of annual emission:

Chipboard	1985	1990	1995
Total	0.166	0.217	0.217
Margin of Uncertainty			-

CH: Chipboard; annual PCDD/PCDF emissions [g I-TEQ]/a

04 06 17
Other processes - smoke curing

Considered pathways/media:

Atmosphere.

National activity rates:

No data provided.

Emission factors:

The applied emission factor for the Swiss inventory goes back to German results at smoke curing installations equipped with (0.1 ng TEQ/m³) and without (1.02 ng TEQ/m³) thermal afterburning from 1993 ‹11›. For calculating the Swiss emission factor the following assumptions were made:

A conventional smoke curing chamber emits about 300 m³/h and produces about 50 kg product per hour. This results in a total waste gas volume of 6000 m³/t product. With the German measurement results the following emission factors are attained: 0.6 µg TEQ/t and 6.0 µg TEQ/t (with and without thermal afterburning). The table shows rounded values.

Smoke curing	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	6.0	6.0	4.9
cold smoke curing, no thermal afterburning		6.0	
cold smoke curing, thermal afterburning		0.6	
hot smoke curing, no thermal afterburning		6.0	
hot smoke curing, thermal afterburning		0.6	

CH: Smoke curing; emission factors

Additionally the Swiss report presents annual emissions related to the number of employees in smoke curing installations:

04 06 17

Other processes - smoke curing

Smoke curing	Dioxin [µg I-TEQ/ Empl.]
CH 1990	40.8

CH: Smoke curing; emission factor per employee

Estimation of annual emission:

Smoke curing	1985	1990	1995
Total	0.39	0.39	0.335
Margin of Uncertainty			-

CH: Smoke curing; annual PCDD/PCDF emissions [g I-TEQ]/a

06 04 06
Preservation of wood

Considered pathways/media:

Atmosphere.

Measurements:

No measurement results quoted.

Emission factors:

The Swiss report only presents an emission factor related to the number of employees working in sawmills, at planing machines, in veneer and waterproofing installations, in the production of furniture and carpentry.

Preservation of wood	emission factor, 1990 [µg I-TEQ/Empl.]
Applied value	39.6

CH: Preservation of wood; emission factor per employee

Estimation of annual emission:

A value (15.2 g I-TEQ/a) from a graphic published in the Netherlands in 1990 was selected for the estimation of annual dioxin emissions form PCP containing wood preservatives in Switzerland ‹16›. The annual Swiss emissions were calculated under the following assumptions:

According to Swiss personal communications the ratio of Dutch to Swiss dioxin emissions form PCP containing wood preservatives is 5 to 1 ‹17,18›.

For 1990 dioxin emissions of 3.0 g I-TEQ /a in Switzerland ensued from this.

Preservation of wood	emission factor, 1990 [g I-TEQ/a]
Annual emission	3.0

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

07 01 01/02/03
Passenger cars

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Estimation of annual emission:

Passenger cars	**1985**	**1990**	**1995**
Total	2.58	1.73	0.728
Margin of Uncertainty			-

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

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

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Estimation of annual emission:

Light duty vehicles < 3.5 t	1985	1990	1995
Total	0.195	0.153	0.073
Margin of Uncertainty			-

CH: 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:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Estimation of annual emission:

Heavy duty vehicles > 3.5 t and buses	**1985**	**1990**	**1995**
Total **Margin of Uncertainty**	0.39	0.39	0.335 -

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

08 03 01/02/03/04
Inland waterways

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Emission factors:

Inland waterways	emission factor, 1985 [µg I-TEQ/GJ]	emission factor, 1990 [µg I-TEQ/ GJ]	emission factor, 1995 [µg I-TEQ/ GJ]
Applied value	?	?	?
boats, 2-stroke	0.023	0.023	0.022
boats, 4-stroke	0.023	0.023	0.022
boats, diesel	0.001	0.001	0.001
steamers, heating oil EL	0.001	0.001	0.001
steamers, heating oil "heavy"	0.003	0.003	0.003
steamers, coal			
freighters, diesel	0.001	0.001	0.001
passenger ship, 4-stroke	0.023	0.023	0.022
passenger ship, diesel	0.001	0.001	0.001

CH: Inland waterways; emission factors

Estimation of annual emission:

Inland waterways	1985	1990	1995
Total	0.04	0.005	0.005
Margin of Uncertainty			-

CH: Inland waterways; annual PCDD/PCDF emissions [g I-TEQ]/a

08 06
Agriculture

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Emission factors:

Agriculture	emission factor, 1985 [µg I-TEQ/GJ]	emission factor, 1990 [µg I-TEQ/ GJ]	emission factor, 1995 [µg I-TEQ/ GJ]
Applied value	?	?	?
agricultural machinery, 2-stroke	0.023	0.023	0.023
agricultural machinery, 4-stroke	0.023	0.023	0.023
agricultural machinery, diesel	0.001	0.001	0.001

CH: Agriculture; emission factors

Estimation of annual emission:

Agriculture	1985	1990	1995
Total	0.059	0.048	0.049
Margin of Uncertainty			-

CH: Agriculture; annual PCDD/PCDF emissions [g I-TEQ]/a

08 07
Forestry

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Emission factors:

Forestry	emission factor, 1985 [µg I-TEQ/GJ]	emission factor, 1990 [µg I-TEQ/ GJ]	emission factor, 1995 [µg I-TEQ/ GJ]
Applied value	?	?	?
forest machinery, 2-stroke	0.023	0.023	0.023
forest machinery, diesel	0.001	0.001	0.001

CH: Forestry; emission factors

Estimation of annual emission:

Forestry	1985	1990	1995
Total	0.001	0.001	0.001
Margin of Uncertainty			-

CH: Forestry; annual PCDD/PCDF emissions [g I-TEQ]/a

08 08
Industry

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Emission factors:

Industry	emission factor, 1985 [µg I-TEQ/GJ]	emission factor, 1990 [µg I-TEQ/ GJ]	emission factor, 1995 [µg I-TEQ/ GJ]
Applied value	?	?	?
industrial machinery, 4-stroke	0.023	0.023	0.023
industrial machinery, diesel	0.001	0.001	0.001

CH: Industry; emission factors

Estimation of annual emission:

Industry	1985	1990	1995
Total	0.026	0.028	0.026
Margin of Uncertainty			-

CH: Industry; annual PCDD/PCDF emissions [g I-TEQ]/a

08 09
Household and gardening

Considered pathways/media:

Atmosphere

Measurements:

No measurement results quoted.

Plant data:

Not applicable.

Emission factors:

Houshold and gardening	emission factor, 1985 [µg I-TEQ/GJ]	emission factor, 1990 [µg I-TEQ/ GJ]	emission factor, 1995 [µg I-TEQ/ GJ]
Applied value	?	?	?
hous./gard. machinery, 2-stroke	0.023	0.023	0.023
hous./gard. machinery, 4-stroke	0.023	0.023	0.023

CH: Household and gardening; emission factors

Estimation of annual emission:

Houshold and gardening	1985	1990	1995
Total	0.039	0.039	0.041
Margin of Uncertainty			-

CH: Household and gardening; annual PCDD/PCDF emissions [g I-TEQ]/a

08 10
Pipeline compressor stations (gas turbines)

Considered pathways/media:

Atmosphere.

Emission factors:

For pipeline compressor stations the same emission factors were applied as for gas turbines with natural gas (see 01 01)

Pipeline compressor stations	**emission factor, 1990 [pg I-TEQ/GJ]**
Applied value	30

CH: Pipeline compressor stations (gas turbines); emission factors

Estimation of annual emission:

Pipeline compressor stations (gas turbines)	**1985**	**1990**	**1995**
Total	< 0.001	< 0.001	< 0.001
Margin of Uncertainty			-

CH: Pipeline compressor stations (gas turbines); annual PCDD/PCDF emissions [g I-TEQ]/a

09 02 01
Incineration of domestic or municipal wastes

General Remark:

The Swiss study considers the incineration of domestic or municipal wastes and the (illegal) burning of household wastes separately (see 09 02 01b).

Considered pathways/media:

Atmosphere.

National activity rates:

Emission factors:

The emission factor for waste incineration without $DeNO_x$ (46.6 µg/t waste) is an arithmetic mean of Swiss and German results from 1991 ‹19,20,21›. In the table a rounded up value is presented. For waste incineration with $DeNO_x$ an emission factor of < 1 ng/m³ related to the waste gas volume is estimated. Half of this emission factor (0.5 ng/m³) is multiplied with an assumed waste gas volume of 6000 m³ per ton of waste giving the table values for plants with $DeNO_x$.

Incineration of domestic or municipal wastes	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	133	50	40
plant without DeNOX		50	
plant with DeNOX (SNCR)		3	
plant with DeNOX (SCR)		3	

CH: Incineration of domestic or municipal wastes; emission factors

Estimation of annual emission:

Incineration of domestic or municipal waste	**1985**	**1990**	**1995**
Total	251	120	96.2
Margin of Uncertainty			-

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

09 02 01 b
Incineration of household wastes (illegal)

General Remark:

Under this especially introduced Corinair code the Swiss study considers the (illegal) burning of household wastes such as: paper, cardboard and plastics. In parts this waste is not disposed of regularly and incinerated in private household firings or in the open air. According to the Swiss study this way of waste disposal was legally banned in Switzerland by it still is put into practice.

Considered pathways/media:

Atmosphere.

Emission factors:

The emission factor for the incineration of household wastes (illegal) is based on Swiss measurements. For this investigations combustible wastes (70 % paper and cardboard and the remainder mainly plastics) were applied ‹22›.

The obtained emission factor does not apply to the incineration of gardening wastes.

Incineration of household wastes (illegal)	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	3230	3230	3230

CH: Incineration of household wastes (illegal); emission factors

Estimation of annual emission:

Incineration of domestic or municipal waste illegal	**1985**	**1990**	**1995**
Total	22.5	26.8	26.9
Margin of Uncertainty			-

CH: Incineration of household wastes (illegal);
annual PCDD/PCDF emissions [g I-TEQ]/a

09 02 02
Incineration of industrial wastes

Considered pathways/media:

Atmosphere.

Emission factors:

For the determination of emission factors the Swiss report assumes that dioxin emissions are correlated to particulate emissions and chlorine concentrations in the waste gas. Therefor the dioxin emission factors in the Swiss report were calculated according to the following formula:

EF (dioxin) = 53 * EF (particulate emis.) * EF (HCl)

EF = emission factor

After entering the emission factors for particulate emissions and chlorine (both in kg/t ‹23›) the results in the following table are attained (in µg/t waste).

Incineration of industrial wastes	**particulate emission, [kg/t]**	**HCl [kg/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.6	2.8	89	428	40
no desulphurization	0.6	2.8	89		
desulphurization	0.6	2.8	89		
no DeNOX	0.6	2.8	89		
DeNOX	0.6	2.8	89		

CH: Incineration of industrial wastes; emission factors

The following table separately presents a dioxin emission factor for the incineration of building site wastes. For the determination of this emission factor the same assumption was used as above. The formula for the calculation of the emission factor was slightly modified ‹24›:

EF (dioxin) = k * EF (particulate emis.) * EF (HCl) or

EF (dioxin) = k' * EF (particulate emis.) * EF (HCl),

as EF (particulate emis.) is constant

EF = emission factor

09 02 02

Incineration of industrial wastes

With k' = 0,075 and the emission factor for HCl (in g/t waste) the value in the following table is obtained. No further explanation is provided why this particular value was selected for the calculation of this emission factor.

Incineration of building site wastes	**particulate emission, [kg/t]**	**HCl [g/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	30	5300	398	390	398

CH: Incineration of industrial wastes; emission factors

Additionally the Swiss report presents an emission factor related to the number of employees working for building construction and waste disposal.

Incineration of industrial wastes	**particulate emission, [kg/Empl.]**	**HCl [kg/Empl.]**	**Dioxin [µg I-TEQ/Empl.]**
CH 1990	26.6	4.7	353

CH: Incineration of industrial wastes; emission factor per employee

Estimation of annual emission:

Incineration of industrial wastes	**1985**	**1990**	**1995**
Total	44.3	11.8	7.32
Margin of Uncertainty			-
Incineration of building site wastes			
Total	16.6	19.9	12.7
Margin of Uncertainty			-

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

09 02 07
Incineration of hospital wastes

Considered pathways/media:

Atmosphere.

Emission factors:

The emission factor for the incineration of hospital wastes was taken from a publication of Glasser and Chang ‹25›.

Incineration of hospital wastes	emission factor, 1985 [µg I-TEQ/t]	emission factor, 1990 [µg I-TEQ/t]	emission factor, 1995 [µg I-TEQ/t]
Applied value	460	460	460

CH: Incineration of hospital wastes; emission factor

Additionally the Swiss report presents an annual emission factor related to the number of beds in Swiss hospitals.

In Swiss hospitals 30.000 t/a are incinerated. The number of beds is 40.932; therefor about 0,73 t of hospital waste per bed is burned every year.

Incineration of hospital wastes	Dioxin [µg I-TEQ/bed]
CH 1990	337

CH: Incineration of hospital wastes; emission factor per bed

Estimation of annual emission:

Incineration of hospital wastes	1985	1990	1995
Total	10.9	13.8	10.4
Margin of Uncertainty			-

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

09 09
Cremation

Considered pathways/media:

Atmosphere.

Emission factors:

The table value was selected because it is approximately in the middle of two other means (7.5 and 12.4 µg/cremation). The lower mean is an arithmetic mean itself of Swiss and German investigations ‹26,27›. The upper value is a mean of 16 measurements at 6 crematoria in Germany ‹11›

Cremation	**emission factor, 1985 [µg I-TEQ/ cremation]**	**emission factor, 1990 [µg I-TEQ/ cremation]**	**emission factor, 1995 [µg I-TEQ/ cremation]**
Applied value	10	10	10

CH: Cremation; emission factor per cremation

Estimation of annual emission:

Cremation	**1985**	**1990**	**1995**
Total	0.316	0.375	0.415
Margin of Uncertainty			-

CH: Cremation; annual PCDD/PCDF emissions [g I-TEQ]/a

09 10 01
Waste water treatment in industry

General Remark:

Under this Corinair code the Swiss study considers the incineration of bark wastes and sewage sludge from commercial/industrial sewage plants. Support fuels were disregarded.

Considered pathways/media:

Atmosphere.

Emission factors:

The emission factor for waste water treatment in industry was taken from a Swiss report from 1990 ‹28›.

Waste water treatment in industry	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	0.7	0.7	0.7

CH: Waste water treatment in industry; emission factor

Estimation of annual emission:

Waste water treatment in industry	**1985**	**1990**	**1995**
Total	0.01	0.01	0.012
Margin of Uncertainty			-

CH: Waste water treatment in industry;
annual PCDD/PCDF emissions [g I-TEQ]/a

09 10 02
Waste water treatment in residential and commercial sectors

Considered pathways/media:

Atmosphere.

Emission factors:

Swiss (50 µg/t dry matter) and German (3 µg/t dry matter ‹20›) emission factors from 1984 were taken as the basis für the calculation of the 1990 emission factor. The slightly modified formula for the estimation of emission factors was applied for the following calculations (see 09 02 02):

EF (dioxin) = k * EF (particulate emis.) * EF (HCl)

The rounded up geometric mean (13 µg/t dry matter) from 1984 and the emission factors for particulate emission (in kg/t) and HCl (in g/t) were used for the calculation of the factor k = 0.0148. With factor k and the emission factors for particulate emission and HCl from 1990 the emission factors for dioxin could be calculated.

Waste water treatment in residential and commercial sectors	**particulate emission, [µg/t]**	**HCl [µg/t]**	**emission factor, 1990 [µg I-TEQ/t]**	**emission factor, 1985 [µg I-TEQ/t]**	**emission factor, 1995 [µg I-TEQ/t]**
Applied value	350	900	4.7	11.6	0.5
no desulphurization	350	1600	8.3		
desulphurization	350	130	0.7		

CH: Waste water treatment in residential and commercial sectors; emission factor

Estimation of annual emission:

Waste water treatment in residential and commercial sectors	**1985**	**1990**	**1995**
Total	0.469	0.268	0.031
Margin of Uncertainty			-

CH: Waste water treatment in residential and commercial sectors; annual PCDD/PCDF emissions [g I-TEQ]/a

12 01
Land fill fires

General Remark:

Under this Corinair code the Swiss study considers the emission of dioxins through open air waste incineration on landfill sites.

Considered pathways/media:

Atmosphere.

Emission factors:

Unpublished Swiss measurement results about dioxin concentrations in the filter dust of waste incinerators (15 µg/kg dust ‹24›) and an estimate (30 kg/t waste) on particulate emission from open waste incineration were taken as the basis für the calculation of the emission factor.

Land fill fires	**Dioxin µg I-TEQ/t**
CH 1990	450

CH: Land fill fires; emission factors

Estimation of annual emission:

Land filling	**1985**	**1990**	**1995**
Total	30.2	19.9	9.13
Margin of Uncertainty			-

CH: Land fill fires; annual PCDD/PCDF emissions [g I-TEQ]/a

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