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Best Available Techniques Reference document for Common Waste Gas Treatment in the Chemical Sector (WGC BREF)

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Preliminary EIPPCB assessment of specific subsectors/products/processes that could need a dedicated approach

INTRODUCTION

The Technical Working Group (TWG) for the drawing up of the BAT reference document for Common Waste Gas Treatment in the Chemical Sector (WGC BREF) held its Kick-off Meeting (KoM) on 25 – 29 September 2017 in Seville, Spain. During this meeting, the TWG determined the process for the drawing up of this new BREF, the scope of the document and the principles of the exchange of information (data collection). The TWG concluded that data will be collected on both channelled and diffuse emissions to air.

The data collection will be carried out using generic worksheets to collect comprehensive and representative information on air abatement techniques and emission levels across the whole chemical industry. Complementary worksheets to the generic questionnaire will be used to collect additional information and data from specific subsectors/products/processes that could need a dedicated approach.

The generic worksheets will contain a section for the plant operator to provide contextual information. This contextual information will identify the specificities of the production of **some** products/processes/subsectors, e.g. when a high pollutant load in the untreated waste gas leads to higher emission levels. This will allow the TWG to set generic BAT-AELs and specific BAT-AELs for specific products/processes/subsectors if and where it is necessary. However, for other products/processes/subsectors, generic worksheets will not be sufficient, e.g. because the emission levels depend on **specific** process-integrated techniques, which could not be adequately described using only the contextual information section of the generic questionnaire.

On 28 July 2017, the EIPPCB provided the TWG with some examples of questions that might indicate the need for complementary worksheets to the generic questionnaire:

- Do existing BAT refer to process-integrated techniques for the reduction of emissions to air or are they purely based on end-of-pipe techniques?
- Are existing BAT-AELs expressed as concentrations or loads? Was there a rationale to express BAT-AELs as specific loads, or was it due to the format of the data provided?
- Do the BAT-AEL ranges differ significantly from other BAT-AEL ranges set in recent BREFs and, if so, why?

- How do specific requirements in MS' legislation differ from the general requirements in that legislation and why?

Based on these questions, the EIPPCB assessed seven examples to help the TWG analyse and assess the need for some subsectors/products/processes to have complementary worksheets.

The TWG was asked to provide the following information by 4 September 2017:

- a list of specific subsectors/products/processes that would, in their view, need a complementary worksheet;
- technical arguments supporting their proposals;
- any other criteria that might be used to assess the need for complementary worksheets.

On 22 September 2017 the EIPPCB issued a preliminary result of the assessment of the consolidated list of specific subsectors/products/processes (on BATIS > Forum > Common Waste Gas Treatment in the Chemical Sector > Kick-off meeting > Invitation and agenda).

At the KoM, the TWG agreed to send further information by 24 October 2017, so that the EIPPCB could complete and finalise the assessment of the 44 products/processes/subsectors by 20 November 2017. Unfortunately, by the 24 October, very few TWG members had sent additional information, or further justifications supporting the need for complementary worksheets. As a consequence, this assessment of the 44 production processes required more work by the EIPPCB and could not be completed by 20 November.

Each of the 44 subsectors/products/processes has been assessed by the EIPPCB according to the following structure:

1. Technical information provided by the TWG.
2. Information in the existing chemical BREFs: the EIPPCB based its analysis, when possible, on the questions provided on 28 July 2017.
3. Information from the General Binding Rules (GBRs) of the Member States (MSs) regarding specific provisions for emission limit values (ELVs) to air for specific subsectors/products/processes; the generic provisions are presented in the annex: Overview of generic thresholds / ELVs in MS legislation for KEIs. In the short time available, the EIPPCB could not analyse the legislation of all 28 MSs. Therefore, the analysis was restricted to the largest MS that use GBRs (i.e. DE, FR and IT). Together, the GBRs of these three MS cover more than 50 % of the total number of European chemical installations. ELVs from other MSs' GBRs have been included in the assessment when the MSs provided the information. However, the GBRs do not contain the technical rationales as to why higher emission levels for the specific subsectors/products/processes have been set, and the MSs did not provide further details.
4. Information collected from other sources of information such as Ullmann's chemical encyclopaedia or industry organisations to identify any significant changes to the production processes since the publication of the existing chemical BREFs.

The EIPPCB preliminary assessment and conclusion are based on the information in points 1 to 4 above.

The TWG proposed that a number of subsectors/products/processes should be excluded from the scope of the WGC BREF and that instead they should be covered in one or more additional chemical BREFs. Those proposals have not been considered in the assessment since this document only aims at answering the question "which products/processes/subsectors would need specific questionnaire worksheets for emissions to air?" The potential review of other chemical BREFs will be dealt with at the level of the IED Article 13 Forum.

TWG members are asked to review the preliminary EIPPCB assessments contained in this document and to upload their comments onto BATIS by 19 January 2018.

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Acronyms used in this document

General acronyms – Definitions

Acronym	Meaning
AN	Ammonium nitrate (NH_4NO_3), a type of fertiliser
BAT	Best Available Techniques (as defined in Article 3(10) of the IED)
BAT-AEL	BAT-associated emission level (as defined in Article 3(13) of the IED)
BATIS	BAT Information System
BREF	BAT reference document (as defined in Article 3(11) of the IED)
CAN	Calcium ammonium nitrate, a type of fertiliser
CN	Calcium nitrate $Ca(NO_3)_2$, a type of fertiliser
CWW BREF	BAT reference document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (published 2016)
EIPPCB	European IPPC Bureau within Directorate B of the Commission's Joint Research Centre
ELV	Emission limit value
E-PRTR	European Pollutant Release and Transfer Register
GBR(s)	General binding rule(s)
IP(s)	Initial position(s)
KEI(s)	Key environmental issue(s)
LVIC-AAF BREF	BAT reference document for the Manufacture of Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers (published August 2007)
LVIC-S BREF	BAT reference document for the Manufacture of Large Volume Inorganic Chemicals – Solids and Others Industry (published September 2007)
LVOC BREF	BAT reference document for the Large Volume Organic Chemical Industry (adopted November 2017, to be published late 2017 or early 2018)
MS(s)	Member State(s)
NMVOC	Non-methane volatile organic compound
NO_X	The sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2
NPK	Compound/multinutrient fertiliser
OFC BREF	BAT reference document for the Manufacture of Organic Fine Chemicals (published August 2006)
PCDD/F	Polychlorinated dibenzo-*p*-dioxin/furan
POL BREF	BAT reference document in the Production of Polymers (published August 2007)
PVC	Polyvinyl chloride
REF BREF	BAT reference document for the Refining of Mineral Oil and Gas (published 2015)
SO_X	The sum of sulphur dioxide (SO_2), sulphur trioxide (SO_3), and sulphuric acid aerosols, expressed as SO_2
TVOC	Total volatile organic carbon
TWG	Technical Working Group
UBA(DE)	Umweltbundesamt (German Federal Environment Agency)
VOC	Volatile organic compound (as defined in Article 3(45) of the IED)
VCI	Verband der Chemischen Industrie (German chemical industry association)
WGC BREF	BAT reference document for Common Waste Gas Treatment in the Chemical Sector

Member States and Organisations that provided information on specific subsectors/products/processes

Acronym/name	Member State/organisation	Information provided by 04.09.2017	Information provided by 24.10.2017
AT	Austria	X	X
BE	Belgium	X	X
CZ	Czech Republic	X	X
DE	Germany	X	X
DK	Denmark	X	
ES	Spain	X	X
FR	France	X	
IT	Italy	X	
NO	Norway		X
PL	Poland		X
PT	Portugal		X
SE	Sweden	X	X
CEFIC	European Chemical Industry Council	X	X
Fertilizers Europe	Association representing the major fertiliser manufacturers in Europe	X	X

Member States' General Binding Rules (GBRs)

DE	First General Administrative Regulation Pertaining the Federal Immission Control Act (Technical Instructions on Air Quality Control – TA Luft) http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Luft/taluft_engl.pdf
FR	Arrêté du 02/02/98 relatif aux prélèvements et à la consommation d'eau ainsi qu'aux émissions de toute nature des installations classées pour la protection de l'environnement soumises à authorisation https://aida.ineris.fr/consultation_document/5657
IT	ALLEGATI al Decreto legislativo 3 aprile 2006, n. 152 http://www.camera.it/parlam/leggi/deleghe/06152dl6.htm

Other sources of information

Ullmann's	Ullmann's Encyclopedia of Industrial Chemistry, electronic release, Wiley-VCH, Weinheim. http://onlinelibrary.wiley.com/mrw/advanced/search?doi=10.1002/14356007
Kirk-Othmer	Kirk-Othmer Encyclopedia of Chemical Technology, electronic release, Wiley. http://onlinelibrary.wiley.com/mrw/advanced/search?doi=10.1002/0471238961
Plastics Europe	http://www.plasticseurope.org
European Man-made Fibres	http://www.cirfs.org

Summary table of the preliminary results of the EIPPCB assessment

This table summarises the results of the assessments below, conducted on the 44 subsectors/products/processes for which a complementary worksheet might be needed in the questionnaire to collect plant-specific information for the drawing up of the WGC BREF.

No	Subsector/ Product/ Process	IED Annex I Ref.	TWG initial position	TWG technical information provided	Result of the preliminary EIPPCB assessment
1	Cement additives	NSM	AT	No feedback	**No complementary worksheet needed**
2	Flame retardants	NSM	AT	No feedback	**No complementary worksheet needed**
3	Cyclohexanone oxidation	4.1b	AT	IT	**No complementary worksheet needed**
4	Urea	4.1d	ES, CEFIC	FE, IT	**Complementary worksheet needed**
5	Aniline	4.1d	CEFIC	CEFIC	**No complementary worksheet needed**
6	Melamine	4.1d	CEFIC	No feedback	**No complementary worksheet needed**
7	Nitrogenous hydrocarbons	4.1d	AT	CEFIC	**No complementary worksheet needed**
8	Nitro compounds	4.1d	CEFIC, ES	CEFIC	**No complementary worksheet needed**
9	Aromatic hydrocarbons containing fluorine	4.1f	AT, EEB	IT	**No complementary worksheet needed**
10	Organometallic compounds	4.1g	EEB	IT	**No complementary worksheet needed**
11	Cellulose nitration	4.1h	AT, IT	IT	**No complementary worksheet needed**
12	Viscose	4.1h	CZ, IT, CEFIC	CZ, DE, IT, CEFIC	**Complementary worksheet needed**
13	Polyamide fibres	4.1h	IT	IT	**No complementary worksheet needed**
14	PVC	4.1h	AT, EEB, IT	DE, FR, IT, SE	**No complementary worksheet needed**
15	Polyester	4.1h	IT	IT	**No complementary worksheet needed**
16	Acrylic fibres	4.1h	IT	DE, IT	**No complementary worksheet needed**

No	Subsector/ Product/ Process	IED Annex I Ref.	TWG initial position	TWG technical information provided	Result of the preliminary EIPPCB assessment
17	Cellulose acetate	4.1h	IT	IT	**No complementary worksheet needed**
18	Polymers and specific plastic materials	4.1h	AT, CEFIC, DE, ES	CEFIC, DE, SE	**Complementary worksheet needed for some polymers**
19	Acrylonitrile polymers	4.1h	IT	DE, IT	**No complementary worksheet needed**
20	Polycarbonate	4.1h	IT	CEFIC, ES, IT	**No complementary worksheet needed**
21	Synthetic rubbers	4.1i	IT	DE, IT	**No complementary worksheet needed**
22	Surface-active agents	4.1k	AT	No feedback	**No complementary worksheet needed**
23	CO reformers (i.e. HyCO plants) and steam reformers	4.2a	CEFIC	CEFIC, FE	**Complementary worksheet on process furnaces/heaters needed**
24	Ammonia	4.2a	AT, DE, IT, CEFIC, ES, FE, NO	DE, ES, FE, IT, NO	**Complementary worksheet on process heaters needed, but not necessarily for ammonia**
25	Hydrofluoric acid	4.2a	DE	DE, CEFIC, IT	**No complementary worksheet needed**
26	Nitrosylsulphuric acid	4.2b	AT, IT	IT	**No complementary worksheet needed**
27	Nitric acid	4.2b	AT, CEFIC, DE, ES, FE	DE, ES, FE, FR, NO	**Complementary worksheet needed**
28	Phosphoric acid	4.2b	DE	DE, FR, FE	**Complementary worksheet needed**
29	Sulphuric acid	4.2.b	AT, CEFIC, DE, ES, Euroalliages, Eurometaux, IT	CEFIC, DE, Euroalliages, Eurofer, Eurometaux, FR, IT	**Complementary worksheet needed**
30	Sodium hydrogen sulphate	4.2d	AT	No feedback	**No complementary worksheet needed**
31	Sodium carbonate	4.2d	CEFIC	CEFIC, ES, FR, IT, PL	**Complementary worksheet on process furnaces needed, but not necessarily for sodium carbonate**
32	Salts	4.2d	IT	IT	**No complementary worksheet needed**
33	Non-metals, metal oxides or other inorganic compounds	4.2e	AT, EEB	IT	**No complementary worksheet needed**
34	Pigments	4.2e	CEFIC	DE, ES, FR	**No complementary worksheet needed**

No	Subsector/ Product/ Process	IED Annex I Ref.	TWG initial position	TWG technical information provided	Result of the preliminary EIPPCB assessment
35	Aluminium fluoride	4.2e	CEFIC	CEFIC	**No complementary worksheet needed**
36	Ferric oxide from copperas	4.2e	CZ	CZ	**Complementary worksheet on process furnaces/heaters and sulphuric acid needed, but not necessarily for ferric oxide**
37	Sodium silicate	4.2e	CEFIC, DE, PL	CEFIC, DE, ES	**Complementary worksheet on process furnaces needed, but not necessarily for sodium silicate**
38	Sulphur	4.2e	AT	DE, IT	**No complementary worksheet needed**
39	Titanium dioxide	4.2e	AT, CZ, DE, IT	CEFIC, CZ, DE, FR, IT	**Complementary worksheet on process furnaces needed, but not necessarily for titanium dioxide**
40	Carbon black	4.2e	AT, CEFIC, DE, IT	DE, CEFIC, IT	**Complementary worksheet on process furnaces needed, but not necessarily for carbon black**
41	Fertilisers (include AN, CN, CAN, NPK, Phosphates (SSP and TSP))	4.3	AT, CEFIC, DE, ES, FE, IT	BE, DE, ES, FR, FE, IT, NO	**Complementary worksheet needed for some fertilisers i.e. NPK, AN, CN, CAN**
42	Plant protection products or biocides	4.4	AT, IT	DE, IT	**No complementary worksheet needed**
43	Pharmaceuticals	4.5	IT, Orgalime, NO	CEFIC, DK, FR, IT	**No complementary worksheet needed**
44	Explosives	4.6	ES	ES	**No complementary worksheet needed**

Notes:
FE = Fertilizers Europe;
NSM = not specifically mentioned in IED Annex I, Section 4.

1. Cement additives

1.1 Technical information provided by the TWG

No technical information was provided by the TWG.

1.2 Information in the BREFs

The LVIC-S BREF describes the production of some chemicals that are used as cement additives, e.g. co-products of the sulphate process route for the production of titanium dioxide, detergent phosphates as dispersing agents and synthetic anhydrides

The LVOC BREF mentions that ethanolamines and some other chemicals are used as cement additives.

1.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for the production of cement additives in general or for specific chemicals used as cement additives.

1.4 Other technical information

There is some information available in the Kirk-Othmer Encyclopedia[1] for cement additives:

Organic materials, such as latexes and water-soluble polymerisable monomers, are sometimes used as additives to impart special properties to concretes or mortars.

There is some information available in the Ullmann's Encyclopedia[2] for cement additives:

Acid-proof, or rather chemically resistant, cement or mortar always consists of an inorganic or organic binder and inorganic fillers. Most of these materials are similar to mortar at normal temperatures, and they harden when the binder undergoes a chemical reaction.

Additives or binders can be organic or inorganic substances. The main additives are potassium silicate or sodium silicate (silicate cements), sulphur, quartz or inert material, phenol-formaldehyde resins, furan resins, epoxy resins, unsaturated polyester resins, vinyl ester resins or bituminous materials.

1.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on the production of cement additives;
- the existing chemical BREFs describe the production of a few substances that can potentially be used as cement additives, but do not specifically address the production of cement additives;

[1] Kosmatka, S. and Updated by Staff 2012. Cement. Kirk-Othmer Encyclopedia of Chemical Technology. 1–40.

[2] Fenner, J. 2000. Cements, Chemically Resistant. Ullmann's Encyclopedia of Industrial Chemistry.

- the GBRs of DE, FR and IT do not seem to contain any specific provision for the production cement additives;
- the available technical information indicates that a wide range of inorganic and organic substances are used as cement additives; the generic approach of the WGC BREF seems appropriate to cover such a variety of substances;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for cement additives.

2 Flame retardants

2.1 Technical information provided by the TWG

No technical information was provided by the TWG.

2.2 Information in the BREFs

- The SIC BREF mentions that some phosphorus compounds are used as flame retardants.
- The LVIC-BREF mentions that purified phosphoric acid can be used as a flame retardant.
- The POL BREF mentions that flame retardants are used as a raw material for some special polystyrene products.
- The OFC BREF mentions that some OFCs, such as organo-bromine compounds and organophosphorous compounds, are used as flame retardants.

2.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for the production of flame retardants

2.4 Other information

Flame retardants include a wide variety of organic and inorganic substances. According to the Kirk-Othmer Encyclopedia[3], flame retardants can often be categorised in seven chemical classes: halogen-based, phosphorus-based, mineral fillers (e.g. magnesium hydroxide, aluminium hydroxide, magnesite), nitrogen-based (e.g. melamine, salts), intumescent (composed of a carbon source, an acid source and a foaming agent), inorganic (e.g. zinc borates, silicon-based, sulfonates) or nanocomposite (polymer combined with nanoscale spheres, rods or plates).

2.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on the production of flame retardants;
- the existing chemical BREFs only mention the production of a few substances that can potentially be used as flame retardants, but not the production of flame retardants in general;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for the production of flame retardants;
- the available technical information indicates that flame retardants cover a wide variety of production processes; the generic approach of the WGC BREF seems therefore appropriate to cover such a variety of substances;

[3] Morgan, A. B. and Worku, A. Z. 2015. Flame Retardants: Overview. Kirk-Othmer Encyclopedia of Chemical Technology. 1–28.

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for flame retardants.

3 Cyclohexane oxidation

3.1 Technical information provided by the TWG

No technical information was provided by the TWG.

3.2 Information in the BREFs

The LVOC BREF mentions the production of cyclohexanone/cyclohexanol by catalytic oxidation of cyclohexane. The process is only briefly described, no information on emissions to air is available and the main environmental issues are water-related.

If benzene emissions result from impurities of the raw materials, similarities with the production of phenol via oxidation of cumene may exist. A BAT-AEL for benzene emissions from the cumene oxidation unit of < 1 mg/m^3 was set in the LVOC BREF, provided that the emission exceeds 1 g/h. The BAT-AEL is solely based on end-of-pipe techniques.

3.3 General binding rules

The DE GBRs provide for cyclohexane oxidation installations a specific ELV for benzene of 3 mg/m^3; the generic ELV for benzene is 1 mg/m^3, if the mass flow exceeds 2.5 g/h. However, all benzene emissions reported in the UBA (DE) report were below the generic ELV of 1 mg/m^3 and/or the generic threshold of 2.5 g/h.

There is no specific provision in the GBRs of FR and IT for cyclohexane oxidation.

In IT benzene emissions are covered by a generic ELV of 5 mg/m^3, if the mass flow exceeds 25 g/h.

3.4 Other information

In principle, benzene emissions could result from impurities in the raw materials (e.g. when cyclohexane is produced by hydrogenation of benzene) or from side reactions. From the chemical reactions involved and the reported side products, it seems more likely that benzene emissions are due to impurities in the raw materials.

No new information has been published on Ullmann's since 2000.

3.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on cyclohexane oxidation;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for cyclohexane oxidation, apart from one ELV in the DE GBRs;
- in the existing LVOC BREFs the main environmental issue from cyclohexane oxidation is water-related and the BREF does not address the production process;
- the generic questionnaire worksheets can take into account some of the potential specificities of cyclohexane oxidation, e.g. elevated concentrations of benzene in the untreated waste gases;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for cyclohexane oxidation.

4 Urea

4.1 Technical information provided by the TWG

IT provided the following information: the LVIC-AAF BREF concluded that for the finishing section a number of process-integrated techniques can improve the overall environmental performance. These include the optimisation of the process conditions of prilling towers and the recycling of scrubbing waters on site (see the LVIC-AAF BREF, page 362). Moreover, urea production is highly integrated with ammonia production.

Fertilizers Europe provided the following information: the LVIC-AAF BREF (Section 8.5) and the IFC Environmental, Health, and Safety information[4] list a large number of process-integrated measures to prevent, minimise and control emissions, including from urea production.

4.2 Information in the BREFs

The LVIC-AAF BREF concluded on BAT-AELs for dust and ammonia and that the emission levels can be achieved by using abatement techniques and/or process-integrated techniques.

BAT is to reduce ammonia and dust emissions from prilling or granulation and to achieve ammonia emission levels of 3–35 mg/Nm^3, e.g. by scrubbing or optimising the operation conditions of prilling towers, and to reuse scrubber liquids on site. If the scrubbing liquid can be reused, then preferably by acidic scrubbing, if not, by water scrubbing. In optimising the emission levels to the values mentioned above, it is assumed that dust emission levels of 15–55 mg/Nm^3 are achieved, even with water scrubbing.

4.3 General binding rules

The FR GBRs do not seem to contain any specific provision for urea production.

The DE GBRs provide for NPK fertilizers and urea (existing installations):

- during prilling, granulation and drying, a specific ELV for dust of 50 mg/m^3; the generic ELV for dust is 20 mg/m^3, if the mass flow exceeds 0.2 kg/h.
- during prilling, a specific ELV for ammonia of 60 mg/m^3; the generic ELV for ammonia is 30 mg/m^3, if the mass flow exceeds 0.15 kg/h.
- during granulation and drying, a specific ELV for ammonia of 50 mg/m^3.

The IT GBRs provide for fertilisers:

- during prilling or fluidised bed granulation, a specific ELV for dust of 100–150 mg/m^3; the generic ELV for dust is 50 mg/m^3, if the mass flow exceeds 0.5 kg/h.
- during processes other than granulation, a specific ELV for dust of 75 mg/m^3.
- during prilling or fluid bed granulation, a specific ELV for ammonia of 200 mg/m^3, the generic ELV for ammonia is 250 mg/m^3, if the mass flow exceeds 2.0 kg/h.

4.4 Other technical information

A new standard article is available on Ullmann's and indicates that new processes, deriving from the Stamicarbon process, may be applied since the last review of the LVIC-AAF BREF: the

[4] http://www.ifc.org/wps/wcm/connect/b237688048855d518e94de6a6515bb18/Final+-+Nitrogenous+Fertilizers.pdf?MOD=AJPERES

urea 2000plus concept (introduced in the 1990s and operated by 10 plants by 2010) and the Avancore process (introduced in 2009).

According to Ullmann's, these new processes help improve the energy efficiency and reduce the emissions of ammonia.

A site visit to a urea production site was organised in Huelva (Fertiberia). The main emissions to air from urea production are dust (urea) and ammonia from the prilling tower exhaust. Ammonia emissions result from residual ammonia enclosed in the urea prills and from urea decomposition during prilling. The Huelva plant uses a vacuum evaporator to remove ammonia from the urea prior to prilling and wet venturi scrubbers to remove dust and ammonia from the prilling tower exhaust gases. The wet scrubbers were installed in 1997 for approximately EUR 80 000 while the vacuum evaporator was installed in 2010 for approximately EUR 1.85 million. The vacuum evaporator resulted in a reduction of the ammonia emissions from approximately 350 mg/Nm^3 to approximately 70 mg/Nm^3.

4.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG and from the site visit in Huelva indicates that the environmental performance of this production process depends on the applied process-integrated techniques;
- the GBRs of DE contain specific provision for emissions of ammonia and dust from urea production; the IT GBRs are applicable to fertilisers in general, including urea;
- the LVIC-AAF BREF suggests that environmental performance depends on specific process-integrated techniques;
- new processes that may have an effect on ammonia emissions have been introduced since the last revision of the LVIC-AAF BREF;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for urea production.

5 Aniline

Aniline is included in the category of nitrogenous hydrocarbons (see Section 7).

5.1 Technical information provided by the TWG

CEFIC proposed to develop a specific worksheet for nitrogenous hydrocarbons including aniline (see Section 7).

CEFIC provided the following information: In an aniline plant the vent gases from the hydrogenation reaction (mainly methane and hydrogen) have a high calorific value and can be used as fuel or incinerated. The vent gases contain various amines, which cause higher NO_X emissions.

5.2 Information in the BREFs

The LVOC BREF briefly describes the production of aniline, either from nitrobenzene or phenol. The nitrobenzene is obtained from the nitration of benzene for which NO_X emissions are described as relevant for emissions to air. The use of scrubbers prior to the discharge to the atmosphere is reported, but no BAT or BAT-AELs have been concluded for the production of aniline.

Similarities with the production of toluene diisocyanate (TDI) and methylene diphenyl diisocyanate (MDI) may exist. BAT 64 of the LVOC BREF concluded on emissions to air: 'In order to reduce the load of .… NO_X, NO_X precursors .… sent to the final waste gas treatment…., BAT is to use a combination of the following techniques: condensation, wet scrubbing, thermal reduction, catalytic reduction'.

5.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for aniline production.

5.4 Other technical information

Aniline can be produced by the reduction of nitrobenzene with iron (salts) or by the catalytic hydrogenation of nitrobenzene in the vapour or liquid phase. A few plants also use phenol as raw material, but they seem to be based outside the EU[5].

5.5 EIPPCB preliminary assessment and conclusion

The EIPPCB preliminary assessment for the production of aniline is included in the preliminary assessment for nitrogenous hydrocarbons (see Section 7)

[5] Ullmann's Encyclopedia of industrial chemistry, aniline, published online 15 October 2011.

6 Melamine

Melamine (1,3,5-triazine-2,4,6-triamine) is included in the category of nitrogenous hydrocarbons (see Section 7).

6.1 Technical information provided by the TWG

CEFIC proposed to develop a specific worksheet for nitrogenous hydrocarbons including melamine (see Section 7).

6.2 Information in the BREFs

The LVOC BREF briefly describes the production of melamine using two different processes. However, issues related to emissions to air are not reported.

6.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for the production of melamine.

6.4 Other technical information

Melamines (2,4,6-triamino-1,3,5-triazines) are produced from urea. They are used in the fabrication of melamine – formaldehyde resins for laminating and adhesive applications. Today, melamine is produced industrially almost exclusively from urea. Most processes using dicyandiamide as raw material were discontinued or replaced at the end of the 1960s.

No new information has been published on Ullmann's since 2006.

6.5 EIPPCB preliminary assessment and conclusion

The EIPPCB preliminary assessment for the production of melamine is included in the preliminary assessment for nitrogenous hydrocarbons (see Section 7).

7 Nitrogenous hydrocarbons

The IED lists in Annex I 4.1(d) the category of nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates.

7.1 Technical information provided by the TWG

CEFIC proposed a specific worksheet for nitrogenous hydrocarbons to ensure that these plants can be identified. High concentrations of nitrogenous hydrocarbons in the untreated waste gas streams are likely to result in high NO_X emissions when waste gas treatments such as thermal oxidisers are used. CEFIC provided information on processes, for example the nitration of aromatic compounds.

7.2 Information in the BREFs

The LVOC BREF includes the production of nitrogenous hydrocarbons in its scope for continuous processes where the total production capacity exceeds 20 kt/yr.

The production of nitrogenous hydrocarbons includes a wide range of substances, although only the production processes of ethanolamine and TDI/MDI are described in illustrative chapters of the LVOC BREF. The short descriptions in Chapter 2 of the LVOC BREF only include the production of aniline (see Section 5), melamine (see Section 6) and nitro compounds (see Section 8).

Below the LVOC threshold, the activity is generally not within the scope of any of the chemical BREFs.

However, the OFC BREF includes in its scope the manufacture of some nitrogenous hydrocarbons including the following IED Annex I activities:

- dyes and pigments (4.1j);
- plant health products and biocides (4.4);
- pharmaceutical products (4.5);
- explosives (4.6; organic compounds).

The OFC BREF applied a generic approach when BAT and BAT-AELs were set for the recovery and abatement of NO_X. BAT-AELs differ between the following sources of waste gas streams:

- chemical production processes, e.g. nitration, recovery of spent acids;
- thermal oxidiser, catalytic oxidiser;
- thermal oxidiser, catalytic oxidiser when waste gas streams include an input of nitrogenous organic compounds.

7.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for the production of nitrogenous hydrocarbons.

7.4 Other technical information

Technical information on individual nitrogenous hydrocarbons can for example be found on Ullmann's and Kirk-Othmer.

7.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG provided technical information for the production of aniline, melamine, nitro compounds and explosives; these production processes are likely to produce higher NO_X emissions when waste gases are treated by thermal oxidisers because of higher contents of nitrogenous hydrocarbons in the untreated waste gas streams;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for the production of nitrogenous hydrocarbons;
- the OFC BREF applied a generic approach and concludes on different BAT-AELs depending on the sources of waste gas streams (i.e. chemical production versus thermal oxidation) and the content of nitrogenous hydrocarbons in the untreated waste gas streams;
- the generic questionnaire worksheets can take into account some of the potential specificities of the production of nitrogenous hydrocarbons, e.g. the presence of NO_X precursors in the untreated waste gas streams;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for nitrogenous hydrocarbons.

8 Nitro compounds

The IED category of activity of nitrogenous hydrocarbons includes nitro compounds (see Section 7).

8.1 Technical information provided by the TWG

CEFIC provided technical information on the common features of nitration reactions.

8.2 Information in the BREFs

The LVOC BREF describes that the main large-scale nitration reactions are the nitration of benzene to produce nitrobenzene and the nitration of toluene to produce dinitrotoluene (which is described in detail in Chapter 10 and is used to manufacture polyurethanes via toluene diisocyanate) and trinitrotoluene (used as an explosive). The common features of nitration reactions are the following:

- large amounts of acid gas are evolved from the process;
- large excesses of acid are used to drive the reaction;
- gas streams rich in NO_X are formed and are treated to recover nitric acid and/or abate NO_X emissions.

8.3 General binding rules

The GBRs of DE and FR do not seem to contain specific provisions for the production of nitro compounds.

The IT GBRs provide for 'cellulose nitration' a specific ELV for NO_X of 2 000 mg/m^3.

8.4 Other technical information

The LVOC BREF will be published soon. The description of the category of nitrogenous hydrocarbons seems to be up to date.

8.5 EIPPCB preliminary assessment and conclusion

The EIPPCB preliminary assessment for the production of nitro compounds is included in the preliminary assessment for nitrogenous hydrocarbons (see Section 7).

9 Aromatic hydrocarbons containing fluorine

9.1 Technical information provided by the TWG

No technical information was provided by the TWG.

9.2 Information in the BREFs

The LVOC BREF contains limited information on the production of chlorofluorocarbons (CFCs), and these are typically not aromatic hydrocarbons. The production of this category of substances is not described in the other chemical BREFs.

9.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for the production of aromatic compounds containing fluorine.

9.4 Other information

The TWG for the drawing up of the WGC BREF concluded during the kick-off meeting that gaseous fluorides (expressed as HF) would be a KEI. This KEI is not specific to aromatic hydrocarbons and will cover all sources of fluorides: inorganic as well as organic, aliphatic as well as aromatic.

9.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on this production process;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for the production of aromatic compounds containing fluorine;
- the generic questionnaire worksheets can take into account some of the potential specificities of the production of hydrocarbons containing fluorine;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for aromatic hydrocarbons containing fluorine.

10 Organometallic compounds

10.1 Technical information provided by the TWG

No technical information was provided by the TWG.

10.2 Information in the BREFs

The LVOC BREF contains limited information on the production of organometallic compounds. Production of organometallic compounds is not described in the other chemical BREFs.

10.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for the production of organometallic compounds.

10.4 Other technical information

Ullmans contains an article on organometallic compounds[6].

Organometallic compounds are widely used both stoichiometrically in research and industrial chemical reactions, as well as in the role of catalysts to increase the rates of such reactions (e.g. as in uses of homogeneous catalysis), where target molecules include polymers, pharmaceuticals, and many other types of practical products[7].

10.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on this production process;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for the production of organometallic compounds;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for organometallic compounds.

[6] Salzer, A. 2010. Organometallic Compounds. Ullmann's Encyclopedia of Industrial Chemistry
[7] https://en.wikipedia.org/wiki/Organometallic_chemistry

11 Cellulose nitration

Cellulose nitration is included in the category of nitrogenous hydrocarbons (see Section 7) and explosives (see Section 44).

11.1 Technical information provided by the TWG

No technical information was provided by the TWG.

11.2 Information in the BREFs

The POL BREF includes a dedicated chapter on the production of viscose, which is a cellulose-based fibre, but does not cover the nitration of cellulose.

The OFC BREF applied a generic approach when BAT and BAT-AELs were set for the recovery and abatement of NO_X. The BAT-AELs differ between following sources of waste gas streams: chemical production processes, e.g. nitration, recovery of spent acids; thermal oxidiser and catalytic oxidiser (including when waste gas streams have an input of nitrogenous organic compounds).

11.3 General binding rules

The GBRs of DE and FR do not seem to contain any specific provision for cellulose nitration.

The IT GBRs provide for 'cellulose nitration' a specific ELV for NO_X: 2 000 mg/m^3.

11.4 Other technical information

The standard article of Ullmann's on cellulose esters provides some information on the production of cellulose nitrate:

- cellulose nitrate is produced by the nitration of cellulose using concentrated nitric and sulphuric acids;
- the total world capacity may be estimated to 150 000 t/y of dry cellulose nitrate, produced by a few companies in DE, ES and FR;
- nitration on an industrial scale is still frequently carried out using the batch process developed from a process described by DuPont in the 1920s;
- continuous nitrating processes, developed in the 1960s, are more economical, ensure a more uniform product quality and are safer to handle.

11.5 EIPPCB preliminary assessment and conclusion

The EIPPCB preliminary assessment for the production of nitro compounds such as cellulose nitrate is included in the preliminary assessment for nitrogenous hydrocarbons (see Section 7).

12 Viscose

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

12.1 Technical information provided by the TWG

CZ provided the following information:

- The CZ legislation provides specific ELVs for viscose production: CS_2: 400 mg/m^3 and H_2S: 50 mg/m^3.
- Emissions of carbon disulphide and hydrogen sulphate occur in the individual production phases:
  - Emissions with high concentrations: CS_2 and H_2S represent 10 % of the volume of total emissions. Part of the carbon disulphide and hydrogen sulphate emissions is cleaned in a two-stage catalytic oxidation plant by conversion to sulphuric acid. The two-stage catalytic oxidation facility operates at 99 % efficiency;
  - Emissions with low concentrations: the emissions cannot be cleaned by catalytic oxidation due to economic (high financial burden) and ecological reasons (global point of view of high consumption of natural gas - emissions from combustion, material, and electricity). They are sent to the exhaust (flow rate of about 550 000 m^3/hour)

CEFIC provided the following information: carbon disulphide is the main product and hydrogen sulphide is a by-product generated in the process. This leads to additional purification technologies that are specifically designed for the process. The CS_2 adsorption, CS_2 condensation and the production of sulphuric acid from the combustion of sulphur-containing exhaust gases are to be taken into account as process-integrated techniques.

12.2 Information in the BREFs

The POL BREF has a dedicated chapter on the production of viscose fibres. They are made from regenerated cellulose pulp, which is usually derived from wood. The POL BREF describes two processes:

- The standard process using CS_2 and NaOH, which generates waste gases containing CS_2 and H_2S. There are nine BAT for the production of viscose fibres, five of which relate to air emissions. Various techniques can be used to recover the CS_2 for reuse or to convert the CS_2 and H_2S to sulphuric acid which can be marketed. Abatement techniques are not described. The emissions of S, CS_2 and H_2S to air are given in kg/t of product for staple fibres and filament yarns. The BAT-AELs are expressed as specific loads, in contrast to the GBRs of several MS where ELVs are expressed in concentrations (see Section 12.3).

- The Lyocell process operated in Austria since 1998, which uses an organic solvent (NNMO = N-methyl-morpholine-n-oxide) instead of CS_2/NaOH, which has the effect of eliminating the odorous and noxious emission of sulphurous gases. The process recovers 99.65 % of the NNMO solvent. The Lyocell product has different properties from those of the standard product so the Lyocell process is not a direct substitute for the standard process. There is no information about waste gas streams.

The POL BREF describes an emerging technique "Catalytic heat regenerative process for H_2SO_4 recovery in viscose fibre production".

12.3 General binding rules

The CZ legislation (Decree no. 415/2012 Coll.) provides ELVs: H_2S: 50 mg/m^3, CS_2: 400 mg/m^3

The GBRs of DE and IT contain specific requirements for the collection and treatment of waste gases from viscose production and ELVs for CS_2 and H_2S. The definition of the ELVs differs between DE and IT.

The DE GBRs provide ELVs for the total waste gas, including the extracted indoor air and air additionally extracted from the machine: H_2S: 50 mg/m^3 and CS_2: 150 to 400 mg/m^3 (depending on the product type).

The IT GBRs provide ELVs for channelled emissions: H_2S: 50 mg/m^3 and CS_2: 150 to 600 mg/m^3 (with different ranges for different specific processes of viscose production, such as spinning of fibres and cellophane).

12.4 Other technical information

No new information has been published on Ullmann's since 2007.

The KoM concluded that hydrogen sulphide is a KEI for the whole WGC BREF and carbon disulphide is a KEI, but for viscose production only.

European Man-made Fibres Association: the most common cellulosic fibre is viscose fibre. Production in Europe is around 0.6 million tonnes cellulosic fibre and consumption is around 0.7 million tonnes cellulosic fibre (2015).

12.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the technical arguments provided by the TWG on the specificity of the applied integrated treatment techniques and their impact on emissions to air;
- the POL BREF focuses on recovery techniques for H_2S and CS_2 from viscose production without mentioning pure abatement techniques;
- the GBRs of CZ, DE and IT provide for ELVs for H_2S and CS_2 emissions from different parts of the process;
- the KoM concluded that hydrogen sulphide is a KEI for the whole WGC BREF and carbon disulphide is a KEI, but for viscose production only;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for viscose production.

13 Polyamide fibres

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

13.1 Technical information provided by the TWG

No technical information was provided by the TWG.

13.2 Information in the BREFs

The POL BREF has a dedicated chapter that covers polyamide production using batch and continuous polymerisation processes followed by the conversion of polyamide into fibres. There is only one BAT for polyamide production which addresses the treatment of flue-gases by wet scrubbing. No process-integrated techniques are described. BAT-AELs for emissions to air were set for caprolactam, VOCs and dust and expressed as g/t of product. The BAT-AELs are expressed as specific loads.

The LVOC BREF describes the production of caprolactam which is one of the main raw materials used to produce polyamides.

13.3 General binding rules

The GBRs of DE and FR do not seem to contain any specific provision for the production of polyamide fibres.

The IT GBRs provide:

- for "PA 6" polymer production by continuous spinning plants, an ELV for caprolactam of 100 mg/m^3, if the mass flow exceeds 2 kg/h;
- for spinning plants for staple fibre, an ELV for caprolactam of 150 mg/m^3.

13.4 Other information

No new information has been published on Ullmann's since 2007.

13.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on this production process;
- the POL BREF concluded only on one specific BAT: to treat waste gas streams by an end-of-pipe technique;
- the GBRs of DE and FR do not seem to contain any specific provision for the production of polyamide fibres and the only reference in the IT GBRs are two ELVs for caprolactam, which is a substance that is not a KEI for the WGC BREF;
- the process emissions to air are similar to those of many other organic polymerisation processes described in the POL BREF and covered by generic BAT;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for polyamide fibres.

14 PVC (Polyvinyl chloride)

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

14.1 Technical information provided by the TWG

CEFIC and SE reported that vinyl chloride emissions to air vary between emulsion PVC (E-PVC) and suspension PVC (S-PVC).

14.2 Information in the BREFs

The LVOC BREF lists 23 VCM production plants in Europe, with capacities in the range of 90 to 620 kt/year (2013 data).

The POL BREF has a dedicated chapter on the production of PVC which describes three different processes: the suspension process (S-PVC), the emulsion process (E-PVC) and the mass (bulk) process (mass PVC). It lists 39 PVC production sites in Europe and their annual production capacities (EU-25 data).

The data on vinyl chloride emissions to air show that diffuse/fugitive emissions form a substantial part of the total emissions.

The POL BREF contains 10 BAT conclusions for PVC production. One relates to PVC dust emissions and eight relate to VCM emissions to air (channelled, fugitive and accidental emissions). Some are related to the use of end-of-pipe techniques:

- dusts: bag filters or cyclones;
- VCM: catalytic oxidation, incineration.

BAT 10 contains BAT-AELs for emissions of VCM and PVC dust to air, with approximately tenfold higher values for E-PVC compared to S-PVC.

The BAT-AELs are expressed as specific loads, in contrast to the GBRs of several MS where limit values are expressed as maximum VCM concentrations in PVC (see Section 14.3).

14.3 General binding rules

The GBRs of DE, FR and IT include specific provisions for PVC production. VCM residues in the PVC must be reduced at the transition point between the closed system and the treatment or drying with the open system and limit values for VCM in the PVC are set depending on the type of production and in the case of FR and IT on the type of PVC (homo-polymer/co-polymer):

Maximum VCM concentrations in PVC (in mg/kg), set in GBRs			
Production process	**Member State**		
	DE	FR	IT
Mass PVC	No ELV	50	10
Suspension PVC	80	100–400	100–400
Micro-suspension and emulsion PVC	500	1 200–1 500	1 500

14.4 Other technical information

Ullmann's does not seem to have reported any new production process since the publication of the POL BREF.

Plastics Europe: PVC is ranked as number 4 in the European plastics demand (around 5 million tonnes per year) and the Mass PVC process is no longer used in Europe.

14.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- although the POL BREF specifies different BAT-AEPLs for VCM from the S-PVC and E-PVC processes, generic end-of-pipe techniques seem applicable;
- the GBRs of DE, FR and IT contain specific provisions for the production of PVC, which specify different ELVs for the residual content of VCM in the PVC product; however, emissions to air seem to be covered by the generic ELVs otherwise;
- no new technical information has been made available since the publication of the POL BREF;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for PVC production.

15 Polyester (PE)

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

15.1 Technical information provided by the TWG

No technical information was provided by the TWG.

15.2 Information in the BREFs

The POL BREF has a dedicated chapter on unsaturated polyesters.

Polyesters are generally produced by condensation of poly-functional carboxylic acids with poly-functional alcohols. Unsaturated polyesters (UPs) can be polymerised with unsaturated compounds and co-polymerised with monomers such as styrene.

A typical UP plant will use batch reactors of 10–40 m^3 capacity, producing a mix of 100–200 products based on 100–150 different raw materials.

There are several BAT for the production of unsaturated polyesters:

- BAT is to use waste gas treatments such as thermal oxidation or active carbon;
- KEIs for emissions to air are TVOC, CO, CO_2, NO_X, SO_2 and dust;
- BAT-AEL ranges for emissions to air are expressed as specific loads.

15.3 General binding rules

The GBRs of DE and FR do not seem to contain any specific provision for the production of polyester.

The IT GBRs provide for the production of terephthalic acid and dimethyterephthalate, integrated in the production of polymers and polyester fibres a specific ELV for TVOC of 350 mg/m^3.

15.4 Other technical information

Ullmann's has not published an update on polyester production since 2007.

The European Man-made Fibres Association provides data on polyester production (2013–15: around 1 Mt) and consumption (2013–15: around 2.7 Mt) in Europe.

15.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the BAT conclusion is to treat waste gases by end-of-pipe techniques;
- the process seems to be similar to processes described in the OFC BREF, which concluded on generic BAT-AELs;
- the GBRs of DE, and FR do not seem to contain any specific provision for the production of polyester and the only reference in the IT GBRs is an ELV for TVOC, which is a KEI for the WGC BREF;
- there is no new technical information since the publication of the POL BREF;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for polyesters.

16 Acrylic fibres

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

16.1 Technical information provided by the TWG

No technical information was provided by the TWG.

16.2 Information in the BREFs

The POL BREF does not contain any dedicated chapters on the production of acrylics and acrylic fibres. It describes the use of acrylonitrile in co-polymerisations of emulsion polymerised styrene butadiene rubbers, solution polymerised styrene butadiene rubbers and polystyrene.

The LVOC BREF describes the production of acrylonitrile in outline only.

16.3 General binding rules

The DE GBRs provide specific ELVs for acrylonitrile emissions to air from the production of acrylic fibres at existing installation (5 or 15 mg/m^3 depending on the type of waste gas stream). Waste gases containing acrylonitrile shall be supplied to end-of-pipe techniques such as scrubbing or adsorption.

The IT GBRs provide a specific ELV for the production of acrylic fibres for N,N-dimethylacetamide (DMF) and N,N-dimethylformamide DMA) of 150 mg/m^3.

The FR GBRs do not seem to contain any specific provision for acrylic fibres.

16.4 Other technical information

The manufacture of acrylic fibres includes the polymerisation and associated activities such as wet spinning using DMF and DMA as solvents and dry spinning using DMA.

The European Man-made Fibres Association provides data on acrylic production and consumption in Europe. Production decreased from 780 kt in 2006 to 610 kt in 2014 while consumption increased from 460 kt to 520 kt over the same period.

16.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the DE GBRs require the use of end-of-pipe techniques to treat waste gas streams containing acrylonitrile;
- in the GBRs of DE and IT the substances (i.e. acrylonitrile, *N*,*N*-DMF) included in specific provisions for emissions to air are not KEIs for the WGC BREF;
- no new technical information has been made available since the publication of the POL and LVOC BREFs and the production in Europe is decreasing;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for acrylic fibres production.

17 Cellulose acetate

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

17.1 Technical information provided by the TWG

No technical information was provided by the TWG.

17.2 Information in the BREFs

The POL BREF (2007) includes a dedicated chapter on the production of viscose, which is a cellulose-based fibre, but does not cover cellulose acetate production.

17.3 General binding rules

The GBRs of DE and FR do not seem to contain any specific provision for the production of cellulose acetate.

The IT GBRs provide a specific ELV for acetone emissions to air of 150 mg/m^3 (Generic ELV: 5 mg/m^3 if mass flow > 25 g/h).

17.4 Other technical information

Cellulose esters are produced by the esterification of the free hydroxyl groups of the cellulose using acids. Cellulose acetate is the most important cellulose ester.

Cellulose acetate is produced by the acetylation of a fibrous cellulose polymer to produce cellulose triacetate, followed by the partial hydrolysis of the acetyl groups to regenerate hydroxyl groups and achieve the desired product specification.

Ullmann's has a standard article on cellulose esters (2012) with some information on the production of cellulose acetate. The industrial processes are as follows:

- Acetylation in a homogeneous system (solution acetate process). The solvents are used glacial acetic acid or methylene chloride.
- Acetylation in a heterogeneous system using carbon tetrachloride, benzene or toluene.

Only a few manufactures worldwide (5) and in Europe (3) are reported. Production was about 0.8 Mt/year in the 1990s, mostly for textiles and cigarette filters.

17.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on this process;
- the existing POL BREF does not address this process in a specific chapter;
- the GBRs of DE and FR do not seem to contain any specific provision for the production of cellulose acetate and the IT GBRs only contain one ELV for acetone, which is not a KEI for the WGC BREF;
- substances reported for the production of cellulose acetate by Ullmann's are addressed as KEIs in the WGC BREF, as single substances or part of TVOC;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for cellulose acetate production.

18 Polymers and specific plastic materials

This section provides an assessment for the production of polymers in general. More specific production processes relevant to polymers are also assessed in this document: cellulose nitration (see Section 11); viscose (see Section 12); polyamide fibres (see Section 13); polyvinyl chloride (see Section 0); polyester (see Section 0); acrylic fibres (see Section 0); cellulose acetate (see Section 0); polyacrylonitrile (see Section 0); polycarbonate (see Section 20); synthetic rubbers (see Section 0).

18.1 Technical Information provided by the TWG

DE and ES provided general information regarding BAT and BAT-AELs from the POL BREF. Emissions of substances are highly dependent on the monomer used as raw material and can vary depending on the production process.

CEFIC gave examples for process-integrated techniques frequently used in the polymers industry to minimise material loss and maximise material utilisation such as recycling of monomers, solvent recovery loops and optimisation of the stripping process. VOC emissions are highly dependent on the polymer produced and can vary by more than one order of magnitude between the polymer based on different monomer types and even depending on the polymer production process. Examples are the production of polyolefins (polyethylene/polypropylene) and the production of PVC (emulsion vs. suspension polymerisation process).

CEFIC proposed a way forward regarding polymers production:

- clarify the definition of polymers and thus clarify the scope of the WGC BREF;
- use specific worksheets for those polymers described in dedicated sections in the POL BREF;
- use generic worksheets for the other polymers.

18.2 Information in the BREFs

The scope of the POL BREF addresses parts of the following sections from Annex I to the IPPC Directive:

4.1. Chemical installations for the production of basic organic chemicals, such as:

(a) basic plastic materials (polymers, synthetic fibres and cellulose-based fibres)

(b) synthetic rubbers

(c) oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resins.

The further processing of polymers to produce final products is generally not included; however, processing techniques such as production of fibres or compounding are included when they are technically connected to the production of the polymer and carried out on the same site.

All BAT-AELs relate to total emissions including point sources and fugitive emissions. BAT-AELs on total emissions are based on measurements and calculations, depending on the availability of data.

However, there are only few data on diffuse/fugitive emissions presented in the POL BREF. In the case of PVC production, the diffuse/fugitive emissions form a substantial part of emissions of vinyl chloride into air.

The following generic BAT for emissions to air have been concluded:

- Fugitive/diffuse emissions (three BAT).

- Reduce dust emissions by a combination of techniques, including end-of-pipe techniques such as filters and scrubbers.

KEIs and BAT-AELs for emissions into air in the POL BREF

Item	**KEI & BAT-AELs**
Generic BAT-AELs for emissions to air	no BAT-AEL
Production of polyolefins*	dust, TVOC
Production of polystyrene**	dust, TVOC
Production of PVC	vinyl chloride, dust
Production of unsaturated polyester	TVOC, CO, CO_2, NO_X, SO_2, dust (particles)
Production of ESBR	TVOC
Solution polymerised rubbers containing butadiene	No specific KEI
Production of polyamides	No specific KEI
Production of polyethylene terephthalate fibres	No specific KEI
Production of viscose fibres	sulphur to air (hydrogen sulphide, carbon disulphide)
* Different BAT-AEL levels for LDPE/HPPE/LLDPE polymers	
** Different BAT-AEL levels for GPPS/HIPS	
*** BAT-AELs for CO, CO_2, NO_X and SO_X refer to the energy consumption for polyester production	

18.3 General binding rules

The table presents specific provisions in the GBRs of DE, FR and IT for the production of 'basic plastic materials':

Production	DE	FR	IT
ABS, SAN			Acrylonitrile*
Cellulose acetate			TVOC
Polyacrylonitrile fibres	Acrylonitrile*		Acrylonitrile*
Polyamide			Caprolactam*, TVOC
Polycarbonate			Dichloromethane
Polyethylene	TVOC		
Polyurethane	Exemptions for the use of propellants, e.g. propane		
Polyvinyl chloride	Vinyl chloride**	Vinyl chloride**	Vinyl chloride**
Viscose fibres	Hydrogen sulphide, carbon disulphide		Hydrogen sulphide, carbon disulphide
Synthetic rubbers		TVOC	Acrylonitrile*
* Acrylonitrile is not a KEI in the WGC BREF; but is included in TVOC			
** Vinyl chloride residues in the PVC must be reduced at the transition point between the closed system and the treatment or drying with the open system and ELVs are expressed as mg VCM/kg PVC.			

18.4 Other technical information

Other information to assess the economic importance of polymer production:

- Plastics Europe provides information on its webpage http://www.plasticseurope.org/, information such as the demand for plastics in Europe (2016).
- European Man-made Fibres association provides production and consumption data for fibres made of polyacryl, polyamide, polyester and cellulosics (mainly viscose) on its webpage http://www.cirfs.org.

18.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG indicates that emissions to air from some polymer production processes rely on process-integrated techniques.
- BAT-AELs in the POL BREF are generally expressed as specific loads due to the format of the data provided taking into account diffuse/ fugitive emissions;
- diffuse/fugitive emissions for some polymer production such as PVC seem to be a substantial part of the total emissions;
- the POL BREF and the Member States GBR provide a few examples for specific provisions on BAT-AELs for emissions into air;
- the WGC BREF concluded to generally express BAT-AEPLs for channelled emissions to air in concentrations, if deemed appropriate coupled with abatement efficiencies; if appropriate, to express BAT-AEPLs in the case of diffuse emissions as loads or solvent losses for example;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for some polymers, e.g. viscose production (see Section 12). In this case, BAT-AELs should be optionally expressed as specific loads to collect information on the production process (e.g. production volumes).

However, the generic worksheet should generally be sufficient for covering other polymer production processes.

19 Acrylonitrile polymers

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

19.1 Technical information provided by the TWG

No technical information was provided by the TWG.

19.2 Information in the BREFs

The POL BREF does not contain any specific chapter on the production of acrylics and acrylic fibres. It describes the use of acrylonitrile (AN) in co-polymerisations of emulsion-polymerised styrene butadiene rubbers, solution-polymerised styrene butadiene rubbers and polystyrene.

The LVOC BREF describes the production of acrylonitrile in outline only.

19.3 General binding rules

The FR GBRs do not seem to contain any specific provision for the production of acrylonitrile polymers.

The GBRs of DE and IT provide specific information for the production of acrylic fibres (see Section 16.3).

19.4 Other technical information

Acrylonitrile (AN) is a versatile and reactive monomer that can be polymerised under a wide variety of conditions and co-polymerised with an extensive range of other vinyl monomers (Kirk-Othmer).

Ullmann's has published no articles on acrylics or acrylic fibres since 2007.

Plastics Europe provides data such as the European consumption of acrylonitrile butadiene rubber resins (ABS) and styrene acetonitrile co-polymer for 2013-2015.

The European Man-made Fibres Association provides data such as acrylic fibres production, see Section 0.

19.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for the production of acrylonitrile polymers; the DE and IT GBRs only provide specific provisions for the production of acrylic fibres, (see Section 0);
- a BAT in the POL BREF requires the use of end-of-pipe techniques to treat waste gas streams or equivalent techniques;
- no new technical information has been made available since the publication of the POL BREF;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for acrylonitrile polymers.

20 Polycarbonate

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

20.1 Technical information provided by the TWG

CEFIC and ES provided technical information:

- Europe has only 5 operating polycarbonate plants in BE, NL, DE (2) and ES.
- Dichloromethane (DCM) is used as a solvent in polycarbonate production but less than 1 % of DCM emissions[8] come from basic plastics production plants.
- There are different chemical routes to produce polycarbonate. The nomination of DCM as a KEI is very specific to a certain type of process which further reduces its significance when compared to the rest of polymers produced.

20.2 Technical information in the BREFs

The POL BREF did not address the production of polycarbonates due to the lack of submitted information.

20.3 General binding rules

The DE and FR GBRs do not seem to contain specific provisions for this production process and the IT GBRs provide specific ELVs for dichloromethane.

20.4 Other technical information

The vast majority of polycarbonates are based on bisphenol A (BPA)[9].

On the site visit to Dormagen (DE), the TWG was shown the polycarbonate production at Covestro, with emissions to air treated in a centralised thermal oxidiser.

Ullmann's contains no new information since the publication of the POL BREF.

20.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG seems to indicate that the production of polycarbonate is not a major environmental issue;
- MSs' legislation do not specifically cover that production process, except for one ELV on dichloromethane in the IT GBRs;
- the existing POL BREF does not address this production process in a specific chapter and dichloromethane was not a KEI for polycarbonate production;
- there is no new technical information since the publication of the POL BREF;
- the site visit and other information showed that air emissions could be treated only by end-of-pipe techniques;

[8] Based on VCI data

[9] Brunelle, D. J. and Staff, U. b. 2014. Polycarbonates. Kirk-Othmer Encyclopedia of Chemical Technology. 1–30.

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for polycarbonate.

21 Synthetic rubbers

This production process is included in the generic assessment for polymers and specific plastic materials (see Section 0).

21.1 Technical information provided by the TWG

No technical information was provided by the TWG.

21.2 Information in the BREFs

The POL BREF has a chapter describing the production of emulsion polymerised styrene butadiene rubbers (ESBR) and contains four specific BAT for emissions to air:

- to reduce and treat emissions from storage tanks;
- to control and minimise diffuse (fugitive) emissions;
- to collect vents from process equipment for treatment using end-of pipe techniques – filters, hydrocyclones and incineration;
- a BAT-AEPL for TVOC of 170–370 g/t of solid product.

The POL BREF has a chapter describing the production of solution-polymerised rubber containing butadiene and contains one specific BAT for emissions to air, to remove solvents by devolatilisation extrusion or steam stripping.

21.3 General binding rules

The DE and IT GBRs do not seem to contain specific provisions for this production process.

The FR GBRs for synthetic rubber production have a specific ELV for NMVOC of 20 mg/m^3 or, where a technique for solvent recovery is applied, an ELV of 150 mg/m^3 expressed as total C. The specific ELV applies when solvent consumption exceeds 15 t/year or annual VOC emissions are less than 25 % of the solvent usage and do not apply to some CMR substances

21.4 Other technical information

Ullmann's[10] published an article on synthetic rubbers in 2011.

21.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- BAT in the POL BREF for air emissions refer to end-of-pipe techniques;
- MSs' legislation do not specifically cover that production process, except for two ELVs in the FR GBRs, to take into account solvent recovery;
- no new technical information has been made available since the publication of the POL BREF,

[10] Threadingham, D., Obrecht, W., Wieder, W., Wachholz, G. and Engehausen, R. 2011. Rubber, 3. Synthetic Rubbers, Introduction and Overview. Ullmann's Encyclopedia of Industrial Chemistry.

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for synthetic rubbers.

22 Surface-active agents

22.1 Technical information provided by the TWG

No technical information was provided by the TWG.

22.2 Information in the BREFs

The LVOC BREF mentions the production of surface-active agents and surfactants as being in the BREF scope. There is no specific chapter or specific BAT-AEPLs.

The OFC BREF mentions the use of some speciality surfactants but does not contain any specific chapter or specific BAT-AEPLs.

22.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for this production process.

22.4 Other technical information

The classification of surfactants is commonly based on the nature of the hydrophilic group. The Kirk-Othmer Encyclopedia[11] indicates that three main classes may be distinguished, namely anionic, cationic, and amphoteric. A fourth class of surfactants, usually referred to as polymeric surfactants, has been used for many years for preparation of emulsions and suspensions and their stabilisation. There are also non-ionic surfactants based on ethylene oxide, referred to as ethoxylated surfactants.

The main environmental concerns are water-related: aquatic toxicity and biodegradability.

22.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the existing chemical BREFs do not address this production process;
- the main environmental concerns are water-related issues;
- the available technical information indicates that surface-active agents and surfactants cover a large range of organic products; the generic approach of the WGC BREF seems therefore appropriate to cover such a variety of products;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for surface-active agents.

[11] Tadros, T. and Updated by Staff 2012. Surfactants. Kirk-Othmer Encyclopedia of Chemical Technology. 1–46.

23 CO reformers (i.e. HyCO plants) and steam reformers

23.1 Technical information provided by the TWG

CEFIC indicated that CO reformers use process-integrated technologies to achieve the highest possible product yield and minimal emissions into the environment. The main environmental issues are to save energy and reduce emissions through process optimisation, e.g. by extensive use of feedstocks and obtaining coupling products (hydrogen). CO reformers aim to minimise energy losses, for example by the application of thermal insulation measures, short distances between vessels, short pipes and the minimisation of empty spaces. For existing plants, the use of SCR/SNCR techniques as a major retrofit is not possible because of the above-mentioned restricted space availability, environmental and economical limitations (e.g. reheating of waste gases because of long pathways would result in higher emissions and energy consumption than the existing solutions).

23.2 Information in the BREFs

The LVIC-AAF mentions CO reformers in the ammonia chapter (see Section 24) and contains BAT-AEPLs for NO_X and net energy consumption from reformers.

The LVOC BREF mentions CO reformers in the aromatics chapter, but no BAT-AEL was set for emissions from reformers.

23.3 General binding rules

The GBRs of DE, FR and IT do not seem to include specific provisions for CO reformers and steam reformers.

23.4 Other technical information

On Ullmann's, the major part of the available information on CO reformers and steam reformers comes from the standard article on ammonia (see Section 24.4).

23.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG indicated a link between emissions levels and applied process-integrated techniques; the TWG also indicated that it is not always possible to retrofit existing plants with newer technologies for the lack of space;
- the LVIC-AAF BREF does not address CO and steam reformers in a specific chapter, but BAT-AELs were set in the ammonia production chapter;
- MSs' legislation (i.e. DE, FR, IT) does not seem to contain any specific provision;
- no new technical information is available since the revisions of the LVIC-AAF BREF;

similarly to the production of ammonia, the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process heaters/boilers, but not necessarily for CO or steam reformers specifically.

24 Ammonia

24.1 Technical information provided by the TWG

DE indicated that emissions are linked to energy consumption and strongly depend on the plant design. In particular, NO_X abatement is achieved by using a combination of integrated and end-of-pipe techniques.

IT stated that ammonia production plants are highly integrated with downstream units (urea, nitric acid, fertilisers).

Fertilizers Europe indicated that the emissions and energy consumption depend on the plant design, the production process, the extent of integration of the plant, the fuel used and the degree of energy optimisation within the ammonia plant or site. For example, in ammonia production plants, a balance must be found between integrated reductions in CO_2 emissions versus integrated reductions in NO_2 emissions.

24.2 Information in the BREFs

The LVIC-AAF BREF contains a specific chapter on ammonia.

The BAT chapter mainly addresses issues related to NO_X emissions and energy consumption.

Different BAT-AELs are given for NO_X emissions from reformers, process heaters or boilers. The BAT-AELs may vary significantly depending on the plant concept.

24.3 General binding rules

The FR legislation provides a generic ELV for ammonia: 50 mg/m^3 if the mass flow exceeds 100 g/h.

The DE legislation provides generic ELVs for ammonia: 30 mg/m^3 if the mass flow exceeds 0.15 kg/h.

The IT legislation provides a generic ELV for ammonia: 250 mg/m^3 if the mass flow exceeds 2 kg/h.

24.4 Other technical information

From the information available on Ullmann's, there does not seem to be any new process for ammonia production since the revision of the LVIC-AAF BREF.[12]

The fact that more than 45 % of world ammonia plants are more than 30–35 years old suggests that there is a major potential for revamp projects, even in plants which have already made modifications.[13]

24.5 EIPPCB preliminary assessment and conclusion

[12] Appl, M. 2011. Ammonia, 2. Production Processes. Ullmann's Encyclopedia of Industrial Chemistry
[13] Appl, M. 2011. Ammonia, 3. Production Plants. Ullmann's Encyclopedia of Industrial Chemistry.

Taking into consideration the following:

- the information provided by the TWG justifies the link between the emissions (especially NO_X emissions), the applied processes and the plant design; this is particularly relevant for reformers, process heaters and boilers;
- in the LVIC-AAF BREF, both process-integrated and end-of-pipe techniques are applicable, and BAT-AELs may differ depending on the plant design;
- the GBRs of DE, FR and IT do not seem to contain any specific provision for this production process;
- no new technical information is available since the revisions of the LVIC-AAF BREF;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process furnaces/heaters, but not necessarily for ammonia production.

Additionally, specific contextual information may be needed to assess emissions from ammonia production (type of reforming, raw material, natural gas/naphtha; process furnace/heater).

25 Hydrofluoric acid

25.1 Technical information provided by the TWG

- DE stated that the minimisation of emissions can only be understood when looking into the process and its parameters, e.g. optimisation of the absorption stage. The optimisation of the energy recovery, the heat exchange system and the catalyst campaign length influence the emission levels and have to be looked at in a process-integrated way before defining a BAT-AEL (mainly for NO_X emissions).

- CEFIC stated that emissions to air from the production of hydrofluoric acid (HF) and anhydrous hydrogen fluoride (AHF) depend on the raw material and the type or range of products manufactured. Some aspects of the process should be taken into account, such as:

    - the consumption of fluorspar (CaF_2) in relation to the amount of P_2O_5.
    - the recovery of H_2SiF_6 and fluorides from gas stream.
    - for the production of AlF_3, direct fluorination or condensing and evaporating HF.

  Concerning the emissions of fluorine, if solid particles of fluorspar (CaF_2) are included in the total amount of F emitted to the atmosphere, the AHF/HF production process would need a specific chapter.

  In CEFIC's view, the relevant KEIs would be:

    - NO_X: Not measured or calculated until now, but AHF/HF would not be a specific process regarding NO_X emission.
    - CO & CO_2: Not measured but only calculated today, but AHF/HF would be in the same situation as all processes using burners and furnaces.
    - CH_4: Not measured or calculated until now, but AHF/HF would be in the same situation as all processes using NG burners and furnaces.
    - SO_2 and SO_X: As SO_2 is a by-product (side reaction with impurities) and SO_X can be emitted from the oleum, the AHF process will probably be in the top range of the chemical industry.
    - H_2S: As a by-product but in low quantity, the AHF process will probably be in the low range of emitters.

25.2 Information in the BREFs

The LVIC-AAF BREF has a descriptive chapter on hydrofluoric acid. Two processes are mentioned: the main fluorite process using fluorspar and the fluosilicic acid process which can be used to recycle large-scale by-product H_2SiF_6. It can also be carried out on an integrated site with the production of phosphoric acid to recycle the sulphuric acid. The direct energy consumption for this process is five to six times higher than the fluorspar process.

The LVIC-AAF BREF contains specific BAT for the production of hydrofluoric acid, addressing the following air-related issues for the fluorspar process:

- the treatment of tail gases (namely fluorides as HF and SO_2);
- dust emissions from fluorspar drying, transfer and storage.

The treatment techniques described in the LVIC-AAF BREF are:

- for dust emissions, to use fabric filters, dry or wet cyclones, wet scrubbers;
- for SO_2 and fluoride emissions to use water and/or alkaline scrubbing.

The LVIC-AAF BREF contains three BAT-AELs for SO_2 (expressed in kg/tonne HF), fluorides (expressed in mg/Nm^3) and dusts (expressed in mg/Nm^3).

One split view was expressed by part of the industry: in their view the dust emission levels were not achievable, mainly because changing the bags in the applied fabric filters more than once a year would not be economically viable.

The LVIC-AAF BREF recommends for future work to gather more data from individual examples, addressing particular techniques on the production of hydrofluoric acid. In particular, to broaden the database on dust emissions.

25.3 General binding rules

The GBRs of DE, FR and IT contain no specific provision for the production of hydrofluoric acid. This is covered by generic ELVs:

- In the FR GBRs: for fluorine and its inorganic compounds: 5 mg/m^3 if the mass flow exceeds 500 g/h.
- In the DE GBRs for F and its gaseous compounds: 3 mg/m^3 if the mass flow exceeds 15 g/h.
- In the IT GBRs: F and its compounds: 5 mg/m^3, if the mass flow exceeds 50 g/h.

25.4 Other technical information

Ullmann's has published no new information since 2000.

25.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the arguments provided by the TWG do not justify abandoning the generic approach for emissions to air associated with hydrofluoric acid production;
- the ranges of the BAT-AEL do not particularly differ from ranges set in MSs' legislation;
- the techniques described in the existing BREFs for the reduction of emissions to air are based on end-of-pipe techniques;
- no new technical information has been made available since the publication of the LVIC-AAF;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for hydrofluoric acid production.

Specific contextual information may be needed to assess emissions from hydrofluoric acid production (e.g. raw material, optimisation of the process).

26 Nitrosyl sulphuric acid

26.1 Technical information provided by the TWG

No technical information was provided by the TWG.

26.2 Information in the BREFs

The LVIC-AAF BREF only mentions the production of nitrosyl sulphuric acid once in the treatment of product H_2SO_4. This is only covered by generic BAT.

26.3 General binding rules

The IT GBRs provide specific ELVs for the production of nitrosyl sulphuric acid:

- NO_X: 2 000 mg/m^3
- SO_X: 800 mg/m^3
- n-hexane: 1 000 mg/m^3

The DE and FR GBRs contain no specific provision for nitrosyl sulphuric acid.

26.4 Other technical information

Ullmann's has published no new information since 2000.

26.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- all the pollutants from the production of nitrosyl sulphuric acid potentially emitted to air are KEIs covered in the scope of the WGC BREF (n-hexane will be included in TVOC);
- the techniques described in the existing BREFs for the reduction of emissions to air are based on common techniques;
- no new technical information has been made available since the publication of the LVIC-AAF;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for nitrosyl sulphuric acid production.

27 Nitric acid

27.1 Technical information provided by the TWG

- Fertilizers Europe stated that NOX is an intermediate generated in stoichiometric quantities and not a by-product. Therefore, the design of the absorption process has a significant influence on the emission level.
  There is still a difference between existing plants and new plants. For example, due to design in an existing plant, secondary N2O abatement technology cannot be improved beyond a certain level. The effectiveness of tertiary abatement technology is influenced by the existing plant design (e.g. the temperature of the tail gas). This argument also applies to DeNOX technology since catalyst performance depends on temperature and pressure of the tail gas.

  The final reduction of NOX and N2O is achieved by selective catalytic (in a few cases non-selective) reduction of the tail gas. A limited number of catalytic processes exist, which are strongly dependant on the tail gas temperature. Process pressure also influences the performance. To achieve the desired temperature the process-integrated heat transfer can be optimised.

- DE stated that the minimisation of the emissions can only be understood when looking into the process and its parameters, e.g. the optimisation of the absorption stage. Therefore specific emission limit values are needed for the production of nitric acid.

- NO also indicated that the emissions depend on the type of catalysts applied.

27.2 Information in the BREFs

The LVIC-AAF BREF has a descriptive chapter on the production of nitric acid and describes four different plant types. In 2006, about 100 plants in Europe were producing nitric acid, with a production capacity varying from 150 to 2 500 tonnes/day.

The LVIC-AAF BREF contains three specific air-related BAT:

- techniques to reduce emissions of N_2O;
- techniques to reduce emissions of $NO_{X;}$
- techniques to reduce NO_X emissions during start-up and shutdown.

The treatment techniques reported in the LVIC-AAF BREF to reduce emissions of NO_X are:

- the optimisation of the absorption stage;
- the combined NO_X and N_2O abatement in tail gases;
- the use of SCR;
- the addition of H_2O_2 to the last absorption stage.

The LVIC-AAF BREF contains two sets of BAT-AELs for N_2O in concentration and specific loads and NO_X (expressed as N_2O) in concentration:

	N_2O emission level		NO_X emission level (as NO_2)
	kg/tonne 100 % HNO_3	Concentration (ppmv)	Concentration (ppmv)
New plant	0.12–0.6	20–100	5–75

Existing plant	0.12–1.85	20–300	5–90

As an indication, the calculated equivalent concentration in mg/Nm^3 at a temperature of 20 °C:

- new plants: 40–190 mg/Nm^3 for N_2O emissions, and 10–150 mg/Nm^3 for NO_X emissions;
- existing plants: 40–570 mg/Nm^3 for N_2O emissions, and 10–180 mg/Nm^3 for NO_X emissions.

The LVIC-AAF BREF recommends for future work to collect information and emission data from example plants which have/will have implemented De-N_2O techniques.

27.3 General binding rules

In the FR GBRs, the limit value for NO_X emissions (excluding N_2O) expressed as HNO_3 is 1.3 kg/tonne of 100 % nitric acid produced. For N_2O, the limit value is 7 kg/tonne of 100 % nitric acid produced.

In the DE GBRs the emissions of NO and NO_2 in the waste gas shall not exceed 200 mg/m^3 (expressed as NO_2). The emissions of N_2O in the waste gas shall not exceed 800 mg/m^3.

The IT GBRs contain no specific provision for nitric acid.

27.4 Other technical information

Industry and one Member State did not agree with the N_2O emission levels associated with the application of BAT for existing plants due to the limited experience with the De-N_2O techniques presented in Sections 3.4.6 and 3.4.7 of the LVIC-AAF BREF.

In their opinion, the applied catalysts were still under development, although already placed on the market. Industry also claimed that the levels should relate to averages achieved in the lifetime of the De-N_2O catalyst, although this was not known at the time. Industry and one Member State claimed that the BAT range should include 2.5 kg N_2O/tonne 100 % HNO_3 for existing plants.

According to Fertilizers Europe, this split view is no longer relevant.

Ullmann's has published no new information since 2000.

27.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the arguments provided by the TWG and the BAT of the LVIC-AAF BREF indicate that both process-integrated and end-of-pipe techniques are relevant for this process; the emissions may vary depending on which process-integrated techniques are applied and the extent to which the process optimisation has been performed;
- there are specific ELVs in the MSs' GBRs that differ from the BAT-AEL ranges in the BREF (load and concentration);
- even though no new technical information has been made available since the publication of the LVIC-AAF BREF, there was a recommendation for future work to collect information and emission data from example plants which have/will have implemented De-N_2O techniques;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for the production of nitric acid.

28 Phosphoric acid

28.1 Technical information provided by the TWG

Fertilizers Europe stated that the production of phosphoric acid by the reaction of phosphate rock with sulphuric acid is presently limited to only six plants in Europe. There are another four plants in Europe that produce nitro-phosphoric acid through the dissolution of rock phosphate with nitric acid. This process is characterised by quite different conditions (compared to phosphoric acid production) in the dissolving section, in which emissions of NO_X for example are central. Relevant emission levels and necessary controls depend on quality of the phosphate used as raw material.
The environmental performance is focused on P_2O_5 (phosphate) recovery/efficiency and on the reduction of phosphate losses to water.
Gaseous emissions mainly concern fluorides for which scrubbers are generally used in an end-of-pipe configuration.
LVIC-AAF (Chapter 8.5) and the IFC Environmental, Health, and Safety information list a large number of process-integrated measures to prevent, minimise, and control emissions, pointing to the specificity of fertiliser manufacturing, including the production of phosphoric acid.

DE stated that the emissions depend on the quality of the phosphate rock used. The resource efficiency is essential for this process. There are also fluoride emissions to water from the production process, which is not covered by the WGC BREF. Due to a lack of data, there was no BAT-AEL in the LVIC-AAF BREF. Therefore, the recommendation for the future works in the LVIC-AAF BREF was for all AAF processes to collect more data sets of waste water (volumes and concentrations). This recommendation can only be taken into account if the process if considered in a process-integrated way.

28.2 Information in the BREFs

The LVIC-AAF BREF has a descriptive chapter on phosphoric acid. The number of plants in western Europe has gradually reduced from 60 in the 1980s to 17 in the early 2000s.

The LVIC-AAF BREF describes two processes for the manufacture of phosphoric acid: the thermal process using elemental phosphorus as the raw material, and the wet process using phosphate minerals and sulphuric acids as raw materials. The share of the wet phosphoric acid in the total phosphoric acid in the EU is of 95 %.

The treatment techniques for air emissions from phosphoric acid production described in the LVIC-AAF BREF are:

- for dust emissions, to use of fabric filters or ceramic filters;
- for fluoride emissions, to use scrubbers with suitable scrubbing liquids.

There are three specific BAT for:

- dust emissions, with BAT-AEPLs of 2.5–10 mg/Nm^3;
- dispersion of phosphate rock dust;
- fluoride emissions, with BAT-AEPLs of 1–5 mg/Nm^3 expressed as HF.

The intermediate production of phosphoric acid is also part of the production of fertilisers (NPK and superphosphates); the nitrophosphate route uses nitric acid for rock phosphate digestion and this is the main source for NO_X emissions into air.

This section contains BAT for the process of rock digestion:

- to minimise the NO_X load by process-integrated measures; and

- to reduce emissions to air by the use of end of pipe techniques such as multi-stage scrubbing.

The emissions levels associated to the techniques above are:

- for fluoride emissions: 0.3–5 mg/Nm^3 expressed as HF (similar to the BAT-AELs in the phosphoric acid production section of the LVIC-AAF BREF);
- for NO_X emissions: 100–425 mg/Nm^3 expressed as NO (additional BAT-AEL compared to the phosphoric acid production section of the LVIC-AAF BREF).

28.3 General binding rules

In the FR GBRs, the specific ELV for the emissions of F and its inorganic compounds from phosphoric acid production is 10 mg/m^3.

The DE and IT GBRs do not seem to contain any specific provision for the production of phosphoric acid.

28.4 Other technical information

Ullmann's has published no new information since 2000.

28.5 EIPPCB preliminary assessment and conclusion

Taking the following in consideration:

- the information provided by the TWG indicates that air emissions can be treated by applying generic techniques; however, part of the production of phosphoric acid is integrated to other processes such as fertilisers production; emissions to air depend on the process and the quality of the raw material;
- the LVIC-AAF BREF indicates that there are several processes for phosphoric acid production, linked with other processes that should require a complementary worksheet (see Sections 0 and 41); moreover, depending on the process, different BAT-AELs have been set for different parameters;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for phosphoric acid.

29 Sulphuric acid

29.1 Technical information provided by the TWG

CEFIC indicated that the operating regime could vary significantly, depending on the production process, from quasi-steady state to non-steady state or any state in-between. Therefore, the applied techniques may also vary depending on the process, as was reflected in the LVIC-AAF BREF.

Eurofer stated that, within coke oven plants, the production of sulphuric acid is an integrated part of the whole process. Gases with a high SO_2 concentration are the raw material input and cannot be compared with the low SO_2 concentration gases treated in an end-of-pipe off-gas (abatement system) in the chemical industry.

29.2 Information in the BREFs

The LVIC-AAF BREF concluded that it is BAT is to apply a combination of both process-integrated and end-of-pipe techniques to achieve the BAT-AELs for SO_2 emissions, expressed as conversion rates and concentrations. BAT-AELs differ depending on the source of sulphur (sulphur burning, coke production or metal ore smelting) and the applied process (double contact, single contact, other). A BAT-AEL for SO_3/H_2SO_4 of 10–35 mg/m^3 was concluded.

29.3 General binding rules

The FR GBRs provide conversion rates combined with specific loads, depending on the process route (regeneration of sulphuric acid, others) and the volume content of the feed gas.

The DE GBRs set ELVs based on conversion rates, depending on the applied process (double contact, single contact, wet catalysis) and the volume content of the feed gas. An ELV for SO_3/H_2SO_4 of 60 mg/m^3 is provided.

The IT GBRs set ELVs based on conversion, the applied process (double contact, single contact, wet catalysis) and the volume content of the feed gas. An ELV for SO_3/H_2SO_4 of 80–100 mg/m^3 is provided.

29.4 Other technical information

Ullmann's has published no new information since 2000.

29.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG indicates that both process-integrated and end-of-pipe techniques are relevant for this process; the emissions may vary depending on the process raw materials and which process-integrated techniques are applied;
- the LVIC-AAF BREF contains a specific chapter on the production of sulphuric acid, and specific BAT-AELs which are related to both process-integrated and end-of-pipe techniques;
- specific ELVs have been set in the DE, FR and IT GBRs;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for the production of sulphuric acid.

30 Sodium hydrogen sulphate

30.1 Technical information provided by the TWG

No technical information was provided by the TWG.

30.2 Information in the BREFs

Sodium hydrogen sulphate is mentioned in several BREFs, namely the LVIC-AAF, LVIC-S, CAK, SIC, CWW and LVOC BREFs, in processes that make use of its chemical properties as a reducing and precipitating agent.

30.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for this production process.

30.4 Other technical information

Ullmann's does not have any articles available.

30.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the existing chemical BREFs only mention sodium hydrogen sulphate as possible end uses for a few products; they do not address the production process;
- the GBRs of DE, FR and IT do not seem to contain any specific provision;
- no new technical information has been made available since the revisions of the other chemical BREFs;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for sodium hydrogen sulphate.

31 Sodium carbonate

31.1 Technical information provided by the TWG

In addition to the information present in the LVIC-S BREF, CEFIC provided the following:

- CO emissions: the soda ash process uses vertical kilns to get the highest content of CO_2 in order to maximise the overall process yield, and so to minimise the impact on the environment (energy consumption, CO_2 and CO emission, consumption of raw material,...). CO content is directly linked with the Baudouard reaction that occurs at the temperature needed to decompose the $CaCO_3$ (950–1 100 °C). CO_2 is reacting in the process, with an excess due to process yields.
- Ammonia is absorbed in brine and is used as intermediate to absorb CO_2 and then react with NaCl to produce sodium bicarbonate. The product is converted into soda ash by heating. Ammonia is recovered in the distillation unit and the gas is recycled into the absorption stage. The waste gases are washed with brine in scrubbers in order to remove the trace quantities of ammonia which is recycled. One of the major achievements of the Solvay process is the high efficiency of the ammonia recycle loop.

IT underlined the relevance of soda ash production for air-related issues such as the emissions of ammonia, carbon monoxide, sulphur oxides, nitrogen oxides, dust and carbon dioxide.

PL and ES stated that a process-specific approach is needed in relation to limiting the energy consumption and maximising the CO_2 concentration in lime kiln gas. The lime kilns should be considered both lime producers and CO_2 producers (key raw material for the Solvay process). The CO_2 content needs to be maximised for process efficiency and this implies cross-media effects.

31.2 Information in the BREFs

The LVIC-S BREF contains a specific chapter and 13 BAT for the production of soda ash by the Solvay process.

Out of these 13 BAT, two are related to carbon dioxide emissions, which is not a KEI in the scope of the WGC BREF and one to the treatment of dust emissions. The other BAT address water-related issues, energy and raw material consumption.

As regards relevant air emissions for the WGC BREF, the LVIC-S BREF provides the following information:

- Ammonia: typical concentration is around 30–40 mg/Nm^3 even though higher values may be encountered, issue relevant for diffuse emissions from processes and handling but, overall, the loss rate of ammonia in the process is very low.
- Dusts: diffuse emissions from handling. For channelled emissions, the reduction of the levels of dust is achieved by using bag filters and wet scrubbers.
- Carbon monoxide: provided the dispersion of CO and CO_2 is adequate and the stack responds to the normal dispersion rules, no local impacts on the environment or on health are expected or experienced.
- NO_X: Since the temperature inside the kiln is moderate (up to 1 100 °C), the formation of NO_X is rather limited.
- SO_X: The formation of SO_X is limited both due to the low sulphur content in fuels used in limestone burning and some auto-purification reactions in the lime kilns. Furthermore, SO_X in the kiln gas sent to the process is absorbed.

31.3 General binding rules

The DE GBRs state that for existing installations ammonia emissions in waste gas shall not exceed 50 mg/m^3.

The FR and IT GBRs do not provide any specific provision for the production of sodium carbonate.

31.4 Other technical information

No new information has been published on Ullmann's since 2000.

31.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG does not justify the link between the emissions levels from this process and the process-integrated techniques; generic techniques (e.g. scrubbers) seem applicable; the energy consumption is an environmental issue: the generic questionnaire will be designed to ensure that cross-media effects can be reported where relevant;
- in the LVIC-S BREF, emissions to air other than dusts are not described as major issues for this production process, and therefore no specific BAT or BAT-AEL apply to them; the BAT for dust refers to generic techniques that can be covered by a generic questionnaire;
- the DE GBRs provide a specific ELV for ammonia on existing plants; however, the FR and IT GBRs do not provide any specific ELVs;
- no new technical information has been made available since the revisions of the LVIC-S BREF;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process heaters/boilers, but not necessarily for sodium carbonate production.

32 Salts

32.1 Technical information provided by the TWG

IT underlined the relevance of $CaCl_2$ production process for air-related issues such as the emissions of dusts and NO_X from rotary drum dryers.

32.2 Information in the BREFs

Salts are mentioned in every chemical BREF as products, co-products or solid waste.

The LVIC-S BREF has a specific chapter on calcium chloride which describes several production routes, from acid limestone production, from natural brines and as a co-product from soda ash manufacture or magnesium salts production.

The LVIC-S BREF contains four BAT for the production of calcium chloride, of which two address air-related issues:

- to reduce HCl emissions from the acid-limestone route by scrubbing the reaction off-gas with water;
- to reduce dust emissions to air by using cyclones, scrubbers or dry bag filters.

32.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for this production process.

32.4 Other technical information

Ullmann's has published no new information since 2000.

32.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG does not justify why the generic approach should not be applicable to the emissions from this production process, as 'salts' covers a wide variety of substances;
- there are no specific ELVs set in MSs' GBR;
- the existing BREFs do not address the production of the generic group of substances 'salts';
- no new technical information has been made available since the publication of the LVIC-S BREF;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for salts.

33 Non-metals, metal oxides or other inorganic compounds

The IED lists in Annex I 4.2(e) the following activities: non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide.

33.1 Technical information provided by the TWG

No technical information was provided by the TWG.

33.2 Information in the BREFs

The LVIC-S BREF describes some of these activities. It contains 'cornerstone chapters' such as the production of titanium dioxide (see Section 39), and carbon black (see Section 40) and selected illustrative chapters such as the production of aluminium fluoride (see Section 35), copperas and related products (see Section 0), sodium silicate (see Section 37).

These activities are also in the scope of the SIC BREF. In order to avoid duplication of information with the LVIC-S BREF, criteria to differ between LVIC and SIC substances were given. The SIC contains as an illustrative family: the speciality inorganic pigments.

The REF BREF describes the production of sulphur by the Claus process.

33.3 General binding rules

MSs' legislation contains specific provisions for the following production processes:

- titanium dioxide (DE, FR, IT);
- sulphur (DE, IT);
- carbon black (DE, IT).

33.4 Other technical information

Ullmann's has no articles for the generic groups of non-metals or metal oxides.

33.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the SIC BREF applies a generic approach; the specific substances in the scope of the LVIC-S BREF are assessed in separate sections of this document;
- MSs' legislation do not seem to contain any specific provision for these products/processes, except titanium dioxide and carbon black;
- the available technical information indicates that this proposal covers a large range of inorganic substances; the generic approach of the WGC BREF seems appropriate to cover such a variety of substances;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for non-metals, metal oxides or other inorganic compounds.

34 Pigments

34.1 Technical information provided by the TWG

No technical information was provided by the TWG.

34.2 Information in the BREFs

Pigments are in the scope of following BREFs:

- LVIC-S BREF: titanium dioxide (see Section 39) and carbon black (see Section 40);
- SIC BREF: other, inorganic pigments such as iron oxides (see Section 0);
- OFC BREF: organic pigments.

34.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for this production process.

34.4 Other technical information

Most information relevant for the chemical BREFs was published before 2007. A number of standard articles on inorganic pigments have been published on Ullmann's, for example[14], [15].

34.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information;
- the pigments are addressed in three chemical BREFs, two of which, OFC and SIC, have a generic approach; the specific substances in the scope of the LVIC-S BREF are assessed in separate sections of this document;
- MSs' legislation does not seem to contain any specific provision;
- the available technical information indicates that pigments cover a range of inorganic and organic substances; the generic approach of the WGC BREF seems appropriate to cover such a variety of substances;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for pigments.

[14] Buxbaum, G., Printzen, H., Mansmann, M., Räde, D., Trenczek, G., Wilhelm, V., Schwarz, S., Wienand, H., Adel, J., Adrian, G., Brandt, K., Cork, W. B., Winkeler, H., Mayer, W. and Schneider, K. 2009. Pigments, Inorganic, 3. Colored Pigments. Ullmann's Encyclopedia of Industrial Chemistry.

[15] Völz, H. G. 2009. Pigments, Inorganic, 1. General. Ullmann's Encyclopedia of Industrial Chemistry.

35 Aluminium fluoride

35.1 Technical information provided by the TWG

CEFIC referred to different processes used for the production of aluminium fluoride; the dry fluorspar process and the wet fluorosilicic acid process (FSA), which is only used by one producer in Europe. Those processes have specific emissions levels, which might be the highest of chemical activities. In integrated processes, most of the waste gas streams are connected to the same scrubber system.

35.2 Information in the BREFs

The LVIC-S BREF contains an illustrative chapter describing the production of aluminium fluoride in the EU using two distinct process routes: the dry fluorspar process and the FSA. The LVIC-S BREF provides specific BAT and BAT-AELs for each process regarding emissions to air:

The BAT-AELs for the dry fluorspar process set specific loads for fluorides (0.01 kg F/t AlF_3) and dust (0.05 kg dust/t AlF_3). These are based on the use of end-of-pipe techniques: scrubber for fluorides and dry filters for dust.

The BAT-AELs for the FSA process set specific loads for fluorides (0.015 kg F/t AlF_3). The BAT-AELs are based on the use of end-of-pipe techniques: scrubber for fluorides.

35.3 General binding rules

The GBRs of DE, FR and IT do not seem to contain any specific provision for this production process.

35.4 Other technical information

Ullmann's contains no specific information.

35.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG indicates that the emissions levels associated with this production process may be higher than other chemical activities; however, in most cases, waste gas streams can be connected to the same end-of-pipe treatment system; therefore the generic approach of WGC seems appropriate;
- BAT-AELs in the LVIC-S BREF are based on the use of end-of-pipe techniques such as scrubbers;
- the GBRs of DE, FR and IT do not seem to contain any specific information;
- no specific information was found regarding this production process;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for aluminium fluoride.

However, contextual information on the production of aluminium fluoride, with potentially specific high pollutant loads, may be needed to assess the origin of waste gas streams.

36 Ferric oxide from copperas

36.1 Technical information provided by the TWG

CZ confirmed that the information in the LVIC-S BREF is still up to date:

- It is a specific technology used by a CZ producer.
- Waste gas treatment system for SO_X from calcination is based on production of sulphuric acid in a dedicated technology line. SO_2 gases are processed by wet catalysis for SO_3 that react with water gases.
- BAT refers to the process-integrated technique by the interconnection of ferric oxide production and sulphuric acid production that need to be harmonised.
- Existing BAT-AELs for SO_X emissions are expressed both as load (max. 32 kg SO_2/t Fe_2O_3) and in concentration that is equivalent to the load (max. 1200 mg SO_2/Nm^3) – in LVIC-S, Section 8.2.3.3 and 7.5.6.5.
- The existing BAT-AEL range differs significantly from other BAT-AEL ranges of related products, e.g. for sulphuric acid (LVIC-AAF, Section 4.5) or for iron oxide pigments by other production routes (SIC, Section 6.1.5).

36.2 Information in the BREFs

The LVIC-S BREF describes the production of copperas and related products in an illustrative chapter. Copperas is ferrous sulphate heptahydrate, originating from the manufacture of TiO_2 by the sulphate process route. The manufacture of iron oxide pigment from copperas has its own chapter and BAT conclusions.

The BAT-AELs related to emissions to air expressed as loads and in concentrations equivalent to the load have been concluded for NO_X (waste gas from kiln), SO_X (emissions from sulphuric acid plant) and dust.

36.3 General binding rules

The GBRs of CZ, DE, FR and IT do not seem to contain any specific provision for this production process.

36.4 Other technical information

Taking into account the information from CZ and in the BREF, no other technical information is expected to be available.

36.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by CZ justifies the link between the emissions (NO_X and SO_X emissions), the applied processes and the operating conditions; this is particularly relevant for the process furnaces such as kilns and sulphuric acid production (see Section 29);
- the GBRs of DE, FR and IT do not contain any specific provisions;
- no new technical information is available since the revisions of the LVIC-S BREF;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process furnaces and sulphuric acid production, but not necessarily for this specific installation in particular.

37 Sodium silicate

37.1 Technical information provided by the TWG

DE indicated that the furnace route involves a high-temperature process identical to the production of glass. Gas or fossil fuel is used to melt the raw material, influencing the emissions of NO_X or SO_X. For the abatement of SO_X and halogen compounds, end-of-pipe techniques like dry or semi-dry sorption in combination with electrostatic precipitator or bag filters (to reduce dust) are used. Nevertheless, for the reduction of NO_X, primary techniques are considered BAT. In addition, raw material selection is another important primary technique to reduce emissions from melting furnaces. In Germany, sodium silicate production is considered a glass melting process (equivalent to IED Annex II 3.3) since raw materials and melting techniques and hence emissions are identical or at least very similar to glass production.

ES indicated that sodium silicates are produced by a unique furnace process comparable to the glass industry: different furnace types like tank furnaces and rotary furnaces with different energy sources are currently in use. The production volume is greater than 1 million tonnes per year (i.e. 3 million tonnes liquid).

CEFIC stated that the production is energy-intensive and lowering the emission limits can significantly increase energy consumption, especially for additional waste gas cleaning processes. This can result in increasing the amount of waste water and solid waste, depending on the process of waste gas cleaning. The production of solid waste, due to the chemicals which are used in the filtering systems, the production of these chemicals itself increases the footprint of the whole production process as well.

37.2 Information in the BREFs

Emissions to air from the production of sodium silicates only seem relevant for the melting process route. The main emission source is the process furnace where the combustion gases are in direct contact with the molten raw materials (i.e. soda ash and silicon dioxide).

The LVIC-S BREF concluded on BAT and BAT-AELs for emissions of dust, SO_2, NO_X, chlorine and fluorine compounds to air for the melting process route.

The BAT-AELs for dust are based on the application of improved furnaces/firing modifications, fabric filters or scrubbers.

The BAT-AELs for SO_2 are mainly based on fuel choice, but end-of-pipe techniques such as dry acid scrubbing are also mentioned.

The BAT-AELs for NO_X differ for tank and revolving hearth furnaces as well as for oil- and gas-fired furnaces, mainly due to differences in the operating temperature. They are mostly based on the use of primary techniques (e.g. low-NO_X burners), but end-of-pipe techniques such as SCR and SNCR are also mentioned.

The BAT-AELs for halogen compounds are based on the use of raw materials with low halogen contents, but end-of-pipe techniques such as dry acid scrubbing are also mentioned. The upper ends of the BAT-AEL ranges for halogen compounds are similar to those that can be expected when using end-of-pipe techniques (i.e. 1 mg/m^3 for fluorine compounds and 5 mg/m^3 for the sum of chlorine and fluorine compounds).

37.3 General binding rules

MSs' legislation (i.e. DE, FR, IT) does not seem to include specific provisions for the production of sodium silicates.

37.4 Other technical information

No new information has been published on Ullmann's since 2000.

37.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG justifies the link between the emissions (especially NO_X emissions), the applied processes and the operating conditions; this is particularly relevant for the process furnaces;
- in the LVIC-AAF BREF, end-of-pipe techniques are generally applicable; however, BAT and BAT-AELs may differ depending on several parameters linked to the process furnace;
- MSs' legislation does not contain any specific provision for this production process;
- no new technical information is available since the revisions of the LVIC-AAF BREF;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process furnaces, but not necessarily for sodium silicates specifically.

However, specific contextual information may be needed to assess emissions from sodium silicate (product; type of process furnace/heater) production.

38 Sulphur

38.1 Technical information provided by the TWG

DE stated that the production of sulphur is within the scope of the REF BREF. No other information has been provided by the TWG.

38.2 Information in the BREFs

The production of the sulphur by the Claus process is within the scope of the REF BREF.

38.3 General binding rules

Only the German legislation includes specific provisions for the Claus process.

38.4 Other technical information

Taking into account that sulphur production is within the scope of the REF BREF, no other technical information has been assessed.

38.5 EIPPCB preliminary assessment and conclusion

Taking into account that sulphur production is within the scope of the REF BREF, the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for sulphur production.

39 Titanium dioxide

39.1 Technical information provided by the TWG

CZ, DE and CEFIC indicated that two processes may be applied to produce titanium dioxide: the chloride process and the sulphate process.

Generally, CEFIC stated that key abatement techniques are unique to the TiO_2 industry. The main specific challenges are:

- for the chloride process:
  - to optimise processing to ensure complete chlorine conversion;
  - high solids contents in waste gas stream for thermal oxidation.
- for the sulphate process:
  - based on batch processing;
  - sulphate route has high reliance on coproduct production and recycling.

CZ proposed a specific approach only for the waste gas treatment system (WGTS) for the sulphate process taking into account batch processing with 'extremely' varying emission profiles and multistage WGTS.

39.2 Information in the BREFs

The category of activity is within the scope of the LVIC-S BREF. The production of titanium dioxide is described in a 'cornerstone chapter' including a BAT-AEL for emissions into air.

Titanium dioxide is currently produced using two distinct process routes: the chloride process and the sulphate process. The LVIC-S BREF provides specific BAT and BAT-AELs for each process regarding emissions to air:

- Chloride process

BAT-AELs for specific loads for dust, SO_2 and HCl were concluded on. They seem to be based on the use of multistage waste gas treatment units, which includes thermal oxidisers and scrubbers and process-integrated techniques for the recovery and reuse of chlorides.

- Sulphate process

BAT-AELs for specific loads for dust, SO_2, NO_2 and H_2S were concluded on. These BAT-AELs differ from the chloride process ones (e.g. emissions of SO_2 from the sulphate process may be up to five times higher than those from the chloride process).

Most plants have proprietary equipment in which there is the catalytic conversion of SO_2 to SO_3 and subsequent absorption to sulphuric acid, which is recycled.

39.3 General binding rules

IED Annex VIII sets technical provisions relating to installations producing titanium dioxide; Part 2 contains the emission limit values for air.

- The concentration limit value for dust emissions is 50 mg/Nm^3 on average for primary sources and 150 mg/Nm^3 on average for other sources.
- The sulphur oxides limit value for digestion and calcination units is 6 kg of SO_2 equivalent per tonne of titanium dioxide produced (annual average) and 500 mg/Nm^3 of SO_2 equivalent for acid waste concentration units (hourly average).

- The concentration limit values for chloride releases for units using the chlorine process are 5 mg/Nm^3 on average daily and 40 mg/Nm^3 at all times.

FR GBR integrates IED Annex VIII Part 2 into their GBR.

IT reported specific ELVs for SO_X for the production of titanium dioxide:

- 10 kg of SO_2 of titanium dioxide (digestion and calcination units);
- 500 mg/m^3 (concentration unit).

DE referred to the IED provisions.

CZ reported that IED provisions are adopted.

39.4 Other technical information

There is updated information available on Ullmann's[16].

39.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the technical arguments provided by the TWG justify the specificity of the WGTS and their impact on emissions to air;
- this production process has a specific chapter in the LVIC-S BREF, for each process (chloride/sulphate process), specific BAT and BAT-AELs were concluded as well as BAT for the recovery of pollutants from waste gases; these BAT-AELs differ depending on the process;
- the IED contains technical provisions that differ depending on the process;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process furnaces (e.g. digestion and calcination) and sulphuric acid production, but not necessarily for titanium dioxide production. Specific contextual information may be needed to assess emissions from titanium dioxide production.

[16] Auer, G., Woditsch, P., Westerhaus, A., Kischkewitz, J., Griebler, W.-d., Rohe, M. and Liedekerke, M. 2017. Pigments, Inorganic, 2. White Pigments. Ullmann's Encyclopedia of Industrial Chemistry. 1–36.

40 Carbon black

40.1 Technical information provided by the TWG

CEFIC stated that the waste gas composition strongly depends on the use of feedstocks, the applied processes and products as described in the LVIC-S BREF. CEFIC pointed to the fact BAT reference documents such as the LVIC-S BREF did not set legally binding standards.

DE suggested that energy efficiency is an important issue. There is one plant[17] using a heat exchanger between the purge gas filter and stack. Corrosive steam emissions from the purge gas filter are condensed and energy is being recovered. This process is working economically. The LVIC-S BREF is not dealing with all KEIs as they are SO_X, TVOC, NO_X, dust, benzene.

40.2 Information in the BREFs

The category of activity is within the scope of the LVIC-S BREF. The production of carbon black is described in a 'cornerstone chapter' including BAT-AEL for emissions into air.

The LVIC-S BREF differs between the following production processes: furnace black, gas black, channel black, lamp black, thermal black, acetylene black. However, 95 % of the global production of carbon black is furnace black.

All BAT conclusions in the LVIC-S BREF refer to the furnace black production. Regarding emissions to air, the following BAT-AELs were concluded, with a particular focus on process furnaces and heaters:

- SO_X: 10–50 kg SO_X/t carbon black produced (assuming that secondary feedstock is natural gas);
- NO_X new installations: 0.6 g/m^3;
- NO_X existing installations: 1.0 g/m^3;
- dust: 20–30 mg/m^3.

The LVIC-BREF also mentions that, due to the large variety of plant configurations, feedstock compositions and product types, it is difficult to present an overview of emissions to air from carbon black plants that fits all plants. Some plants operate with separate stacks for the tail-gas combustion units and for the product dryers, whereas others combine the flue-gases from these sources. An attempt to present the emissions per potential source (e.g. tail-gas combustion, dryers, filter system) was abandoned for this reason.

[17] No details to identify the plant

40.3 General binding rules

The DE GBRs contain specific provisions for carbon black production including ELVs.

Product	CO g/m^3	NO_X g/m^3	SO_X g/m^3	TVOC g/m^3	Benzene mg/m^3
Gas black	0.5			0.10	5
Furnace black		0.6	0.85		
Lamp black		0.6	0.85		

The FR GBRs do not contain specific provisions

The IT GBRs contain specific ELVs for carbon black production: dust 15–30 mg/m^3, SO_X 2 600 mg/m^3 and NO_X 1 000 mg/m^3.

40.4 Other technical information

There is new information on Ullmann's available[18]; however, there does not seem to be any new process for the production of carbon black since the revision of the LVIC-S BREF.

The furnace black process is currently the most important production process. It accounts for more than 95 % of the total worldwide production. The advantages of the furnace black process are its great flexibility, which allows the manufacture of various grades of carbon black, and its better economy compared to other processes. However, in spite of the more advantageous furnace black process, the production processes (except for the channel black process) are still in use for the production of special carbon blacks which cannot be obtained.

40.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the technical arguments provided by the TWG justify the specificity of the WGTS and their impact on emissions to air;
- the DE GBR differs between carbon black products;
- this LVIC-BREF acknowledges the variety of the configurations with a particular focus on process furnaces and heaters;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for process furnaces, but not necessarily for carbon black production. However, specific contextual information may be needed to assess emissions from carbon black production (feedstock, product).

41 Fertilisers (including AN, CN, CAN, NPK, phosphates (SSP and TSP))

41.1 Technical information provided by the TWG

BE indicated that fertiliser production is the main source of NH_3, dust and N_2O emissions to air from the chemical sector. BAT-AELs for fertilisers are expected to differ significantly from other BAT-AELs in the chemical sector and process-integrated measures have an important role in the determination of BAT.

IT stated that process-integrated recycling of streams of liquid or solid material significantly influences final emissions. Air volumes conveyed to stacks are very high because air is used for particulation and cooling the final product. This restricts the applicability of certain end-of-pipe techniques).

Fertilizers Europe indicated that the LVIC-AAF BREF specifically covers many different types of fertilisers. Emissions from the respective wet and finishing sections of the various processes differ widely:

- Process conditions within the processes for the different type of fertilisers (N, P, NPK) vary and lead to quite different temperature or pH levels for example, both effecting the environmental performance and the reduction possibilities.
- For AN and CAN production, the previous data basis was insufficient for the establishment of specific BAT conclusions.
- Air volumes associated with fertiliser production are generally very high compared to other chemical processes, as air is needed not only for particulation but also for subsequent cooling.
- The LVIC-AAF BREF (Chapter 8.5) and the IFC Environmental, Health, and Safety information list a large number of process-integrated measures to prevent, minimise, and control emissions, pointing to the specificity of fertiliser manufacturing, including NPK, AN, CN, CAN, SSP and TSP production.

41.2 Information in the BREFs

The LVIC-AAF BREF contains several detailed chapters on the production of fertilisers, for NPK and CN, urea and UAN (see Section 41.1), AN, CAN and for superphosphates.

The main environmental concerns for emissions to air are dusts, NO_X, ammonia, hydrochloric acid (in some cases) and fluorides. The BAT described in the LVIC-AAF BREF indicate that both process-integrated and end-of-pipe techniques can be used to reduce emissions to air. The BREF also sets specific BAT-AELs:

- for NPK fertilisers: NO_X, dusts, ammonia, fluorides and hydrochloric acid;
- for AN and CAN: dusts (only from dolomite grinding);
- for superphosphates: ammonia, dusts, fluorides and hydrochloric acid.

For superphosphates, the BAT for reducing emissions of fluorides, ammonia, dusts and hydrochloric acids are only based on end-of-pipe techniques (i.e. use of ceramic or fabric filters, cyclones, wet or combined scrubbing).

41.3 General binding rules

The FR GBRs provide an ELV for fluorides from the phosphates production: 10 mg/m^3.

The DE GBRs (TA Luft) provide for the fertiliser sector for existing installations (NPK including AN and urea):

- during prilling, granulation and drying, a specific ELV for dust of 50 mg/m^3; the generic ELV for dust is 20 mg/m^3, if the mass flow exceeds 0.2 kg/h.
- during prilling, a specific ELV for ammonia of 60 mg/m^3, the generic ELV for ammonia is 30 mg/m^3, if the mass flow exceeds 0.15 kg/h.
- during granulation and drying, a specific ELV for ammonia of 50 mg/m^3.

The IT GBRs provide for NPK fertilisers:

- during prilling or fluid bed granulation, a specific ELV for dust of 100–150 mg/m^3; the generic ELV for dust is 50 mg/m^3, if the mass flow exceeds 0.5 kg/h.
- during processes other than granulation, a specific ELV for dust of 75 mg/m^3;
- during prilling or fluid bed granulation, a specific ELV for ammonia of 200 mg/m^3, the generic ELV for ammonia is 250 mg/m^3, if the mass flow exceeds 2.0 kg/h.

41.4 Other technical information

Ullmann's contains no new process information for NPK, CN, SSP or TSP. No new information on AN and CAN has been published since 2000.

During the revision of the LVIC-AAF BREF, because of insufficient data, no conclusions could be drawn for emissions to air from neutralisation, evaporation, granulation, prilling, drying, cooling and conditioning, for AN/CAN. More particularly, a recommendation was made for future work in order to collect more data on air emissions for the production of NPK and AN/CAN.

41.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG underlined the conclusions of the LVIC-AAF BREF on the production of fertilisers, justifying the link between the emissions levels from these processes and the applied process-integrated techniques;
- MSs' legislation contain different ELVs for the production of fertilisers; however, some production processes seems to be covered by generic ELVs (e.g. superphosphates);
- the LVIC-AAF BREF confirms that for the many processes, the emissions to air depend on process optimisation, process-integrated techniques and end-of-pipe techniques; however, for some fertilisers (e.g. superphosphates), the BREF only mentions end-of-pipe techniques in order to reduce emissions;
- the LVIC-AAF BREF could not conclude on BAT-AELs in the case of AN/CAN because of insufficient data, and it was recommended to gather more information on those production processes, with a particular attention to air emissions;

the EIPPCB considers that the technical arguments are sufficient to support the development of a complementary worksheet for some groups of fertilisers, namely AN, CN, CAN and NPK.

42 Plant protection products or biocides

42.1 Technical information provided by the TWG

No technical information was provided by the TWG.

42.2 Information in the BREFs

The OFC BREF contains a brief chapter (Chapter 1.3.4) on biocides and plant health products. This chapter describes the different groups of biocides but does not address the production process, or air-related emissions and their treatment techniques.

The main environmental concerns related to the production of biocides are emissions to water, because of their high toxicity to fish, daphnia, algae, bacteria, etc.

42.3 General binding rules

The FR legislation provides the following ELVs for fine chemistry (including plant health products), when solvent consumption is greater than 50 tonnes/year:

- channelled emissions of NMVOC: 20 mg/m^3 expressed as total carbon or 150 mg/m^3 where solvent recovery techniques are applied;
- diffuse emissions: less than 5 % of the total quantity of solvent used (15 % for plants permitted before 1 January 2001).

The DE legislation (TA Luft 5.4.4.1) provides ELVs for total dust, including slowly degradable, highly accumulative and highly toxic organic substances: 5 g/h or 2 mg/m^3.

The IT legislation provides a specific ELV for dusts during the production of pesticides: 10 mg/Nm^3.

42.4 Other technical information

No new information is available on Ullmann's.

42.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the TWG did not provide any technical information on this production process;
- the existing chemical BREFs do not address the production processes;
- MSs' legislation contain specific ELVs; however, in the case of FR these ELVs are generic to the fine chemistry sector;
- no new technical information is available since the revisions of the other chemical BREFs;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for plant protection products and biocides.

43 Pharmaceuticals

43.1 Technical information provided by the TWG

CEFIC provided the following information:

- The waste gas composition strongly depends on the raw materials being used (e.g. solvents, organochlorine compounds, amines).
- The range of products being produced can vary over the time. The time frame of the questionnaire of one year for example may not cover the whole production range.
- Due to the nature of the waste gas in pharmaceutical production, the waste gas treatment system must be able to treat all possible pollutants effectively. Predominantly the final treatment is done by thermal oxidisers.

DK indicated the following:

- There are larger productions and smaller, and there are both batch and continuous productions. Great variations in productions may occur at the same plant – some are short term, while others are of longer duration.
- In general, mass balances are used and not emission monitoring for compliance assessment of these sites. The emission limits are hence expressed in the percentage of solvent loss.

43.2 Information in the BREFs

The OFC BREF focuses on the batch manufacture of organic chemicals such as pharmaceuticals in multipurpose plants. All BAT and BAT-AELs concluded in the OFC BREF are generic.

43.3 General binding rules

The FR legislation provides the following ELVs for fine chemistry in general (including pharmaceuticals), when solvent consumption is greater than 50 tonnes/year:

- channelled emissions of NMVOC: 20 mg/m^3 expressed as total carbon or 150 mg/m^3 where solvent recovery techniques are applied;
- diffuse emissions: less than 5 % of the total quantity of solvent used (15 % for plants permitted before 1 January 2001).

Concerning dust, DK has special provisions including emission limits for Medicinal Dust. Dusts containing medicinal active compounds have very strict limits. Dust data from these sites will therefore be very low and not comparable with other dust sources.

The IT legislation provides specific ELVs for TOC during the production of pharmaceuticals (solvent consumption > 50 t/yr):

- 20 mg C/m^3;
- 150 mg C/m^3 (only in case of application of techniques that allow reuse of the recovered solvent).

Other MSs' legislation seems to include specific provisions for batch production in general (e.g. in DE), but not specifically for the production of pharmaceuticals.

43.4 Other technical information

No new information has been published on Ullmann's since 2000.

Information gathered during the site visit in Geel:

The plant of Janssen Pharmaceuticals operates around 290 different syntheses through batch processes and uses 1 000 different chemical substances. Despite the large variety of products, processes and, therefore, significant variations in the composition of the waste gases, generic techniques are applied, such as:

- integrated reduction of emissions from production: condensers, scrubbers, regenerative active carbon;
- catalytic oxidiser switching to regenerative thermal oxidiser

43.5 EIPPCB preliminary assessment and conclusion

Taking into consideration the following:

- the information provided by the TWG and from the site visit in Geel confirms the variety of products and production processes but also indicates that generic final treatments are predominant; particular attention should be paid to the format of the data;
- the existing OFC BREF addresses the production processes in a generic manner;
- some GBRs contain specific ELVs, mainly to take solvent recovery into account, while other GBRs address fine chemicals in a generic manner;
- the information gathered during the site visit in Geel shows that, even in the case of specific products and processes, with variable emissions, common treatment techniques may be applicable regardless of the process or the product;

the EIPPCB considers that the technical arguments are not sufficient to support the development of a complementary worksheet for pharmaceuticals.

44 Explosives

44.1 Technical information provided by the TWG

ES reported that, even though the OFC BREF focuses on batch products, some organic explosives are manufactured through a continuous process. The emissions covered by the SIC BREF for explosives production might not be relevant; however, some of the emissions to air from organic explosives production may be of high relevance, for example NO_X from nitration processes.

44.2 Information in the BREFs

Explosives may be composed of a broad range of organic and inorganic compounds. Therefore, quite different treatment techniques are used to abate emissions to air.

The OFC BREF focused on the batch manufacture of organic chemicals such as explosives in multipurpose plants. All BAT and BAT-AELs concluded in the OFC BREF are generic.

The SIC BREF focused on six families of inorganic substances such as inorganic explosives and concluded on generic BAT-AELs for emissions to air of dust, hydrogen cyanide, ammonia and hydrogen chloride.

The SIC BREF reports no significant emissions to air from the production of explosives (see Section 6.4.3.4. of the SIC BREF). No specific BAT-AELs for emissions to air regarding explosives were concluded.

44.3 General binding rules

MSs' legislation (i.e. DE, FR, IT) does not seem to include specific provisions for the production of explosives in general. A specific case might be the nitration of cellulose (see Section 11).

44.4 Other technical information

No new information has been published on Ullmann's since 2003.

44.5 EIPPCB preliminary assessment and conclusion

The EIPPCB preliminary assessment for the production of explosives is included in the preliminary assessment for nitrogenous hydrocarbons (see Section 7) and cellulose nitration (see Section 11).

Annex: Overview of generic thresholds / ELVs in MS legislation for KEIs

KEI	MS thresholds in mass flows and emissions limit values in concentration		
	DE	FR	IT
1,3 Butadiene	2.5 g/h or 1 mg/m^3	2 mg/m^3 if mass flow > 10 g/h	25 g/h or 5 mg/m^3
Ammonia (NH_3)	150 g/h or 30 mg/m^3	50 mg/m^3 if mass flow > 100 g/h	2000 g/h
Benzene	2.5 g/h ([1]) or 1 mg/m^3	2 mg/m^3 if mass flow > 10 g/h	25 g/h or 5 mg/m^3
Carbon disulphide		NT	
Carbon monoxide (CO)	NT	100 mg/m^3 if NMVOC emissions	NT
Chlorine (Cl_2)	15 g/h or 3 mg/m^3	50 mg/m^3 if mass flow > 1 kg/h ([2])	50 g/h or 5 mg/m^3
Chloromethane	100 g/h or 20 mg/m^3	20 mg/m^3 if mass flow > 100 g/h	100 g/h or 20 mg/m^3
Dichloromethane	100 g/h or 20 mg/m^3	20 mg/m^3 if mass flow > 100 g/h	100 g/h or 20 mg/m^3
Dust ([5])	200 g/h or 20 mg/m^3	100 mg/m^3 if mass flow < 1 kg/h 40 mg/m^3 otherwise ([3])	50 mg/m^3 if mass flow > 500 g/h 150 mg/m^3 otherwise
Ethylene dichloride	2.5 g/h or 1 mg/m^3	2 mg/m^3 if mass flow > 10 g/h	25 g/h or 5 mg/m^3
Ethylene oxide	1.5 g/h or 0.5 mg/m^3	2 mg/m^3 if mass flow > 10 g/h	25 g/h or 5 mg/m^3
Formaldehyde	12.5 g/h or 5 mg/m^3 ([4])	2 mg/m^3 if mass flow > 10 g/h	100 g/h or 20 mg/m^3
Gaseous chloride	150 g/h or 30 mg/m^3	50 mg/m^3 if mass flow > 1 kg/h ([2])	300 g/h or 30 mg/m^3
Gaseous fluoride	15 g/h or 3 mg/m^3	5 mg/m^3 if mass flow > 500 g/h	50 g/h or 5 mg/m^3

Hydrogen cyanide (HCN)	15 g/h or 3 mg/m^3	5 mg/m^3 if mass flow > 50 g/h	50 g/h or 5 mg/m^3
Hydrogen sulphide	15 g/h or 3 mg/m^3	NT	50 g/h or 5 mg/m^3
Lead and its compounds	2.5 g/h or 0.5 mg/m^3	1 mg/m^3 if mass flow > 10 g/h	25 g/h or 5 mg/m^3
Nickel and its compounds	2.5 g/h or 0.5 mg/m^3 ([8])	5 mg/m^3 if mass flow > 25 g/h ([8])	5 g/h or 1 mg/m^3([8])
Nitrogen oxides (NO_X)	1.8 kg/h or 0.35 g/m^3	500 mg/m^3 if mass flow > 25 kg/h	5 kg/h or 500 mg/m^3
Nitrous oxide (N_2O)	NT	NT	NT
PCDD/F (dioxins + furans)	0.25 µg I-TEQ/h or 0.1 ng/m^3	NT	20 mg/h or 0.01 mg/m^3([5])
Propylene oxide	2.5 g/h or 1 mg/m^3	2 mg/m^3 if mass flow > 10 g/h	25 g/h or 5 mg/m^3
Sulphur oxides (SO_X)	1.8 kg/h or 0.35 g/m^3	300 mg/m^3 if mass flow > 25 kg/h	5 kg/h or 500 mg/m^3
Tetrachloromethane	100 g/h or 20 mg/m^3	20 mg/m^3 if mass flow > 100 g/h	100 g/h or 20 mg/m^3
Toluene	100 g/h or 20 mg/m^3 ([6])	NT	3000 g/h or 300 mg/m^3
Trichloromethane	100 g/h or 20 mg/m^3	20 mg/m^3 if mass flow > 100 g/h	100 g/h or 20 mg/m^3
TVOC	500 g/h or 50 mg/m^3	110 mg/m^3 if mass flow > 2 kg/h ([7])	NT
Vinyl chloride monomer (VCM)	2.5 g/h or 1 mg/m^3	5 g/h	25 g/h or 5 mg/m^3

([1]) 1.5 g/h in draft new TA Luft.

([2]) Expressed as HCl.

([3]) A higher ELV applies for mass flows below this threshold.

([4]) TA Luft gives 100 mg/h, but the value was lowered via a recommendation of the German Länder. 12.5 g/h is also the mass flow threshold in the draft new TA Luft.

([5]) Toxicity equivalents not specified.

([6]) Due to its classification as toxic to reproduction.

([7]) Refers to NMVOC, expressed as total carbon. Lower ELV for thermal oxidisers

([8]) Lower threshold values apply for carcinogenic Ni compounds.

NB: NI = no information available; NT = no threshold.

Source: DE: TA Luft; DK: Guidelines for Air Emission Regulation; FR: Arreté du 02/02/98; IT: Allegati al Decreto legislativo 3 aprile 2006, n. 152.