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Strategy to review the chemical BREFs

1 Purpose of this paper

In the overall context of the review of the BREF documents and based on the discussions carried out at the 17th, 18th and 19th Information Exchange Forum (IEF) meetings, the purpose of this paper is to present the strategy adopted by the IEF in order to review the chemical BREFs.

2 Introduction

The current set of eight chemical BREFs is composed of:

- **one** '**horizontal**' BREF:
  - Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW) – Adopted in 2003
- **four** '**vertical**' BREFs to cover the **inorganic** chemistry sector:
  - Chlor-alkali Manufacturing Industry (CAK) – adopted in 2001
  - Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers (LVIC-AAF) – finalised in 2006
  - Large Volume Inorganic Chemicals – Solid & Others (LVIC-S) – finalised in 2006
  - Speciality Inorganic Chemicals (SIC) – finalised in 2006.
- **three** '**vertical**' BREFs to cover the **organic** chemistry sector:
  - Large Volume Organic Chemicals (LVOC) – adopted in 2003
  - Organic Fine Chemicals (OFC) – adopted in 2006
  - Polymers (POL) – finalised in 2006.

3 Coverage of Annex I (Section 4) by the current series of chemical BREFs

A preliminary analysis of the current set of chemical BREFs has been carried out on the following two aspects: possible gaps in terms of scope and in terms of technical issues addressed.

<u>List of chemical substances/processes to be considered for the review of the chemicals BREFs</u>

About 40 substances/processes or groups of substances/processes (not specifically addressed in the current BREFs) have been identified by the IEF to be considered for the review of the chemical BREFs. These substances have been assigned priorities by the IEF according to the indications set up in Appendix 1.

This list of substances/processes can be found in Appendix 2.

With regard to industrial gases (some are cited in Annex I to the IPPC Directive), the most important ones are not produced by chemical processes (e.g. nitrogen, oxygen, argon). The production of hydrogen is addressed in the Mineral Oil and Gas Refineries BREF and in the LVIC-AAF BREF. The production of chlorine is addressed in the CAK BREF.

Therefore, the IEF does not currently see the need to address industrial gases in a new separate BREF and is of the opinion that the issues related to the production of H_2 and CO are scrutinised to a greater extent during the review process of the LVIC-AAF (see also Appendix 2).

<u>Issues to be considered for further analysis</u>

It was also noted that a number of important issues/subjects were not consistently addressed within the chemical BREFs or were only partially addressed. These issues are:

- decommissioning of installations (which has a particular importance in the CAK BREF for mercury-cell plants)
- energy and energy efficiency (a reference document is currently under development)
- monitoring (a reference document exists)
- water saving measures
- efficient use of raw materials
- collection, use and treatment of rainwater
- waste prevention
- accident prevention (noting that the purpose is not to duplicate work performed under other EU legislation – e.g. SEVESO or under other initiatives).

It is therefore suggested that for the review of the 'vertical' chemical BREFs and in the context of the determination of the Wish List by the TWG for each of the BREFs, the issues mentioned above should be specifically assessed to decide whether and how the relevant BREFs can be improved.

Furthermore, a way to improve the chemical BREFs should be explored in the context of the review and the ways the outcome of the risks reduction strategies adopted in the context of Regulation 793/93/EC on existing substances can be used as well as the future risk management measures foreseen under the REACH proposal (still to be adopted).

4 Relationship between the Common Waste Water and Waste Gas BREF (CWW) and the 'vertical' chemical BREFs

The CWW BREF was one of the first chemical BREFs to have been developed. Its scope covers the whole chemical industry sector. Because of this and due to its focus on 'common' abatement systems, it has been widely used in the development of, and is referenced in, a number of other chemical BREFs. The CWW BREF is also referenced in a number of non-chemical BREF documents. It is an important BREF as its scope covers substances or groups of substances which are not covered specifically in the 'vertical' chemical BREFs. In addition, a review of the CWW BREF would enable BAT conclusions to be updated based on the experience gained from the other BREFs.

The CWW BREF will be the first chemical BREF to be reviewed. The review will be based on:

i. **a comparative analysis of the existing chemical BREFs carried out by the European IPPC Bureau in the first half of 2007**

ii. **the recommendations for future work indicated in the actual document**

iii. **the possible generic aspects from all the 'vertical' chemical BREFs that could be better addressed in the CWW BREF.**

The TWG of each 'vertical' chemical BREF will assess the generic conclusions in the CWW BREF and decide if they should be made more specific in the 'vertical' chemical BREFs.

It is recommended that the review of the CWW BREF should give greater consideration to water saving measures.

The CWW BREF includes 'horizontal BAT' which are defined in the document as:

- the methodology to prevent waste water/waste gas discharge, identify the need for, and carry out, emissions improvement and find the best option for waste water/waste gas collection and treatment (effluent management)

- the identification of the best and most suitable [in the sense of Art. 2(11)] treatment technologies.

Because the ‘vertical’ BREFs intended to minimise the duplication of information with other reference documents (in particular the CWW BREF), they generally do not repeat ‘horizontal BAT’. Avoiding repetition leads to smaller BREF documents, and this is strongly advocated by end-users.

In addition, the ‘vertical’ chemical BREFs cannot cover all production processes, therefore the CWW BREF constitutes the ‘default’ BREF in case none of the ‘vertical’ chemical BREF is considered appropriate. The CWW BREF will retain the ‘horizontal BAT’.

Special attention should also be drawn to the consistency of the terms used in the series of chemical BREFs. The first document that will be reviewed will set a precedent in this respect and therefore consideration should be given to very careful use and definition of terms. This would enhance clarity and consistency in the series of chemical BREF documents.

Similarly, the review of the series of chemical BREFs should provide the opportunity to complete, when necessary, the BAT chapters as well as the chapters on consumption and emission levels with averaging times (i.e. the time over which a monitoring result is taken as representative of the average load or concentration of the emission. This may be for example hourly, daily, yearly, etc.) and reference conditions (e.g. in gases it is usual to give concentrations expressed as mass per normal cubic metre, where “normal” means at a standard temperature, pressure, water content – dry/humid – and a reference oxygen concentration).

5 Order and timing for the review of the current set of chemical BREFs

The series of chemical BREFs is currently considered adequate to cover the chemical industry sector for the purpose of the IPPC Directive so it is not proposed to modify the current structure of the eight chemical BREFs.

Several criteria <u>*(in line with those agreed at the 17th IEF meeting and reflected in the "Generic schedule for the review of BREFs" and the revised "IPPC BREF Outline and Guide")*</u> have been used in combination to propose an order for the review of the chemical BREFs including:

1. the time when the BREF was finalised

2. the substances/processes and issues not covered in the first series of chemical BREFs which have a relevant environmental impact (see in particular Appendix 2 to this paper)

3. new and important developments in techniques or processes.

It should also be stressed, as agreed at previous IEF meetings, that the objective of the review of a BREF is not to rewrite the whole BREF but to review new information (for instance regarding new techniques or processes to be covered in the BREF) which can have an impact on BAT conclusions. The review should also enable the correction of errors and possible incoherence with other BREFs.

Considering these criteria, the IEF decided to **review the current set of chemical BREFs in the following order** (an approximate timing for starting the revision is indicated. The timing of the reviews could vary to lessen the burden, to take into account the finalisation of the first round of BREFs as well as to accommodate the review programme of the non-chemical BREFs:

<u>BREFs starting review in 2007:</u>

- **CWW (towards the end of 2007).**

<u>BREFs starting review in 2008:</u>

- **LVOC with a possible focus on covering the main 'gaps' and improving the generic BAT conclusions.**

- **CAK with a focus on decommissioning of mercury-cell plants.**

<u>BREFs considered as second priority (starting review in 2009 – 2011):</u>

- **LVIC-S by including the chemical substances 'left-out' of the current BREF and by developing additional generic BAT conclusions.**

- **SIC by including the chemical substances 'left-out' of the current BREF.**

- **LVIC-AAF (with a focus on nitric acid plants).**

<u>BREFs considered as third priority (starting review in 2011 – 2013):</u>

- **OFC.**

- **POL.**

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Appendix 1

Purpose of the list of chemicals to be considered for the review of the chemicals BREFs

The purpose of this list is for the IEF to provide strong guidance to the TWGs of the relevant chemical BREFs and to ensure that the key substances/processes currently missing in the first series of BREFs are properly dealt with during the review process. Substances considered as priorities for the review process should be addressed in the BAT information exchange. If difficulties arise regarding these substances, the Bureau will report to the IEF as soon as possible.

In view of the lack of data in certain cases, this exercise does not therefore aim at being exhaustive and should not replace the forthcoming technical discussions in the relevant TWG. In addition, final decisions to draw up BAT conclusions on the substances targeted will depend on the data provided during the information exchange.

How the list of chemicals in Appendix 2 was developed

About 40 substances/processes or groups of substances/processes (not specifically addressed in the current chemical BREFs) were identified in a preliminary analysis and ought to be considered for the review of the chemical BREFs. This indicative list of substances/processes can be found in Appendix 2. This list provides an indication of potential substances/processes to be addressed during the review of the 'vertical' chemical BREFs.

This list was developped based on:

- the information contained in the concluding remarks of the chemical BREFs (some of these substances/processes have already been identified by the TWGs during the development of the existing 'vertical' chemical BREFs as candidates for review). If this is the case, it is indicated in Appendix 2 in the column 'Suggested in Concluding Remarks'

- the examples of chemicals mentioned in Annex I to the IPPC Directive

- expert judgment of the European IPPC Bureau taking into account (when available) information on production volume, number of producers and installations in Europe, environmental impacts and unit processes/operations not covered by the existing series of chemical BREFs

- the views expressed by IEF members.

<u>Meaning and purpose of the term 'priority/importance' in the list</u>

Substances/processes marked as **priority/importance '1'** are meant to give a strong signal to TWGs: the IEF members consider that these particular substances/processes **<u>have to</u> be included in the first review of the chemical BREFs**. Priority/importance '1' is generally set for a substance/process that:

1) is mentioned in the concluding remarks of any of the chemical BREFs and/or

2) had partial information submitted (e.g. but not enough to conclude on BAT) during the first round of BREFs and/or

3) is considered to be of high importance taking into account the available information on production volume, number of producers and installations in Europe, environmental impact and unit processes/operations not covered by the existing series of chemical BREFs.

Substances/processes with a **priority/importance '2'** should **be considered by the relevant TWG for inclusion** in the first review of the chemical BREFs. Priority/importance '2' is generally set for substances/processes for which the IEF lacks information at this stage on the level of production and the environmental issues or for which it is not clear whether the number of sites will be sufficient to conduct a meaningful exchange of information.

Substances marked as **priority/importance '3' are not considered in principle as a priority** for the review of the chemicals BREFs. These substances might therefore not be included in the first review of the chemical BREFs. However, the relevant TWG could decide to include it in the review of the BREF concerned if new information is provided.

Appendix 2

Chemical substances/processes to be considered for the review of the chemical BREFs

Substances/ processes	Suggested in Concluding Remarks	Prod. in EU (kt/year)	Number of producers in EU	Number of sites in EU	Main environmental issues	Proposed priority/ importance 1 = high 2 = medium 3 = low	Could be included in BREF	Remarks
HCN	yes in SIC	500		6 in DE	Air: CO, NO_X Water: NH_3 deriv., CN^-	1	LVIC-AAF	Used as raw material, e.g. in the production of speciality cyanides (NaCN and KCN). HCN is mainly obtained by the reaction of ammonia with carbon monoxide (Andrussow process) or with natural gas (methane) in the presence of rhodium/platinum catalyst (BMA or Degussa process). It can be prepared also by the reaction of cyanide salts, e.g. calcium cyanide, with a strong acid (sulphuric acid). Smaller volumes of hydrogen cyanide are obtained as a by-product from the acrylonitrile process. As the latter is an organic process, a cross-reference from the LVOC BREF to the LVIC-AAF BREF should be made. Also, the strong up- and downstream linkage of HCN with LVIC (NH_3 as a raw material) and SIC (KCN and NaCN) should be pointed out. Germany is a potential provider of information (an UBA report was published in 2003).
Purification of non-fertiliser grade wet phosphoric acid	no					2	LVIC-AAF	Non-fertiliser grade wet phosphoric acid is used in the production of inorganic phosphates but, most typically, it is produced at the site of the phosphoric acid facility. It is no longer produced in the UK. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.

Substances/ processes	**Suggested in Concluding Remarks**	**Prod. in EU (kt/year)**	**Number of producers in EU**	**Number of sites in EU**	**Main environmental issues**	**Proposed priority/ importance** 1 = high 2 = medium 3 = low	**Could be included in BREF**	**Remarks**
Sulphur dioxide (SO_2)	no				Air: SOx	2	LVIC-AAF	Sulphur dioxide is produced industrially in greater quantities than any other single sulphur compound. It is generated at the first stage in the manufacture of virtually all the sulphuric acid used by industry. Most liquid SO_2 is made in association with sulphuric acid plants and SO_X vents pass to the H_2SO_4 plant so there are few separate emission points. If included in the LVIC-AAF BREF, it should be together with the H_2SO_4 section. Two types of production process: (1) absorption from weak SO_2 streams, desorption as 100%, then liquefaction; or (2) from sulphur and SO_3/oleum as 100% gas then liquefaction (as at IneosChlor). Licensing/confidentiality arrangements may make a detailed information exchange difficult. Cefic is a potential provider of information. Sulphur dioxide is also produced in pulp and paper plants, especially at pulp mills in which sulphite technology is used.
Synthesis gas (CO and H_2)	no					2	LVIC-AAF	Synthesis gas (CO and H_2) should be considered in the review of the chemical BREFs not only because of the context to the production of ammonia (partial oxidation), but also because a significant number of new installations can be expected in the near future (e.g. because of CO_2 capture and storage - CCS -, integrated gasification combined cycle - IGCC - power production or biomass to liquid processes).
Aluminium chloride ($AlCl_3$)	no	545	1 in PT (PAC)	20	Air: HCl Water: HCl, $CaSO_4$ Waste: $Al(OH)_3$, gypsum	1	LVIC-S	Aluminium chloride also covers the production of different types of poly aluminium chlorides (PAC) Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.

Substances/ processes	Suggested in Concluding Remarks	Prod. in EU (kt/year)	Number of producers in EU	Number of sites in EU	Main environmental issues	Proposed priority/ importance 1 = high 2 = medium 3 = low	Could be included in BREF	Remarks
Aluminium sulphate ($Al_2(SO_4)_3$)	no	1200	1 in PT	65	Energy and water consumption Air: H_2SO_4, dust, Al, CO_2 Waste: filter cake	1	LVIC-S	Aluminium sulphate is probably the best candidate for the revision of the LVIC-S BREF, not only because of the industrial importance of this inorganic chemical but also because of the production volume in Europe and the number of plants operated. Its production has, probably, a similar environmental impact to $AlCl_3$, lower specific emissions but higher production output. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.
Chromium compounds	no			1 in UK	Soil and ground water: chromium salts, in particular Cr(VI) Waste: Cr mud, Na_2SO_4	1	LVIC-S	There is only one known producer of Cr(VI) – sodium/potassium dichromate, chromic acid – in the EU, i.e. Elementis on the Teesside site (UK). No information was provided for this product during the exchange of information for the LVIC-S BREF. Elementis in Germany and other installations in Europe manufacture Cr(III) compounds, mainly from Cr(VI). These may be providers of information in the future. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.

Substances/ processes	Suggested in Concluding Remarks	Prod. in EU (kt/year)	Number of producers in EU	Number of sites in EU	Main environmental issues	Proposed priority/ importance 1 = high 2 = medium 3 = low	Could be included in BREF	Remarks
Ferric chloride ($FeCl_3$)	no	1300		30	Air: CO_2, H, HCl Water: Fe, Zn, heavy metals Waste: solid waste	1	LVIC-S	Ferrous chloride (II) is already included in the LVIC-S BREF. However, ferric chloride (III), $FeCl_3$, which is industrially much more important was not included due to late submission of information. Also, note that the production of ferric chloride is related to the production of steel and is, to a broad extent, covered in the BREF on Ferrous Metals Processing Industry (FMP). A difficulty relates to the wide variety of raw materials used for producing ferric chloride. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.
Potassium carbonate (K_2CO_3)	no				Air: handling of solid materials Water: water emissions are generated from the water evaporated during the crystallisation step Waste: negligible	2	LVIC-S	Potassium carbonate (K_2CO_3, also called pearl ash or potash) is the major representative of the potassium family. Potassium carbonate finds its major application in the speciality glass industry, e.g. in television screens where it performs better than glass made with soda ash. It was not included in the LVIC-S BREF as no information was provided by the TWG. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.

Substances/ processes	Suggested in Concluding Remarks	Prod. in EU (kt/year)	Number of producers in EU	Number of sites in EU	Main environmental issues	Proposed priority/ importance 1 = high 2 = medium 3 = low	Could be included in BREF	Remarks
Potassium chlorate ($KClO_3$)	no					2	LVIC-S	It was not included in the LVIC-S BREF as no information was provided by the TWG. However, as there are clear similarities in processes and techniques used in the production of sodium and potassium chlorate (typically, both $NaClO_3$ and $KClO_3$ are produced in the same convertible plant), the sodium chlorate process (covered in the LVIC-S BREF), based on the electrolysis of sodium chloride brine, can be taken as illustrative for the production of $KClO_3$ based on the electrolysis of potassium chloride brine. There seems to be a limited number of plants in Europe.
Potassium sulphate (K_2SO_4)	no					2	LVIC-S	Suggested by Austria in the discussions on the strategy to review the chemical BREFs. Potassium sulphate occurs naturally as shoenite and in lake brines from which it is separated by fractional crystallisation. It may also be produced by the Hargreaves process ($2KCl + H_2SO_4 = K_2SO_4 + 2HCl$), either in the inorganic chemical industry or in the fertiliser industry sector, where it is used as the source of potassium (K^+) for chloride-sensitive plants, such as tobacco and citrus.

Substances/ processes	Suggested in Concluding Remarks	Prod. in EU (kt/year)	Number of producers in EU	Number of sites in EU	Main environmental issues	Proposed priority/ importance 1 = high 2 = medium 3 = low	Could be included in BREF	Remarks
Sodium sulphate (Na_2SO_4)	no	2100		41		2	LVIC-S	All the reported environmental issues are mainly related to the upstream industries (by-products) of sodium sulphate production. In the UK, there is no production from salt and sulphuric acid at the moment. However, there are upstream industries, i.e. by-products from other inorganic and organic processes. The only known inorganic processes are the Mannheim furnace and the manufacture of chromium compounds (see above). Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.
Hydroxylamine (NH_2OH)	no					2	LVIC-S	Hydroxylamine is an inorganic product manufactured via an inorganic process. Industrial production of hydroxylamine is carried out by reduction of the higher oxidation states of nitrogen. For example, nitric oxide or nitric acid can be hydrogenated catalytically to hydroxylamine. World production is around 800 kt/year. Hydroxylamine and its salts are commonly used as reducing agents in a myriad of organic and inorganic reactions. However, it is mainly used for the production of caprolactam.
Ammonium chloride (NH_4Cl)	no					3	LVIC-S	Ammonium chloride is strongly relevant to the production of soda ash and in particular, in Asia, ammonium chloride plants are included in soda ash complexes. Other production routes also exist, e.g. often produced as a by-product in the production of other chemicals. Initially considered for the LVIC-S BREF but finally not pursued as Cefic indicated that the production scale in Europe was negligible and of no industrial importance.

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Acrylic Acid (AA) - esters	no	810 (capacity) 214 in DE	6		Releases into the environment are to be expected during production and processing, mainly via waste water and lesser amounts via exhaust gases. Further releases are to be expected through residual monomeric AA-esters contents in the final products.	2	LVOC	Acrylic acid is produced from propylene, a gaseous product of oil refineries. It undergoes the typical reactions of a carboxylic acid and, when reacted with an alcohol, it will form the corresponding ester. Acrylic acid and its esters readily combine with themselves or other monomers (e.g. amides, acrylonitrile, vinyl, styrene and butadiene) forming polyacrylic acid – esters, which are used in the manufacture of various plastics, coatings, adhesives, elastomers as well as floor polishes and paints. Acrylic acid can be considered as readily biodegradable. There is an EU Risk Assessment Report for Acrylic Acid (EUR 19836 EN)
Adipic acid ($C_6H_{10}O_4$)	yes	1000	5	6	Air: N_2O	1	LVOC	Adipic acid, also called hexanedioic acid, is the most commercially important aliphatic dicarboxylic acid. It is manufactured worldwide on a large scale. Its primary application is in the production of nylon 66 polyamide. Currently, however, all large-scale production is via nitric acid oxidation of cyclohexanol [108-93-0], cyclohexanone [108-94-1], or a mixture of the two [ketone – alcohol (KA) oil]. There are several CDM projects on reducing N_2O emissions from adipic acid production, therefore, a lot of performance data will be available (cdm.unfccc.int).

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Bisphenol A (BPA)	no	700 (630 in DE)	4	6 (based in DE, NL, BE and ES)	Although the vast majority of BPA is converted into products at manufacturing sites, low level releases of BPA to the environment are possible (e.g. BPA may be released to the environment in the waste water)	2	LVOC	Bisphenol A (BPA) is produced using an acid catalysed condensation reaction of phenol with acetone. It is used in the production of epoxy resins (about 40% of BPA are converted to epoxy resins) and polycarbonate plastics. BPA is less toxic than phenol and can even be used in foods and cosmetics according to Ullmann's encyclopedia. However, according to the EU Risk Assessment Report for Bisphenol A (EUR 20843 EN), there are uncertainties surrounding the potential for bisphenol A to produce adverse effects at low doses.
Ethanolamines	no	350	5	8	Air: NH_3, VOC Water: NH_3 and soluble amines Waste: spent catalysts	1	LVOC	Ethanolamines (EA) are substances under the umbrella of Cefic; but ethyl amine is not (they are under the umbrella of the European Industrial Gases Association). There are three types of EA produced at the same time and distilled afterwards: mono EA, di EA and tri EA. Mono EA is used as a raw material to produce ethylenamines and also to produce detergents, metal working fluids and as gas sweetening. Di EA is mainly used as gas sweetening and in agrochemicals. Tri EA is used in detergents, cosmetic applications and cement additives. CEFIC is a potential provider of information.

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Ethylbenzene (EB)	yes	6000	12	17	Air: CO, NO_X,VOC Water: benzene Waste: spent catalysts	1	LVOC	Produced mainly by the alkylation of benzene with ethylene. Almost exclusively used as the raw material for styrene production (ethylbenzene and styrene are produced in the same plants in the EU). Some EB may be produced as by-product on other benzene alkylation plants, e.g. for toluene, xylene and cumene. EB could be included in the styrene section of LVOC. CEFIC is a potential provider of information.
Methanol and its derivatives	no	2800	6	5	Air: NO_X Water: inorganic chloride compounds	1	LVOC	By far, the largest use of methanol is in producing other chemicals. About 40% of methanol is converted to formaldehyde, and from there into products as diverse as plastics, plywood, paints, explosives, and permanent press textiles. Methanol is mainly synthesised by the oxidation of methane with oxygen and a suitable catalyst. It can also be synthesised by carbon dioxide recycling with hydrogen or water in an electrochemical process. The latter process has much in common with ammonia synthesis and other steam reforming processes. There may be an argument for pulling together all the H_2- and CO-producing processes by steam reforming of methane/hydrocarbons that are currently covered in both LVIC-AAF and Refineries BREFs. CEFIC is a potential provider of information.
Phenol	yes	2300	7	9	Air: VOC, NO_X, SO_2 Water: phenol	1	LVOC	Phenol can be made from the partial oxidation of benzene or benzoic acid, by the Cumene process, or by the Raschig process. It can also be found as a product of coal oxidation. CEFIC is a potential provider of information.
Propylene oxide	yes	2400	7	10	Air: isobutane, fugitives Water: AOX, TOC	1	LVOC	There are three processes available and the market is dominated by two players. Hence, there may be potential issues of confidentiality and cooperation.

Substances/ processes	Suggested in Concluding Remarks	Prod. in EU (kt/year)	Number of producers in EU	Number of sites in EU	Main environmental issues	Proposed priority/ importance 1 = high 2 = medium 3 = low	Could be included in BREF	Remarks
Styrene	yes	5500	12	17	Air: H_2, benzene, EB Water: TOC Waste: residues from distillation	1	LVOC	Styrene is most commonly produced by the catalytic dehydrogenation of ethylbenzene (EB). Styrene and EB are produced in the same plants in the EU. CEFIC is a potential provider of information.
Chlorodifluoromethane HCFC 22 or R22	no	140	7	10	Air: R23	1	LVOC	Despite the requirements to phase out HCFC in most of applications by 2030 (as a result of the 1987 Montreal Protocol), HCFC 22 or R22 production might remain for certain uses, in particular feedstock. R22 is a raw material for the production of the polymer politetrafluoroethylene, PTFE or Teflon. Production of Teflon could also be dealt with in the same BREF (OFC). R22 is still important in the EU and is increasing in developing countries. Production of R22 can lead to emissions of R23 which has a high global warming potential. Cefic is a potential provider of information (an industry document is under development). There are several CDM projects being carried out on HCFC abatement, therefore a lot of performance data should be available (cdm.unfccc.int). DE thinks that a general survey of fluoro-organic compounds is necessary, because in many cases these compounds are persistent. Sweden has suggested that the production of carbon tetrachloride (R10), an organic halogen compound, should be covered alongside with the production of R22 (see below)

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Carbon tetrachloride or R10	no	285 (1990) 18.5 (2005 – excluding prod. for feedstock uses)			Air: Carbon tetrachloride is an ozone-depleting greenhouse gas. Water: It is neither persistent in water, nor bioaccumulable	2	LVOC	Carbon tetrachloride is produced by the chlorination of carbon disulphide and it is also a by-product in the synthesis of dichloromethane and chloroform. Under the Montreal Protocol, a phase-out was scheduled with the exception of some essential and feedstock uses. In the EU, use was phased out by end of 1994 except for small authorised quantities (EU Regulation 3093/94). Feedstock, process agent and essential uses of carbon tetrachloride are still allowed. Feedstock uses include production of CFC 11 and 12, which are, in turn, used as intermediates for other chemicals. Process agent uses of carbon tetrachloride include extraction of nitrogen trichloride from liquid chlorine, recovery of chlorine from tail gas, chlorinated rubber manufacture and pharmaceutical processing.
Glyoxylic acid	no					2	LVOC	Glyoxylic acid is an important building block for the production of acids, esters, aldehydes and heterocycles. A short process description is provided in the LVOC BREF. An Austrian UBA document exists. There is no production reported in Germany.
Hydrogen peroxide[1] (H_2O_2)	no	1200	7 (1 in PT)	23	Air: VOC Water: TOC Waste: where appl., reversion agent	2	LVOC	Hydrogen peroxide is an inorganic product manufactured using an organic process: the antraquinone process. There is an H_2O_2 industry document (mini-BREF) in preparation (will be sent to the EIPPCB when completed). Cefic is a potential provider of information.
Melamine	no	270				2	LVOC	Melamine is a trimer (polymer) of cyanamide, and is synthesised based on urea. It condenses with formaldehyde to give a thermosetting resin. A process description is given in the LVOC BREF. CEFIC is a potential provider of information.

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Methyl ester biodiesel	no				Disposal of the by-product glycerol, and indirect environmental impacts from source/type of vegetable oil, and from methanol production can be significant factors	2	LVOC	Biodiesel is mainly produced from oil crops, such as rapeseed and sunflower. The extracted oils are converted by transesterification to produce methyl ester biodiesel. Current volumes and numbers of producers are not known but they are significant. Production is increasing all the time (unlike the majority of other chemicals), with installations being built across the whole size spectrum from 250 to 250000 t/yr and, unlike most chemical plants, methyl ester plants are brand new or only a few years old. The raw materials and products are similar for all plants but the detailed processes and techniques vary considerably.
Surfactants	no	2800	30 (2 in PT)			2	LVOC	Among this sector, a selection to be made of the best illustrative case, consequently the volume will drop. Potentially covers a number of large plants producing different types of surfactants. Cefic is a potential provider of information.
Production of ion exchange resins, e.g. from amination, chloromethylation					Bis-chloromethyl ether formation	2	OFC	Suggested by Austria in the discussions on the strategy to review the chemical BREFs. Ion exchange resins are made from cross linked polystyrene with some functional groups added to achieve an activated surface. As there is only a small volume of highly specialised products, this is to be tackled in the OFC BREF. Germany reports a consumption of 58000 t in 2004.

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Epoxy resins	no	257 in DE				2	POL	Epoxy resins are pre-polymers that contain, on average, two or more epoxide groups per molecule. They are mainly used in paints, coatings and adhesives. In the production of the resin, a rather low molecular weight resin is produced. The main part of the polymerisation happens at the costumer's or the processor's site. There are many variants of epoxy esters produced and the majority are manufactured in batch processes. The production in Germany was 257000 t in 2004. Plastics Europe is a potential provider of information.
Inorganic salts of nickel and copper	yes	70	7		Air: As, Cu, dust, NO_x, Ni, Pb, Sb Water: As, Cu, Ni, Pb, Sb, Zn Wastes: mud from the WWTP, wet residues (iron cake)	1	SIC	Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.
Activated carbon[2]	no	120	8		Water: COD, TSS	2	SIC	Regeneration of activated carbon is addressed in the Waste Treatments BREF. However, its manufacture using calcinations of carbonaceous materials is not included. The manufacture of (commodity) activated carbon may have relevance in Europe; it is mainly produced in Asia and the US. In Europe, the production of special activated carbon types (e.g. impregnated or post-treated) which can be carried out by chemical processes could be of greater relevance. Cefic is a potential provider of information.

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Potassium chloride (KCl)	yes in LVIC-S					2	SIC	Potassium chloride occurs naturally as sylvite, and it can be extracted from sylvinite. It is also extracted from salt water and can be manufactured by crystallisation from solution, flotation or electrostatic separation from suitable minerals. It is often manufactured as a by-product in the production of other chemicals (e.g. it is a by-product from the manufacture of nitric acid from potassium nitrate and hydrochloric acid). Initially considered in LVIC-S but finally not pursued.
Sodium sulphide (Na_2S)	no					2	SIC	Initially considered for the LVIC-S BREF but finally not pursued. As sodium sulphide (Na_2S) is often produced as a by-product in the manufacture of other chemicals, it is proposed to be included in the BREFs where those are covered. For example, Na_2S should belong to the SIC BREF or to a BREF where, for instance, H_2S is reacted with NaOH (sodium sulphide can be produced in many industrial sectors where there is a need for the utilisation of H_2S).
Sulphur dichloride (SCl_2)	no				Air: SCl_2 hydrolyses with release of HCl	2	SIC	It is produced by the chlorination of either elemental sulphur or disulphur dichloride.
Zinc chloride ($ZnCl_2$)	no				Air: dust	2	SIC	Anhydrous $ZnCl_2$ can be prepared from zinc and hydrogen chloride. Hydrated forms and aqueous solutions may be readily prepared using concentrated hydrochloric acid and pieces of Zn. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm

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Zinc sulphate ($ZnSO_4$)	no		4	4	Energy consumption Air: dust, CO_2 Waste: sludge	2	SIC	Zinc sulphate occurs naturally as the mineral goslarite, and can be prepared by reacting zinc with sulphuric acid. It is used to supply zinc in animal feeds, fertilisers, and agricultural sprays; in making lithopone; in coagulation baths for rayon; in electrolyte for zinc plating; as a mordant in dyeing; as a preservative for skins and leather; and in medicine as an astringent and emitic. There may not be enough producers in the EU to make information available for commercial reasons. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.

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Silicon	no		4		Air: Cl compounds, dust Wastes: from the slicing, grinding, and polishing operations. Used packaging is a problem in general, and not a lot of recycling is being done at the moment. For polycrystalline: Disposal of silicon tetrachloride, which is usually disposed of by production of fumed silica and sold as a by-product. For single crystal silicon: NO_x and some spent acids and caustics which need to be neutralised and disposed of.	2	SIC	The production of silicones is addressed in the SIC BREF. The production of silicon metal is addressed in the Non Ferrous Metal Industry BREF. High purity silicon can be produced by conversion of silicon to silanes (being organochlorine derivatives of silicon as used in the production of silicones) and then distilled and treated by pyrodecomposition to produce elemental silicon. An organic process is also reported to be used and could be described in the OFC BREF if necessary. High purity (ultra-pure) silicon is of growing importance for the semiconductor industry. There are at least four companies producing high purity silicon in Europe, some with more than one manufacturing site: Siltronic AG – Germany Okmetic – Finland MEMC – Italy Topsil – Denmark An UBA Report (2003) is available.

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Fluorine (F_2)	no	<17	5	5 of which 2 are nuclear install.	Air: F_2 (may not be significant), HF Water: hydrofluoric acid	3	SIC	The only method for the production of fluorine, both in the laboratory and in industry, is the electrolysis of anhydrous hydrogen fluoride containing dissolved potassium fluoride to achieve sufficient conductivity. Fluorine is mainly used for UF_6 and SF_6 production. There are only a few producers in Europe (Solvay produces F_2 and they think they are the only producer with two other reprocessing producers – from UF_6). The few European producers manufacture mainly for immediate use in UF_6 or SF_6 production and only small amounts are kept as F_2 in cylinders. There is no sector group or association within Cefic.
Other metalloids and non-metals (e.g. B, Ge, Te, Ga, As, Se)	no					3	SIC	According to Eurometaux, there are only a limited number of producers in Europe and thus, limited production. Confidentiality arrangements may make the information exchange difficult.
Silver nitrate ($AgNO_3$)	no					3	SIC	Seems to be in relatively minor production in Europe. Can be produced by dissolving silver in nitric acid. Used in the photographic industry.
Sodium bisulphate ($NaHSO_4$)	no			2	Energy consumption Air: dust, SO_2, NO_X, CO_2 Water: Cl^-, SO_4^{2-}, NO_3^-, NH_4^+, Zn^{2+}	3	SIC	There is small scale production across the EU-25. Additional information is available on the EIPPCB website: http://eippcb.jrc.es/pages/FActivities.htm.
Sulphuryl chloride (SO_2Cl_2)	no					3	SIC	Low priority. No longer produced in the UK.
Thionyl chloride ($SOCl_2$)	no					3	SIC	Liquid compounds produced using processes similar to the phosphorus compounds covered in the SIC BREF. No longer produced in the UK.

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Industrial gases (e.g. H_2, O_2, CO, CO_2, Ar)	no		3 in PT			3	See remarks beside	Some are cited in Annex I to the IPPC Directive. Most industrial gases are not produced by chemical processes (e.g. nitrogen, oxygen, argon). The production of hydrogen (H_2) is addressed in the Mineral Oil and Gas Refineries BREF and indirectly in the LVIC-AAF BREF as it is a raw material for ammonia production. The production of CO_2 is also covered indirectly in the LVIC-AAF BREF as a by-product of ammonia production, which is frequently used in the manufacture of urea. The production of chlorine is addressed in the Chlor-Alkali BREF. According to Germany, synthesis gas (CO and H_2) should be considered in the review of the chemical BREFs not only because of the context to the production of ammonia (partial oxidation), but also because a significant number of new installations can be expected in the near future (e.g. because of CO_2 capture and storage (CCS), integrated gasification combined cycle (IGCC) power production or biomass to liquid processes). EIGA represents the sector at EU level. The European IPPC Bureau does not see currently the need to address the industrial gases in a new separate BREF, but recommends that the issues related to the production of H_2 and CO are scrutinised to a greater extent during the review process of the LVIC-AAF BREF (see p.3 above).

[1] organic synthesis process
[2] produced either by treatment of carbon with gases, or by carbonisation of carbonaceous materials with simultaneous activation by chemical treatment