Category		Title
NFR	1.A.2	Manufacturing industries and construction (combustion)
SNAP	03	Combustion in manufacturing industry
ISIC		
Version	Guidebook 2016	
Update history	November 2016	For details of past updates please refer to the chapter update log available at the online Guidebook website

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Contents

1 Overview

This chapter covers the methods and data needed to estimate emissions associated with fuel combustion in manufacturing industries and construction (Nomenclature for Reporting (NFR) source categories 1.A.2). The sub-sectors cover combustion installations activities in the following source categories:

* 1.A.2.a — Iron and steel
* 1.A.2.b — Non-ferrous metals
* 1.A.2.c — Chemicals
* 1.A.2.d — Pulp, paper and print
* 1.A.2.e — Food processing, beverages and tobacco
* 1.A.2.f — Non metallic minerals
* 1.A.2.g.viii - Others

The activities essentially cover combustion activities in industry. The technologies applied can often be the same or very similar to those applied in source categories 1.A.1 and 1.A.4.

Where combustion activities essentially relate to the use of fuels in conventional boilers, furnace, gas turbine, engine or other combustion devices the user is guided to Chapters 1.A.1 Energy industries and 1.A.4 Small combustion for information on technologies and emissions.

This sub-sector provides guidance on estimating emissions where the combustion process is an integral part of the manufacturing process (for example where fuels are process by-products or where combustion products and the process materials directly mix) and, where combustion products may be modified by the interaction with the production activity.

Guidance on where to find emission guidance for the combustion emissions is provided in Table 1-1.

In many instances release of pollutants can occur due to both the process and combustion activities. Guidance on estimating process emissions is provided within section 2 of this chapter (see section 2, Table 2-1). It is generally not possible to allocate an emission between the process and combustion processes. Furthermore, inclusion of a mechanism which could allocate the emission between the process and combustion activity adds complexity to the inventory, leads to loss of transparency and perhaps double-counting.

The Guidebook adopts a pragmatic approach to apply the most appropriate emission factors consistent with the quality objectives of the emission inventory. Within the tiered estimating methodology (section 3 of the present chapter), at Tier 1, default emission factors are provided in source category1.A.2 to be used with energy-based activity data. However, at the second Tier, default emission factors for activities other than conventional combustion are provided which are intended to be used with production-based activity data.

Due to the complexity of industrial processes, this approach will result in some double-counting of industrial emissions at the lowest Tier due to some overlapping of combustion and process emissions. However, if assessed at the lowest Tier then the sector is considered to be of low importance and this additional uncertainty should be acceptable. In order to minimise the risk of double-counting at the second Tier, relevant pollutant emissions for an activity have generally been allocated to either the combustion (chapter 1.A.2) or process (chapter 2) element of the activity. It is

recognised that this is not a realistic reflection of emission processes but has been adopted as a practical mechanism for accounting for emissions within the NFR reporting structure.

Table 1-1   Summary of activity codes and most appropriate chapter for combustion emissions

NFR code and description	Activity	Primary chapter for guidance on combustion emissions
1.A.2.a Iron & steel	Combustion in boilers, gas turbines and stationary engines	1.A.1.a, 1.A.4.a/c
	Combustion in blast furnace cowpers	1.A.2
	Combustion in sinter and pelletizing plant	1.A.2
	Combustion in reheating furnaces	1.A.2
	Combustion in gray iron foundries	1.A.2
1.A.2.b Non-ferrous metals	Combustion in boilers, gas turbines and stationary engines	1.A.1.a, 1.A.4.a/c
	Combustion in primary and secondary Pb/Zn/Cu production	1.A.2
	Combustion in secondary Al production	1.A.2
	Combustion in alumina, magnesium and nickel production	1.A.2
1.A.2.c Chemicals	Combustion in boilers, gas turbines and stationary engines	1.A.1.a, 1.A.4.a/c
1.A.2.d Pulp, paper and print	Combustion in boilers, gas turbines and stationary engines	1.A.1.a, 1.A.4.a/c
1.A.2.e Food processing, beverages and tobacco	Combustion in boilers, gas turbines and stationary engines	1.A.1.a, 1.A.4.a/c
1.A.2.f Other	Combustion in boilers, gas turbines and stationary engines	1.A.1.a, 1.A.4.a/c
	Combustion in plaster furnaces	1.A.2
	Combustion in other furnaces	1.A.4.a/c
	Combustion in cement, lime, asphalt, glass, mineral wool, bricks and tiles, fine ceramic material	1.A.2
	Combustion in enamel production	1.A.2
	Combustion in other processes with contact	1.A.4.a/c
	Combustion in other mobile machinery/industry	1.A.2.f.ii (Other non-road mobile machinery)

2 Description of sources

2.1   Process description

The combustion activities undertaken in manufacturing industries generally provide process heat (directly or indirectly usually via steam, water or oil), electricity, or the fuel may be transformed in the production activity.

The reader seeking more detail of the activities described is advised to consult the relevant process emission chapter for the Guidebook and Best Available Techniques Reference (BREF) document for the sectors (see Table 2-1) (European Integrated Pollution Prevention and Control Bureau (EIPPCB)).

Table 2-1   Summary of source categories and IPPC guidance documents

NFR Code	Activity	Process chapter	BAT reference document
1.A.2.a	Iron and steel	2.C.1 2.C.2	Iron and steel production Ferrous metal processing
1.A.2.b	Non-ferrous metals	2.C.3, 2.C.5	Non-ferrous metal processes
1.A.2.c	Chemicals	2.B	Large volume organic chemicals Organic fine chemicals Large volume inorganic chemicals — (i) ammonia, acids and fertilisers (ii) solids and others Speciality inorganic chemicals Polymers
1.A.2.d	Pulp, paper and print	2.D.1	Pulp and paper manufacture
1.A.2.e	Food processing, beverages and tobacco	2.D.2	Food, drink and milk processes
1.A.2.f	Other	2.A.1, 2.A.2, 2.A.6 2.G	Cement and lime production Glass manufacture

Additional information is also available in the US Environmental Protection Agency (US EPA) Emission Factor Handbook (US EPA, AP-42). Emissions from industrial combustion installations are significant due to their size and numbers, different type of combustion techniques employed, and range of efficiencies and emissions. In some countries, particularly those with economies in transition, combustion plant and equipment may be outdated, polluting and inefficient.

Figure 2-1   Illustration of the main process in industrial combustion installations.
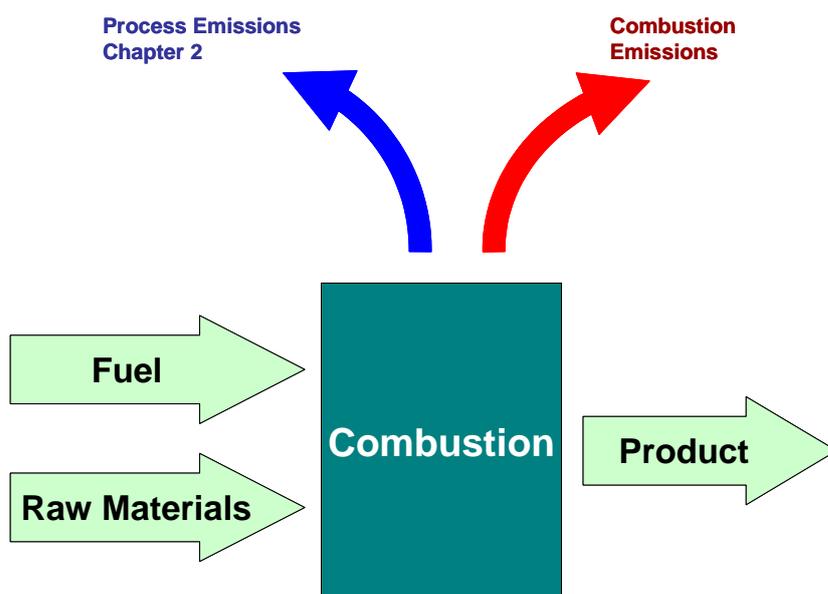
Source: Adapted from Figure 2.4 2006 IPCC Guidelines for Stationary Combustion for National Greenhouse Gas Inventories

2.2   1.A.2.a — Iron and steel

2.2.1   Blast furnace

The blast furnace operates as a countercurrent process. Iron ore sinter and size-graded iron ore, coke and limestone are charged as necessary into the top of the furnace. Preheated air is introduced through a large number of water-cooled nozzles at the bottom of the furnace (tuyeres) and passes through the descending charge. Carbon monoxide is produced, which reacts with the heated charge to form molten high-carbon iron, slag and blast furnace gas. The molten iron and slag are periodically discharged.

2.2.2   Sintering and pelletizing plants

The sintering process is a pretreatment step in the production of iron in which metal ores, coke and other materials are roasted under burners (using gaseous fuels derived from other activities in the iron production). Agglomeration of the fine particles is necessary to increase the passageway for the gases during the blast furnace process. The strength of the particles is also increased by agglomeration.

2.2.3   Reheating furnaces

Reheating furnaces prepare cool iron material for further processing by an appropriate temperature increase. In soaking pits, ingots are heated until the temperature distribution over the cross section of the ingots is acceptable and the surface temperature is uniform for further rolling into semifinished products (blooms, billets and slabs). In slab furnaces, a slab is heated before being rolled into finished products (plates, sheets or strips).

2.2.4 Grey iron foundries

Combustion in foundries includes heating of moulds, castings and the melting furnace.

2.3   1.A.2.b — Non-ferrous metals

2.3.1 Primary metal production

Combustion is relevant to primary production of many metals. Use of coke, carbon monoxide and carbonyl formation are relevant to several production schemes. Apart from primary metal production there are combustion activities used for melting, casting and heat-treatment furnaces.

2.3.2 Secondary metal recovery

Use of melting furnaces for scrap recovery and subsequent purification is typical of many secondary metal recovery activities.

2.4   1.A.2.c — Chemicals

Combustion in the chemicals sector ranges from conventional fuels in boiler plant and recovery of process by-products using thermal oxidisers to process-specific combustion activities (for example catalytic oxidation of ammonia during nitric acid manufacture).

2.5   1.A.2.d — Pulp, paper and print

The production of pulp and paper requires considerable amounts of steam and power. Most pulp and paper mills produce their own steam in one or more industrial boilers or combined heat and power (CHP) units which burn fossil fuels and/or wood residues. Mills that pulp wood with a chemical process (Kraft, sulphite, soda, semi-chemical) normally combust their spent pulping liquor in a combustion unit, for example a Kraft recovery furnace, to recover pulping chemicals for subsequent reuse. These units are also capable of providing process steam and power for mill operations.

2.6   1.A.2.e — Food processing, beverages and tobacco

Food processing can require considerable amounts of heat, steam and power. Many food and beverage processes produce their own steam in one or more industrial boilers which burn fossil fuel and/or biomass. Process residues may often be dried for fuel use or prepared for animal feed.

2.7   1.A.2.f — Non-metallic minerals

2.7.1 Range of activities

The 1.A.2.f category includes a variety of activities in industries not covered in 1.A.2.a–e including:

- combustion in boilers, gas turbines and stationary engines,
- plaster furnaces,
- other furnaces,
- cement, lime, asphalt, glass, mineral wool, bricks and tiles, fine ceramic material,
- enamel production,
- other processes with contact,
- other mobile machinery/industry.

Emissions for mobile machinery are presented elsewhere. In common with other 1.A.2 activities, information on general combustion in boilers, gas turbines and engines can be found in 1.A.1 and 1.A.4. The other activities are described briefly below.

2.7.2 Cement manufacture

Portland cement can be produced either by dry or wet processes (there are also semi-dry and semi-wet processes). In the wet process, the raw material is a chalk which is first slurried with water; this slurry is passed with other constituents into a rotary kiln for calcining and cement clinker formation. In the dry process, limestone is dry-mixed with other constituents, milled and typically passed to a pre-heater tower and/or a precalciner furnace before a rotary kiln. The dry process requires less energy than the wet process. In all processes the clinker is cooled after leaving the kiln, milled and blended with additives to form various grades of cement.

Combustion occurs in the kiln and, where relevant, the pre-calciner furnace. A key feature of modern cement plant operation is that a wide range of wastes are recovered for energy in cement manufacture. The waste fuels cover a wide variety of materials including tyres, recovered liquid fuel, household waste, meat and bone meal, sewage sludge, plastics and paper waste. In addition, greater use is made of waste-derived materials (fly ash and ground blast furnace slag) to blend with cement.

2.7.3 Lime manufacture

Lime is heated in a kiln to decarbonise (calcine). Two major types of kilns are in use: vertical and rotary kilns. The vertical kilns, because of larger size of charge material, lower air velocities, and less agitation emit lower amounts of particles but higher amounts of sulphur dioxide and carbon monoxide.

2.7.4 Asphalt manufacture

Combustion in a roadstone coating plant is mainly associated with drying of aggregates which generally occurs in a rotary dryer. Plants produce asphalt and other road coatings through either batch or continuous aggregate operations. In either operation the aggregate is transported first to a gas- or oil-fired rotary dryer, hot dry aggregate is blended and passed to a mixing chamber where bitumen is added and mixed to produce the hot asphalt mix which then passes to storage bins prior to discharge to delivery lorries.

2.7.5 Glass

Combustion occurs in the melting and subsequent processing of glass. In the melting furnaces, the glass is melted at high temperature; furnaces are generally large, shallow, and well-insulated vessels that are heated from above. In operation, raw materials are introduced continuously on top of a bed of molten glass, where they are heated and start to fuse, melt and dissolve to form a molten glass.

In order to achieve higher energy efficiency and a higher flame temperature, the combustion air is preheated. Glass-melting furnaces can use electric heating or use natural gas and/or oil as a fuel, since the use of hard coal or lignite would import ash contaminants into the glass phase. A number of different product groups are included; flat glass, container glass, domestic glass, special glass and continuous filament glass fibre (CFGF). Flat and container glass are the main product groups.

2.7.6 Mineral wool

In the manufacture of mineral wool, glass and stone wool fibres are made from molten glass, and a chemical binder is simultaneously sprayed on the fibres as they are created. Two methods of creating fibres are used by the industry. In the rotary spin process, centrifugal force causes molten glass to flow through small holes in the wall of a rapidly rotating cylinder to create fibres that are broken into pieces by an air stream. This is the newer of the two processes and dominates the industry today.

2.7.7 Bricks, tiles and ceramics

Brick and tiles manufacture

Formed clay is dried and then fired at high temperature in a kiln; the drying process can be in a separate oven but is often part of the firing kiln.

Ceramic manufacture

Various combustion processes are undertaken in ceramic manufacture. Clay is heated to calcine it; there are drying activities, heat treatment and the firing process.

2.7.8 Enamel manufacture

Enamel is prepared by fusing a variety of minerals in a furnace and then rapidly quenching the molten material. The constituents vary depending on the intended use. The components are measured and mixed before passing to a melting furnace. The cast frit is broken by quenching with water and, if required, is then dried in an oven.

2.8 1.A.2.g.viii — Other

This source category should be used to report other sources of emissions not included in the preceding source categories.

2.9 Techniques

2.9.1 Conventional combustion

Combustion plant > 50 MW$_{th}$

Please refer to chapter 1.A.1 (NFR 1.A.1.a) and the Best Available Techniques Reference (BREF) note on Large Combustion Plant for detailed information on boilers, furnaces, stationary engines and gas turbines.

Combustion plant < 50 MW$_{th}$

Please refer to chapter 1.A.4 (NFR 1.A.4.a/c) for detailed information on boilers, furnaces, stationary engines and gas turbines.

2.9.2 Other combustion processes

Several combustion activities involve the mixing of combustion products and/or the fuel with the product or raw materials. This can modify the emissions from combustion, for example adding or removing particulate matter (PM), SO_2, non-methane volatile organic compounds (NMVOC). The

potential for modification of the emissions is important if trying to separate combustion and process emissions.

A number of processes can be involved:

- attrition/suspension of PM (and PM fractions) from contact between combustion gases and a solid phase product;
- evolution of NMVOC from heating of material;
- absorption or desorption of acid gases;
- combustion of raw materials or product;
- gasification or pyrolysis of fuel and other raw products;
- modification of pollutant evolution due to atypical conditions compared to normal combustion activities (higher temperature, reducing furnace, oxygen enhancement).

The actual mechanisms will depend on the activity undertaken. However, for the purposes of inventory guidance, each pollutant is assigned to either a combustion or a process source — no apportioning of the emission between process and combustion activities is considered. It is recognised that this is not a realistic reflection of emission processes but has been adopted as a practical mechanism for accounting for emissions within the NFR-reporting structure.

2.10 Emissions

The emissions will depend on the fuel and process activity. Relevant pollutants are generally as described for combustion: SO_2, NO_x, CO, NMVOC, particulate matter (TSP, PM_{10}, $PM_{2.5}$), black carbon (BC), heavy metals (HM), polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzo-dioxin and polychlorinated dibenzo-furans (PCDD/F) and, for some activities, polychlorinated biphenyls (PCB) and hexachlorobenzene (HCB).

Note that the inventory methodologies for Greenhouse gas emissions (carbon dioxide, methame and nitrous oxide) are not included – refer to IPCC guidance [IPCC, 2006].

Sulphur oxides — in the absence of emission abatement, the emission of SO_2 is dependent on the sulphur content of the fuel. For cement manufacture, some of the SO_2 (and other acid gases) is absorbed through contact with alkaline media in the cement kiln and, in the dry process, the raw meal.

Nitrogen oxides — emission of NO_x is generally in the form of nitric oxide (NO) with a small proportion present as nitrogen dioxide (NO_2). Nitric acid manufacture includes catalytic combustion of ammonia to provide NO_2 for subsequent absorption.

TSP, PM_{10}, $PM_{2.5}$, BC — particulate matter in flue gases from combustion of fuels can also include entrained material from product or feedstock. Drying activities can generate significant non-combustion PM; for example, drying of cement feedstock, aggregate in roadstone plants, china clay, dark grains, other vegetable matter, pulp and wood. A part of the particulate matter from the combustion of fuels will be emitted in the form of black carbon (BC)[1].

A number of factors influence the measurement and determination of primary PM emissions from activities and, the quantity of PM determined in an emission measurement depends to a large extent

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[1] For the purposes of this guidance, BC emission factors are assumed to equal those for elemental carbon (EC). For further information please refer to Chapter 1.A.1 Energy Industries

on the measurement conditions. This is particularly true of activities involving high temperature and semi-volatile emission components – in such instances the PM emission may be partitioned between a solid/aerosol phase and material which is gaseous at the sampling point but which can condense in the atmosphere. The proportion of filterable and condensable material will vary depending on the temperature of the flue gases and in sampling equipment.

A range of filterable PM measurement methods are applied around the world typically with filter temperatures of 70-160°C (the temperature is set by the test method). Condensable fractions can be determined directly by recovering condensed material from chilled impinger systems downstream of a filter – note that this is condensation without dilution and can require additional processing to remove sampling artefacts. Another approach for total PM includes dilution where sampled flue or exhaust gases are mixed with ambient air (either using a dilution tunnel or dilution sampling systems) and the filterable and condensable components are collected on a filter at lower temperatures (but depending on the method this can be 15-52°C). The use of dilution methods, however, may be limited due to practical constraints with weight and/or size of the equipment.

The PM emission factors (for TSP, PM_{10} and $PM_{2.5}$) can represent the total primary PM emission, or the filterable PM fraction. The basis of the emission factor is described (see individual emission factor tables).

Heavy metals (HM) — the emission of heavy metals strongly depends on their contents in the fuels and process feedstock.

PCDD/F — the emissions of dioxins and furans are highly dependent on the conditions under which combustion and subsequent treatment of exhaust gases is carried out. The sintering process in iron and steel manufacture has been identified as a significant source of dioxins.

HCB — in general, processes leading to PCDD/F formation also lead to emissions of HCB but emission factors for combustion are very uncertain.

PAH — emissions of polycyclic aromatic hydrocarbons results from incomplete (intermediate) conversion of fuels. Emissions of PAH depend on the combustion process, particularly on the temperature (too low temperature favourably increases their emission), the residence time in the reaction zone and the availability of oxygen.

CO — carbon monoxide is found in gas combustion products of all carbonaceous fuels, as an intermediate product of the combustion process and in particular for under-stoichiometric conditions. CO is the most important intermediate product of fuel conversion to CO_2; it is oxidized to CO_2 under appropriate temperature and oxygen availability. Thus, CO can be considered as a good indicator of the combustion quality. The mechanisms of CO formation, thermal-NO, NMVOC and PAH are, in general, similarly influenced by the combustion conditions.

NMVOC — apart from combustion emission, the heating of plant feedstock and product can lead to substantial NMVOC emission.

2.11 Controls

Reduction of emissions from combustion process can be achieved by either avoiding formation of such substances (primary measures) or by removal of pollutants from exhaust gases (secondary measures). Primary measures include measures to avoid pollutant formation and could include use of low sulphur fuel or feedstock.

Secondary emission reduction measures are generally abatement technologies.

3 Methods

3.1 Choice of method

Figure 3-1 presents the procedure to select the methods for estimating process emissions from the relevant activities. The main ideas behind the decision tree are:

- if detailed information is available, use it;

- if the source category is a key source, a Tier 2 or better method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method, since it is expected that it is easier to obtain the necessary input data for this approach than to collect facility level data needed for a Tier 3 estimate.

Figure 3-1   Decision tree for source category 1.A.2
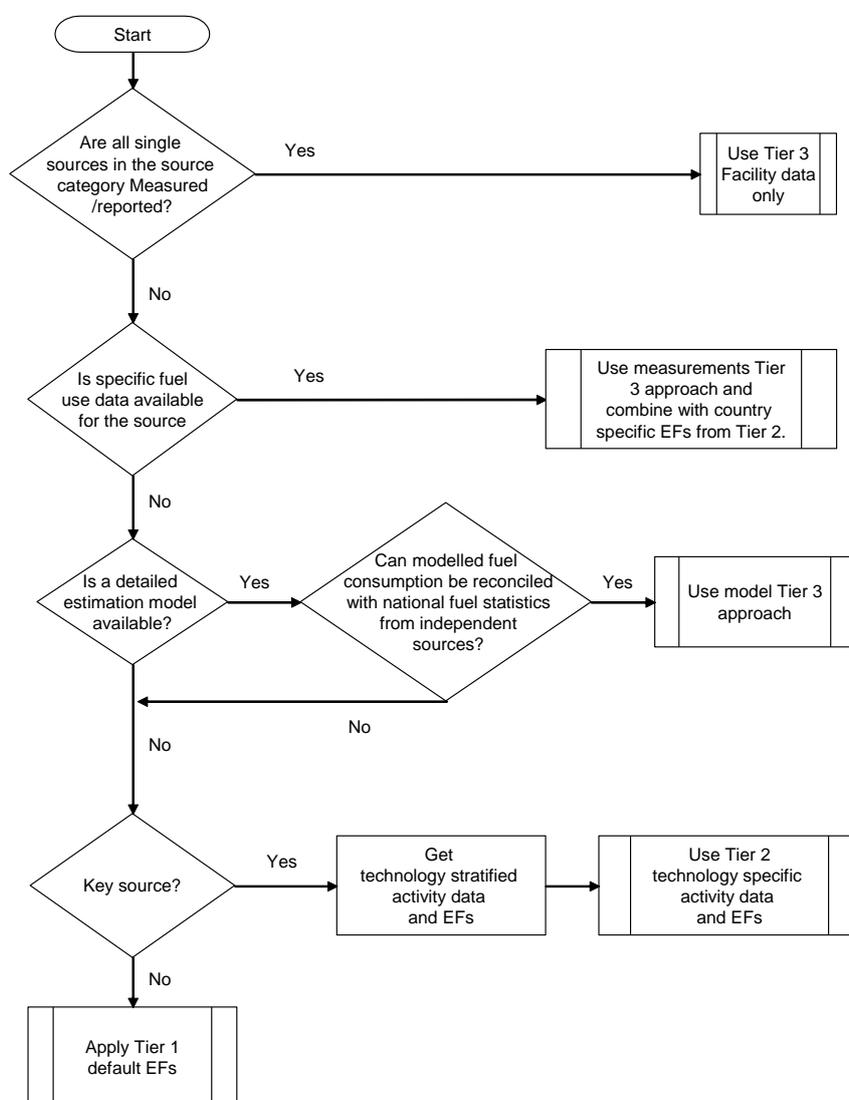
Note that for the major activities in this chapter it is likely that in many cases a Tier 3 approach will be relevant, but this would likely include all emissions (process and combustion). Tier 1 or 2 would be adopted where detailed activity information on individual installations are unavailable.

In many instances release of pollutants can occur due to both the process and combustion activities. Within the industrial combustion activities there are conventional combustion activities (i.e. boilers, furnaces/heaters, engines and gas turbines used to provide process heat and power without mixing of combustion gases with production activities) and 'in-process' combustion.

It is generally not possible to allocate an emission between the process and combustion processes and this is particularly the case for the 'in-process' combustion activities. Furthermore, inclusion of a mechanism which could allocate the emission between the process and combustion activity adds complexity to the inventory, leads to loss of transparency and perhaps double-counting.

The Guidebook adopts a pragmatic approach to apply the most appropriate emission factors consistent with the Tiers. At the lowest Tier (Tier 1), default emission factors are provided to be used with energy-based activity data. In effect, these emission factors assign all fuel use to conventional combustion plant. This approach, used with Tier 1 process emission factors for industrial processes (section 2 of the present chapter) will result in some double-counting of industrial emissions at the lowest Tier due to some overlap of combustion and process emissions. However, if a Tier 1 approach is appropriate, then the sector is considered to be of low significance and this additional uncertainty should be acceptable.

At Tier 2, default emission factors are provided for conventional combustion activities (on an energy input basis) and for in-process combustion activities which are intended to be used with production-based activity data. In order to minimise the risk of double-counting between combustion and process emissions at Tier 2, relevant pollutant emissions for an in-process combustion activity have generally been allocated to either the combustion (source category 1.A.2) or process (section 2 of the present chapter) element of the activity. Clearly for some processes the inventory compiler would need to have activity data which allows allocation of fuel input between process and conventional combustion.

In general, NO_x, SO_2 and CO emissions are assigned to combustion and all other pollutants are assigned to process emissions. Note that to avoid underestimating emissions of other pollutants, the user should refer to emission factors provided for other pollutants in the relevant process activity in section 2 of the present chapter ([2]). An exception to this is the cement manufacture in which all emissions except particulate matter are assigned to combustion.

3.2   Tier 1 default approach

3.2.1   Algorithm

The Tier 1 approach for process emissions from industrial combustion installations uses the general equation:

([2]) It is recognised that in an individual process, a pollutant may be more correctly attributed to combustion (or process) but at Tier 2 such issues are largely unimportant. The approach adopted is intended to assure that the emission is included in the combustion or process NFR rather than being omitted or included twice.

$$E_{pollutant} = \sum_{fuels} AR_{fuel\,consumption} \times EF_{fuel,pollutant} \qquad (1)$$

where:

$E_{Pollutant}$ = emissions of pollutant (kg),

$AR_{fuel\,consumption}$ = fuel used in the industrial combustion (TJ) for each fuel,

$EF_{fuel,pollutant}$ = an average emission factor (EF) for each pollutant for each unit of fuel type used (kg/TJ).

This equation is applied at the national level, using annual national fuel consumption for combustion installations in various activities.

In cases where specific abatement options are to be taken into account, a Tier 1 method is not applicable and a Tier 2 or, if practical, Tier 3 approach must be used.

3.2.2 Default emission factors

Information on the use of energy suitable for estimating emissions using the Tier 1 simpler estimation methodology is available from national statistics agencies or the International Energy Agency (IEA).

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 2 on Stationary Combustion www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

The Tier 1 emission factors are energy based (g pollutant per GJ net thermal input) as are those provided in chapter 1.A.1.a and 1.A.4.a/c at Tier 1. In general, industrial combustion processes are on a smaller scale than provided in chapter 1.A.1.a and use of default factors provided for chapter 1.A.4.a/c (commercial/institutional/agricultural heating) are recommended. If knowledge exists that the industrial plants are larger, it is recommended to consider using the EFs presented in Chapter 1A1. Especially, for biomass combustion there are very few data between the very small plants and the very large plants. Special attention should therefore be given to selecting the proper EFs for biomass combustion. These Tier 1 default emission factors are provided for aggregated fuel types summarised in Table 3-1 below. The default 1.A.4.a/c Tier 1 emission factors for these fuel types are provided in Table 3-2 to Table 3-5 below.

Please note that the fuel groupings presented in Table 3-1 are not consistent with the definitions of the fuels, but are based on the emission characteristics of fuels rather than the original physical state of the fuel.

Where 'Guidebook 2006' is referenced in the tables, the emissions factor has been taken from chapter B216 of the 2006 Guidebook. The original reference could not be determined and the factor represents an expert judgement based on the available data.

In NFR sectors where large (> 50 MW$_{th}$) combustion plant are known to be used, then the default Tier 1 emission factors provided at chapter 1.A.1.a may be more appropriate (for example combustion activities in iron and steel production).

Black carbon (BC) emission factors are assumed to equal those for elemental carbon (EC). For further information please refer to Chapter 1.A.1 Energy Industries.

Table 3-1   Summary of fuel aggregations at Tier 1

Tier 1 fuel type	Associated fuel types
Solid fuels	Hard coal, coking coal, other bituminous coal, sub-bituminous coal, coke, brown coal, lignite, oil shale, manufactured 'patent' fuel, peat
Gaseous fuels	Natural gas, gas works gas, coke oven gas, blast furnace gas, natural gas liquids, liquefied petroleum gas, biogas, refinery gas
Liquid fuels	Residual fuel oil, refinery feedstock, petroleum coke, gas oil, kerosene, naphtha, orimulsion, bitumen, shale oil
Biomass	Wood, charcoal, vegetable (agricultural) waste

Note: The fuel groupings indicated in the table is only to be used for guiding the choice of EFs. When reporting fuel consumption data the agreed fuel definitions as used by the IPCC should be used.

Table 3-2   Tier 1 emission factors for 1.A.2 combustion in industry using solid fuels

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	1.A.2	Manufacturing industries and construction			
Fuel	Solid Fuels				
Not applicable					
Not estimated	NH3				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	173	g/GJ	150	200	Guidebook (2006) chapter B216
CO	931	g/GJ	150	2000	Guidebook (2006) chapter B216
NMVOC	88.8	g/GJ	10	300	Guidebook (2006) chapter B216
SOx	900	g/GJ	450	1000	Guidebook (2006) chapter B216
TSP	124	g/GJ	70	250	Guidebook (2006) chapter B216
PM10	117	g/GJ	60	240	Guidebook (2006) chapter B216
PM2.5	108	g/GJ	60	220	Guidebook (2006) chapter B216
BC	6.4	% of PM2.5	2	26	See Note
Pb	134	mg/GJ	50	300	Guidebook (2006) chapter B216
Cd	1.8	mg/GJ	0.2	5	Guidebook (2006) chapter B216
Hg	7.9	mg/GJ	5	10	Guidebook (2006) chapter B216
As	4	mg/GJ	0.2	8	Guidebook (2006) chapter B216
Cr	13.5	mg/GJ	0.5	20	Guidebook (2006) chapter B216
Cu	17.5	mg/GJ	5	50	Guidebook (2006) chapter B216
Ni	13	mg/GJ	0.5	30	Guidebook (2006) chapter B216

Se	1.8	mg/GJ	0.2	3	Guidebook (2006) chapter B216
Zn	200	mg/GJ	50	500	Guidebook (2006) chapter B216
PCB	170	µg/GJ	85	260	Kakareka et al. (2004)
PCDD/F	203	ng I-TEQ/GJ	40	500	Guidebook (2006) chapter B216
Benzo(a)pyrene	45.5	mg/GJ	10	150	Guidebook (2006) chapter B216
Benzo(b)fluoranthene	58.9	mg/GJ	10	180	Guidebook (2006) chapter B216
Benzo(k)fluoranthene	23.7	mg/GJ	8	100	Guidebook (2006) chapter B216
Indeno(1,2,3-cd)pyrene	18.5	mg/GJ	5	80	Guidebook (2006) chapter B216
HCB	0.62	µg/GJ	0.31	1.2	Guidebook (2006) chapter B216

Note:
900 g/GJ of sulphur dioxide corresponds to 1.2 % S of coal fuel of lower heating value on a dry basis 24 GJ/t and average sulphur retention in ash as value of 0.1.

No information was specifically available for small boilers. The BC share is taken as the same value as for residential sources and referenced to Zhang et al. (2012).

The basis of the TSP, PM10 and PM2.5 emission factors could not be determined in the reference.

Table 3-3   Tier 1 emission factors for 1.A.2 combustion in industry using gaseous fuels

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	1.A.2	Manufacturing industries and construction			
Fuel	Gaseous Fuels				
Not applicable					
Not estimated	NH3, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NO$_x$	74	g/GJ	46	103	See note
CO	29	g/GJ	21	48	See note
NMVOC	23	g/GJ	14	33	See note
SO$_x$	0.67	g/GJ	0.40	0.94	See note
TSP	0.78	g/GJ	0.47	1.09	See note
PM$_{10}$	0.78	g/GJ	0.47	1.09	See note
PM$_{2.5}$	0.78	g/GJ	0.47	1.09	See note
BC	4.0	% of PM$_{2.5}$	2.1	7	See note
Pb	0.011	mg/GJ	0.006	0.022	See note
Cd	0.0009	mg/GJ	0.0003	0.0011	See note
Hg	0.54	mg/GJ	0.26	1.0	See note
As	0.10	mg/GJ	0.05	0.19	See note
Cr	0.013	mg/GJ	0.007	0.026	See note
Cu	0.0026	mg/GJ	0.0013	0.0051	See note
Ni	0.013	mg/GJ	0.006	0.026	See note
Se	0.058	mg/GJ	0.015	0.058	See note
Zn	0.73	mg/GJ	0.36	1.5	See note
PCDD/F	0.52	ng I-TEQ/GJ	0.25	1.3	See note
Benzo(a)pyrene	0.72	µg/GJ	0.20	1.9	See note
Benzo(b)fluoranthene	2.9	µg/GJ	0.7	12	See note
Benzo(k)fluoranthene	1.1	µg/GJ	0.3	2.8	See note
Indeno(1,2,3-cd)pyrene	1.08	µg/GJ	0.30	2.9	See note

Note:
Average of Tier 2 EFs for commercial/institutional gaseous fuel combustion for all technologies. See Chapter 1A4 Small combustion.

The TSP, PM10 and PM2.5 emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions.

Table 3-4   Tier 1 emission factors for 1.A.2 combustion in industry using liquid fuels

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	1.A.2	Manufacturing industries and construction			
Fuel	Liquid Fuels				
Not applicable					
Not estimated	NH3, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	513	g/GJ	308	718	See note
CO	66	g/GJ	40	93	See note
NMVOC	25	g/GJ	15	35	See note
SOx	47	g/GJ	28	66	See note
TSP	20	g/GJ	12	28	See note
PM$_{10}$	20	g/GJ	12	28	See note
PM$_{2.5}$	20	g/GJ	12	28	See note
BC	56	% of PM$_{2.5}$	33	78	See note
Pb	0.08	mg/GJ	0.04	0.16	See note
Cd	0.006	mg/GJ	0.003	0.011	See note
Hg	0.12	mg/GJ	0.04	0.17	See note
As	0.03	mg/GJ	0.02	0.06	See note
Cr	0.20	mg/GJ	0.10	0.40	See note
Cu	0.22	mg/GJ	0.11	0.43	See note
Ni	0.008	mg/GJ	0.004	0.015	See note
Se	0.11	mg/GJ	0.06	0.22	See note
Zn	29	mg/GJ	15	58	See note
PCDD/F	1.4	ng I-TEQ/GJ	0.3	7.1	See note
Benzo(a)pyrene	1.9	mg/GJ	0.2	1.9	See note
Benzo(b)fluoranthene	15	mg/GJ	1.5	15	See note
Benzo(k)fluoranthene	1.7	mg/GJ	0.2	1.7	See note
Indeno(1,2,3-cd)pyrene	1.5	mg/GJ	0.2	1.5	See note

Note:
Average of Tier 2 EFs for commercial/institutional liquid fuel combustion for all technologies. See Chapter 1A4 Small combustion.

The TSP, PM10 and PM2.5 emission factors have been reviewed and it is unclear whether they represent filterable PM or total PM (filterable and condensable) emissions

Table 3-5   Tier 1 emission factors for 1.A.2 combustion in industry using biomass

Tier 1 default emission factors					
	Code	Name			
NFR Source Category	1.A.2	Manufacturing industries and construction			
Fuel	Biomass				
Not applicable					
Not estimated					
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NO_x	91	g/GJ	20	120	Lundgren et al. (2004) [1]
CO	570	g/GJ	50	4000	EN 303 class 5 boilers, 150-300 kW
NMVOC	300	g/GJ	5	500	Naturvårdsverket, Sweden
SO_2	11	g/GJ	8	40	US EPA (1996) AP-42, Chapter 1.9
NH_3	37	g/GJ	18	74	Roe et al. (2004) [2]
TSP	150	g/GJ	75	300	Naturvårdsverket, Sweden
PM_{10}	143	g/GJ	71	285	Naturvårdsverket, Sweden [3]
$PM_{2.5}$	140	g/GJ	70	279	Naturvårdsverket, Sweden [3]
BC	28	% of $PM_{2.5}$	11	39	Goncalves et al. (2010), Fernandes et al. (2011), Schmidl et al. (2011) [4]
Pb	27	mg/GJ	0.5	118	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Cd	13	mg/GJ	0.5	87	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Hg	0.56	mg/GJ	0.2	1	Struschka et al. (2008)
As	0.19	mg/GJ	0.05	12	Struschka et al. (2008)
Cr	23	mg/GJ	1	100	Hedberg et al. (2002) , Struschka et al. (2008)
Cu	6	mg/GJ	4	89	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
Ni	2	mg/GJ	0.5	16	Hedberg et al. (2002), Struschka et al. (2008), Lamberg et al. (2011)
Se	0.5	mg/GJ	0.25	1.1	Hedberg et al. (2002)
Zn	512	mg/GJ	80	1300	Hedberg et al. (2002), Tissari et al. (2007) , Struschka et al. (2008), Lamberg et al. (2011)
PCBs	0.06	µg/GJ	0.006	0.6	Hedman et al. (2006)
PCDD/F	100	ng I-TEQ/GJ	30	500	Hedman et al. (2006)
Benzo(a)pyrene	10	mg/GJ	5	20	Boman et al. (2011); Johansson et al. (2004)
Benzo(b)fluoranthene	16	mg/GJ	8	32	
Benzo(k)fluoranthene	5	mg/GJ	2	10	
Indeno(1,2,3-cd)pyrene	4	mg/GJ	2	8	
HCB	5	µg/GJ	0.1	30	Syc et al. (2011)

1) Larger combustion chamber, 350 kW

2) Assumed equal to low emitting wood stoves

3) PM_{10} estimated as 95 % of TSP, $PM_{2.5}$ estimated as 93 % of TSP. The PM fractions refer to Boman et al. (2011), Pettersson et al. (2011) and the TNO CEPMEIP database.

4) Assumed equal to advanced/ecolabelled residential boilers

5) If the reference states the emission factor in g/kg dry wood the emission factors have been recalculated to g/GJ based on NCV stated in each reference. If NCV is not stated in a reference, the following values have been assumed: 18 MJ/kg for wood logs and 19 MJ/kg for wood pellets.

6) The TSP, PM10 and PM2.5 emission factors represent filterable PM.

3.2.3 Activity data

The activity rate and the emission factor have to be determined on the same level of aggregation depending on the availability of data. The activity statistic should be determined within the considered country or region by using adequate statistics. The activity should refer to the energy input of the emission sources considered (net or inferior fuel consumption in [GJ]).

Further guidance is provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 2 on Stationary Combustion www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

3.3   Tier 2 technology-specific approach

3.3.1 Algorithm

The Tier 2 approach is similar to the Tier 1 approach, using activity data and emission factors to estimate the emissions. The main difference is that the detailed methodology requires more fuel-, technology- and country-specific information. Development of the detailed methodology has to be focused to the combinations of the main installation types/fuels used in the country.

The annual emission is determined by an activity data and an emission factor:

$$E_i = \sum_{j,k} EF_{i,j,k} \cdot A_{j,k} \quad , \tag{1}$$

where

E_i annual emission of pollutant i ,

$EF_{i,j,k}$ default emission factor of pollutant i for source type j and fuel k,

$A_{j,k}$ annual consumption of fuel k in source type j.

However, unlike Tier 1, Tier 2 in-process combustion emission factors are provided based on production data which is perhaps a more relevant or available statistic than energy use. For conventional combustion, the inventory compiler is directed towards the Tier 2 1.A.4.a/c (or 1.A.1.a) default emission factors which are expressed in terms of energy use. In-process combustion emission factors are provided for NO_x, SO_2 and CO which are the pollutants primarily attributable to the combustion activity. Emission factors for other pollutants are provided in the relevant process chapter under NFR code 2 as the majority of emissions from these pollutants will be from the industrial process specific component. Factors below are expressed as grams pollutant per tonne of product unless noted otherwise. A summary of the combustion emission factors is provided in Table 3-6.

For the purposes of inventory guidance NO_x, SO_2 and CO emissions are generally assigned to a combustion activity (chapter 1.A.2) and other pollutants are assigned to a process activity (section 2 of the present chapter) — no apportioning of the emission between process and combustion activities is considered. Note that to determine total emissions from an activity the inventory compiler has to consider both combustion and process emissions.

It is recognised that this allocation is not a realistic reflection of emission processes within the activities for several pollutants but it provides a practical mechanism for accounting for emissions within the NFR reporting structure.

Black carbon (BC) emission factors are assumed to equal those for elemental carbon (EC). For further information please refer to Chapter 1.A.1 Energy Industries.

In many instances the Tier 2 factors are based on data on current emissions provided in the BREF guidance documents. In older BREF documents, emission data are drawn from the EU-15 countries, although some include non-EU data. More recent BREFs include data for EU-25 countries, but whilst these represent a wide range of technologies and emissions, they may not represent the full range of emissions outside the EU.

Note that the Tier 2 default factors are generally the geometric mean of the ranges provided in the BREF documents.

Table 3-6   Summary of Tier 2 default emission factors by source category

NFR	Subsection	Main activity	Process	Table
1.A.2.a	0	Iron and steel manufacture	Blast furnace cowpers	Table 3-7
			Sinter plant	Table 3-8
			Pelletizing plant	Table 3-9
			Reheating furnaces	Table 3-10
			Grey iron foundries	Table 3-11
1.A.2.b	0	Non-ferrous metals production	Primary copper	Table 3-12
			Secondary copper	Table 3-13
			Primary lead	Table 3-14 Tier 2 emission factors for source category 1.A.2.b, Primary lead production
			Secondary lead	Table 3-15
			Primary zinc	

				Table 3-16
			Secondary zinc	Table 3-17
			Secondary aluminium	Table 3-18
			Nickel	Table 3-19
			Magnesium	Table 3-20
			Alumina	Table 3-21
1.A.2.f	0	Other manufacture	Plaster (gypsum) furnace (*)	Table 3-22
			Lime	Table 3-23
			Cement	Table 3-24
			Asphalt (roadstone coating)	Table 3-25
			Glass	Table 3-26
			Mineral wool	Table 3-27
			Bricks and tiles	Table 3-28
			Fine ceramics	Note: The SOx emission depends on the percentages of sulphur in raw materials (which can be highly variable); SOx emissions can be more accurately estimated for an installation using mass balance procedures. However, the amount of SOx released may be reduced by contact with alkaline components of the raw materials or additives. For coal-fired kilns, the contribution of the fuel sulphur to SOx emissions must also be accounted for

						when performing mass balance calculations. Table 3-29
					Enamel	
						Table 3-30
(*) Gypsum (the input material) is calcined in a furnace to produce plaster (the output material).						

3.3.2 Technology-specific emission factors

Combustion in 1.A.2.a — Iron and steel manufacture

Default emission factors are provided for NO$_x$, SO$_x$ and CO. Guidance on estimating other pollutants is provided in chapter 2.C.1. Where BREF data are referenced, these include new data from the Iron and Steel BREF (EIPPCB 2012)

Table 3-7   Tier 2 emission factors for source category 1.A.2.a, Blast furnace cowpers

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.a	Iron and steel			
Fuel	Coke/Blast Furnace Gas/Coke oven gas/NG/oil/BOF ga				
SNAP (if applicable)					
Technologies/Practices	Blast Furnace				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	8	g/tonne pig iron	2	30	European Commission (2012a)
CO	27	g/tonne pig iron	22	36	European Commission (2012a)
SOx	38	g/tonne pig iron	7	194	European Commission (2012a)

Table 3-8   Tier 2 emission factors for source category 1.A.2.a, Sinter plants

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.a	Iron and steel			
Fuel	Blast Furnace Gas/Coke Oven Gas				
SNAP (if applicable)	030301	Sinter and pelletizing plants			
Technologies/Practices	Sinter Plants				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	558	g/tonne sinter	302	1030	European Commission (2012a)
CO	18000	g/tonne sinter	8780	37000	European Commission (2012a)
SOx	463	g/tonne sinter	220	973	European Commission (2012a)

Table 3-9   Tier 2 emission factors for source category 1.A.2.a, Pelletizing plants

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.a	Iron and steel			
Fuel	Blast Furnace Gas/Coke Oven Gas/Nat Gas				
SNAP (if applicable)	030301	Sinter and pelletizing plants			
Technologies/Practices	Pellitising Plants				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	287	g/tonne pellet	150	550	European Commission (2012a)
CO	64	g/tonne pellet	10	410	European Commission (2012a)
SOx	48	g/tonne pellet	11	213	European Commission (2012a)

Table 3-10   Tier 2 emission factors for source category 1.A.2.a, Reheating furnaces

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.a	Iron and steel			
Fuel	Coke/Blast Furnace Gas/Coke Oven Gas/Nat Gas				
SNAP (if applicable)	030302	Reheating furnaces steel and iron			
Technologies/Practices	Reheating Furnace				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	170	g/tonne	80	360	European Commission (2001)
CO	65	g/tonne	5	850	European Commission (2001)
SOx	13	g/tonne	0.3	600	European Commission (2001)

Table 3-11   Tier 2 emission factors for source category 1.A.2.a, Grey iron foundries

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.a	Iron and steel			
Fuel	Coke/oil/gas				
SNAP (if applicable)	030303	Grey iron foundries			
Technologies/Practices	Grey iron furnace				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	548	g/Mg charged d	300	1000	European Commission (2005)
CO	2236	g/Mg charged	500	10000	European Commission (2005)
SOx	1732	g/Mg charged	1000	3000	European Commission (2005)

Notes:
Emission factors are grams pollutant per tonne of material charged to the furnace.
Process emissions of foundries are described in Chapter 2.C.2, Ferroalloys production

Combustion in 1.A.2.b — Non-ferrous metal

Default emission factors are provided for NO_x, SO_2 and CO. Guidance on estimating other pollutants in Chapters 2.C.3 Aluminium production and in the various chapters for activities within 2.C.5 (including copper, lead, nickel and zinc production).

Table 3-12   Tier 2 emission factors for source category 1.A.2.b, Primary copper production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Coal/gas/oil				
SNAP (if applicable)	030306	Primary copper production			
Technologies/Practices	Primary copper production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	7060	g/tonne	4240	12100	Guidebook (2006) chapter B336
SOx	10300	g/tonne	6600	16000	European Commission (2001)

Note: NO$_x$ emission factor derived from Guidebook factor (based on quantity of ore processed) and non-ferrous metal BREF (EIPPCB, 2001) data on consumption and production. Note that the Guidebook refers to AP-42 as a source of NO$_x$ emission factors, but no NO$_x$ data are provided in the primary copper chapter.

Table 3-13   Tier 2 emission factors for source category 1.A.2.b, Secondary copper production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Oil/coal/coke				
SNAP (if applicable)	030309	Secondary copper production			
Technologies/Practices	Secondary copper production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	400	g/tonne	73.9	1570	US EPA (1990)
CO	4690	g/tonne	2000	11000	European Commission (2001)
SOx	1230	g/tonne	500	3000	European Commission (2001)

Table 3-14   Tier 2 emission factors for source category 1.A.2.b, Primary lead production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Coke/gas/oil				
SNAP (if applicable)	030304	Primary lead production			
Technologies/Practices	Primary lead production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NOx, CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
SOx	6190	g/tonne	1000	45000	European Commission (2001)

Table 3-15   Tier 2 emission factors for source category 1.A.2.b, Secondary lead production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Oil/gas				
SNAP (if applicable)	030307	Secondary lead production			
Technologies/Practices	Secondary lead production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	186	g/tonne	108	323	US EPA (1990)
SOx	2200	g/tonne	210	7800	European Commission (2001)

Table 3-16   Tier 2 emission factors for source category 1.A.2.b, Primary zinc production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Coke/gas/oil				
SNAP (if applicable)	030305	Primary zinc production			
Technologies/Practices	Primary zinc production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NOx, CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
SOx	5290	g/tonne	2500	9000	European Commission (2001)

Table 3-17   Tier 2 emission factors for source category 1.A.2.b, Secondary zinc production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Coke/gas/oil				
SNAP (if applicable)	030308	Secondary zinc production			
Technologies/Practices	Secondary zinc production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,				

Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NOx	1500	g/tonne	100	3950	European Commission (2001)
SOx	12200	g/tonne	9150	20000	European Commission (2001)

Table 3-18   Tier 2 emission factors for source category 1.A.2.b, Secondary aluminium production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Oil/gas				
SNAP (if applicable)	030310	Secondary aluminium production			
Technologies/Practices	Secondary Aluminium				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	**413**	**g/Mg**	**280**	**610**	**European Commission (2009)**
SOx	**285**	**g/Mg**	**220**	**370**	**European Commission (2009)**

Table 3-19   Tier 2 emission factors for source category 1.A.2.b, Nickel production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.b	Non-ferrous metals			
Fuel	Gas				
SNAP (if applicable)	030324	Nickel production (thermal process)			
Technologies/Practices	Nickel Production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NOx, CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
SOx	18000	g/tonne	9000	27000	European Commission (2001)

Table 3-20   Tier 2 emission factors for source category 1.A.2.b, Magnesium production

Tier 2 emission factors		
	Code	Name

NFR Source Category	1.A.2.b	Non-ferrous metals
Fuel	Natural Gas	
SNAP (if applicable)	030323	Magnesium production (dolomite treatment)
Technologies/Practices	Magnesium Production	
Region or regional conditions	NA	
Abatement technologies	NA	
Not applicable		
Not estimated	CO, NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene	

Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NOx	3050	g/tonne	1830	4270	European Commission (2001)
SOx	335	g/tonne	16	7000	European Commission (2001)

Table 3-21   Tier 2 emission factors for source category 1.A.2.b, Alumina production

Tier 2 emission factors		
	Code	Name
NFR Source Category	1.A.2.b	Non-ferrous metals
Fuel	Gas/Oil	
SNAP (if applicable)	030322	Alumina production
Technologies/Practices	Alumina	
Region or regional conditions	NA	
Abatement technologies	NA	
Not applicable		
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB	

Pollutant	Value	Unit	95% confidence interval		Reference
			Lower	Upper	
NOx	945	g/tonne	660	1350	CORINAIR (1990)
CO	135	g/tonne	55	330	CORINAIR (1990)
SOx	637	g/tonne	88	4610	CORINAIR (1990)

Note: Emission factors derived from thermal input emission factors from 2006 Guidebook and energy use data for alumina production from the non-ferrous metals BREF (EIPPC 2001)

Combustion in 1.A.2.f.i — Other manufacture

Default emission factors are provided below for NOₓ, SO₂ and CO where information is available. Guidance on estimating other pollutants is provided in the industrial processes chapters when relevant process-related emissions are known to occur.

Table 3-22   Tier 2 emission factors for source category 1.A.2.f.i, Plaster (gypsum) furnaces

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other			
Fuel	Gas/Oil				
SNAP (if applicable)	030204	Plaster furnaces			
Technologies/Practices	Plaster (gysum) manufacture				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	CO, NMVOC, SOx, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, PCBs, HCB, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene,				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	1060	g/tonne	800	1400	US EPA (1990)

Table 3-23   Tier 2 emission factors for source category 1.A.2.f.i, Lime production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other			
Fuel	Coal/gas/oil				
SNAP (if applicable)	030312	Lime (includes iron and steel and paper pulp industries)			
Technologies/Practices	Lime				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	1369	g/tonne	150	12500	European Commission (2010)
CO	1940	g/tonne	300	12500	European Commission (2010)
SOx	316	g/tonne	10	10000	European Commission (2010)

Table 3-24   Tier 2 emission factors for source category 1.A.2.f.i, Cement production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other			
Fuel	Coal/pet. Coke/gas/oil/recovered wastes				
SNAP (if applicable)	030311	Cement			
Technologies/Practices	Cement manufacture				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NH3, TSP, PM10, PM2.5, BC				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	1241	g/te clinker	330	4670	European Commission (2010)
CO	1455	g/te clinker	460	4600	European Commission (2010)
NMVOC	18	g/te clinker	2.3	138	European Commission (2010)
SOx	374	g/te clinker	20	11120	European Commission (2010)
Pb	0.098	g/te clinker	0.024	0.4	European Commission (2010)
Cd	0.008	g/te clinker	0.004	0.016	European Commission (2010)
Hg	0.049	g/te clinker	0.01	0.24	European Commission (2010)
As	0.0265	g/te clinker	0.014	0.05	European Commission (2010)
Cr	0.041	g/te clinker	0.028	0.06	European Commission (2010)
Cu	0.0647	g/te clinker	0.022	0.19	European Commission (2010)
Ni	0.049	g/te clinker	0.016	0.15	European Commission (2010)
Se	0.0253	g/te clinker	0.016	0.04	European Commission (2010)
Zn	0.424	g/te clinker	0.2	0.9	European Commission (2010)
PCB	103	µg/te clinker	46	230	VDZ (2011)
PCDD/F	4.1	ng I-TEQ/te clinker	0.0267	627	European Commission (2010)
Benzo(a)pyrene	0.000065	g/te clinker	0.000033	0.000098	US EPA (1995), chapter 11.6
Benzo(b)fluoranthene	0.00028	g/te clinker	0.00014	0.00042	US EPA (1995), chapter 11.6
Benzo(k)fluoranthene	0.000077	g/te clinker	0.000039	0.00012	US EPA (1995), chapter 11.6
Indeno(1,2,3-cd)pyrene	0.000043	g/te clinker	0.000022	0.000065	US EPA (1995), chapter 11.6
HCB	4.6	µg/te clinker	2.3	9.2	SINTEF (2006)

Note: Emissions of all pollutants (except particulate matter) are allocated to combustion in cement manufacture. Factors are expressed as grams pollutant per tonne of clinker produced. For HMs the values in the BREF have been converted using 2000 Nm^3 per tonnes as done in GB2009. For HCB and PCBs the values in the references have been converted using 2300 Nm^3 per tonnes.

Table 3-25   Tier 2 emission factors for source category 1.A.2.f.i, Roadstone coating (asphalt) plants

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other			
Fuel	Gas/Oil				
SNAP (if applicable)	030313	Asphalt concrete plants			
Technologies/Practices	Asphalt				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	35.6	g/tonne	12.5	60	US EPA (2004), chapter 11.1
CO	200	g/tonne	100	300	US EPA (2004), chapter 11.1
SOx	17.7	g/tonne	2.3	44	US EPA (2004), chapter 11.1

Table 3-26   Tier 2 emission factors for source category 1.A.2.f.i, Glass production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other			
Fuel	Gas/Oil				
SNAP (if applicable)	0303	Processes with contact			
Technologies/Practices	Glass (flat, container, domestic, special,cont. filament glass fibre)				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	2930	g/tonne	220	14700	European Commission (2008)
CO	6.13	g/tonne	3.07	258	European Commission (2008)
SOx	1960	g/tonne	118	15100	European Commission (2008)

Note: BREF data referenced include new data from the draft revised Glass BREF (EIPPCB 2008). A final BREF document was published in 2012, but the results have not yet been incorporated.

Table 3-27   Tier 2 emission factors for source category 1.A.2.f.i, Mineral wool production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other			
Fuel	Gas/Oil				
SNAP (if applicable)	030316 030318	Glass wool (except binding) Mineral wool (except binding)			
Technologies/Practices	Mineral Wool				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	1630	g/tonne	220	10600	European Commission (2008)
CO	525	g/tonne	1	149000	European Commission (2008)
SOx	223	g/tonne	1	4800	European Commission (2008)

Note: BREF data referenced include new data from the draft revised Glass BREF (EIPPCB 2008). A final BREF document was published in 2012, but the results have not yet been incorporated.

Table 3-28   Tier 2 emission factors for source category 1.A.2.f.i, Bricks and tiles

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other (			
Fuel	Gas/oil/coal				
SNAP (if applicable)	030319	Bricks and tiles			
Technologies/Practices	Bricks and tiles production				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	184	g/Mg	49	255	European Commission (2007)
CO	189	g/Mg	155	800	European Commission (2007)
SOx	39.6	g/Mg	2.45	2550	European Commission (2007)

Note: The SOx emission depends on the percentages of sulphur in raw materials (which can be highly variable); SOx emissions can be more accurately estimated for an installation using mass balance procedures. However, the amount of SOx released may be reduced by contact with alkaline components of the raw materials or

additives. For coal-fired kilns, the contribution of the fuel sulphur to SOx emissions must also be accounted for when performing mass balance calculations.

Table 3-29   Tier 2 emission factors for source category 1.A.2.f.i, Fine ceramic materials

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)			
Fuel	Gas/oil/coal				
SNAP (if applicable)	030320	Fine ceramic materials			
Technologies/Practices	Fine ceramic				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	850	g/tonne	425	1280	RIVA (1992)
CO	456	g/tonne	130	1600	RIVA (1992)
SOx	247	g/tonne	210	290	RIVA (1992)

Table 3-30   Tier 2 emission factors for source category 1.A.2.f.i, Enamel production

Tier 2 emission factors					
	Code	Name			
NFR Source Category	1.A.2.f.i	Stationary combustion in manufacturing industries and construction: Other (Please specify in your IIR)			
Fuel	Gas/Oil				
SNAP (if applicable)	030325	Enamel production			
Technologies/Practices	Enamel				
Region or regional conditions	NA				
Abatement technologies	NA				
Not applicable					
Not estimated	NMVOC, NH3, TSP, PM10, PM2.5, BC, Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, PCDD/F, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, PCBs, HCB				
Pollutant	**Value**	**Unit**	**95% confidence interval**		**Reference**
			Lower	**Upper**	
NOx	12000	g/tonne	7100	29300	European Commission (2012b)
CO	2400	g/tonne	1200	3600	US EPA (1997), chapter 11.14
SOx	1000	g/tonne	200	5000	European Commission (2012b)

3.3.3 Abatement

A number of add-on technologies exist that are aimed at reducing emissions from combustion in these source activities (primarily PM, but other pollutants are also abated). The resulting emissions can be calculated by extending the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{technology,abated} = (1 - \eta_{abatement}) \times EF_{technology,unabated} \qquad (5)$$

However, as abatement technology is rarely specified in terms of efficiency, it may be more relevant to develop abated emission factors from the final emission concentrations achieved using abatement.

Guidance on estimating emission factors from concentrations for combustion processes is provided in chapter 1.A.1.

3.3.4 Activity data

In most cases the statistical information includes data on annual fuels consumption in the relevant activities. However, data on use of allocation of fuels between conventional combustion and in-process combustion and in specific activities may be limited. To fill these data gaps the following sources could be used:

- information from emission trading schemes;
- information from the fuel suppliers and individual companies;
- energy conservation/climate change mitigation studies for relevant sectors;
- energy demand modelling.

To improve reliability of the activity data, appropriate efforts should be made in order to encourage the institution responsible for national energy statistics to report the fuel consumption at the adequate level of sectoral disaggregation in their regular activity.

Also, when data on the fuel consumption are provided at an appropriate level of sectoral split, they should be checked for possible anomalies. The recovery of waste fuels in some sectors requires particular consideration.

3.4 Tier 3 use of facility data

3.4.1 Algorithm

Where facility-level emission data of sufficient quality (see Chapter 3, Data collection, in part A) are available, it is good practice to use these data. There are two possibilities:

- the facility reports cover all relevant processes in the country;
- facility-level emission reports are not available for all relevant processes in the country.

However, it should be recognised that facility data is unlikely to be disaggregated between combustion and process emissions. Measures must be applied to avoid double-counting of combustion emissions where facility combustion data is difficult to disaggregate from process emissions.

If facility level data are available covering all activities in the country, the implied emission factors (reported emissions divided by the national fuel use) should be compared with the default emission factor values or technology specific emission factors. If the implied emission factors are outside the 95 % confidence intervals for the values given, it is good practice to explain the reasons for this in the inventory report.

Depending on the specific national circumstances and the coverage of the facility-level reports as compared to the total combustion activity, the emission factor (*EF*) in this equation should be chosen from the following possibilities, in decreasing order of preference:

- technology-specific emission factors, based on knowledge of the types of technologies implemented at the facilities where facility-level emission reports are not available;

- the implied emission factor derived from the available emission reports:

$$EF = \left.\sum_{Facilities} E_{Facility, pollutant} \middle/ \sum_{Facilities} Production_{Facility}\right. \tag{7}$$

- the default Tier 1 emission factor. This option should only be chosen if the facility-level emission reports cover more than 90 % of the total national production.

Sources of emission factor guidance for facilities include the US EPA, BREF and industry sector guidance (for example from Eurelectric and Concawe trade associations).

Many industrial installations are major facilities and emission data for individual plants might be available through a pollutant release and transfer registry (PRTR) or another national emission reporting scheme. When the quality of such data is assured by a well-developed QA/QC system and the emission reports have been verified by an independent auditing scheme, it is good practice to use such data. If extrapolation is needed to cover all activity in the country either the implied emission factors for the facilities that did report, or the emission factors as provided above could be used.

3.4.2 Activity data

Since PRTR generally do not report activity data, such data in relation to the reported facility level emissions are sometimes difficult to find. A possible source of facility level activity might be the registries of emission trading systems.

In many countries national statistics offices collect production data on facility level, but these are in many cases confidential. However in several countries, national statistics offices are part of the national emission inventory systems and the extrapolation, if needed, could be performed at the statistics office, ensuring that confidentiality of production data is maintained.

4 Data quality

4.1 Completeness

No specific issues.

4.2 Avoiding double counting with other sectors

In cases where it is possible to split the emissions, it is good practice to do so. However, care must be taken that the emissions are not double counted. This is particularly relevant to this activity where process emissions may incorporate combustion discharges.

4.3 Verification

4.3.1 Best Available Techniques emission factors

The BREF notes provide guidance on achievable emission levels for combustion emissions.

Guidance on the range of combustion emission factors for conventional combustion is provided within Chapters 1.A.1 Energy industries and 1.A.4 Small combustion.

4.4 Developing a consistent time series and recalculation

The emissions of non-CO_2 emissions from fuel combustion change with time as equipment and facilities are upgraded or replaced by less-polluting energy technology. The mix of technology used with each fuel will change with time and this has implications for the choice of emission factor at Tier 1 and Tier 2.

4.5 Uncertainty assessment

4.5.1 Emission factor uncertainties

There is uncertainty in the aggregated emission factors used to estimate emissions. The sizes and technologies in the sector will impact on the uncertainty to be expected from the application of an 'average' emission factor.

4.5.2 Activity data uncertainties

The allocation of fuel use between in-process combustion and conventional combustion in some of the processes may be difficult. In addition, activity data for fuel use in an industry sector (or facility) may be subject to uncertainty due to waste recovery within industrial combustion activities.

4.6 Inventory quality assurance/quality control QA/QC

No specific issues.

4.7 Mapping

No specific issues.

4.8 Reporting and documentation

No specific issues.

5 Glossary

Boiler:	any technical apparatus in which fuels are oxidised in order to generate thermal energy, which is transferred to water or steam
Brown coal:	refers to brown coal/lignite (NAPFUE 105) of gross caloric value (GHV) less than 17 435 kJ/kg and containing more than 31 % volatile matter on a dry mineral matter free basis
CHP:	Combined Heat and Power refers to a co-generation installation where fuel is used for both power generation and heat supply
Cogeneration:	refers to a facility where both power generation and heat (typically steam) is produced
Coke:	refers to the solid residue obtained from hard coal (NAPFUE 107) or from brown coal (NAPFUE 108) by processing at high temperature in the absence of air
Gaseous fuels:	refers to natural gas (NAPFUE 301), natural gas liquids (NAPFUE 302) and biogas (NAPFUE 309)
Hard coal:	refers to coal of a gross caloric value greater than 17 435 kJ/kg on ash-free but moisture basis, i.e. steam coal (NAPFUE 102, GHV > 23 865 kJ/kg), sub-bituminous coal (NAPFUE 103, 17 435 kJ/kg < GHV < 23865 kJ/kg) and anthracite
Liquid fuels:	refers to kerosene (NAPFUE 206), gas oil (gas/diesel oil (NAPFUE 204), residual oil, residual fuel oil (NAPFUE 203), liquefied petroleum gases (LPG; NAPFUE 303), and other liquid fuels (NAPFUE 225)
Peat:	refers to peat-like fuels (NAPFUE 113)
Biomass:	refers to wood fuels which are wood and similar wood wastes (NAPFUE 111) and wood wastes (NAPFUE 116) and agricultural wastes used as fuels (straw, corncobs, etc; NAPFUE 117)

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7 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projection's expert panel on combustion and industry. Please refer to the TFEIP website (www.tfeip-secretariat.org/) for the contact details of the current expert panel leaders.