

II

(Acts whose publication is not obligatory)

COMMISSION

COMMISSION DECISION

of 29 January 2004

establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council

(notified under document number C(2004) 130)

(Text with EEA relevance)

(2004/156/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC⁽¹⁾, and in particular Article 14(1) thereof,

Whereas:

- (1) The complete, consistent, transparent and accurate monitoring and reporting of greenhouse gas emissions in accordance with these guidelines is fundamental for the operation of the greenhouse gas emission allowance trading scheme established in Directive 2003/87/EC.
- (2) The guidelines contained in this Decision set out detailed criteria for the monitoring and reporting of greenhouse gas emissions resulting from the activities listed in Annex I to Directive 2003/87/EC of greenhouse gases specified in relation to those activities, based on the principles for monitoring and reporting set out in Annex IV to that Directive.
- (3) Article 15 of Directive 2003/87/EC requires Member States to ensure that reports submitted by operators are verified in accordance with the criteria set out in Annex V to that Directive.

- (4) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 8 of Council Decision 93/389/EEC⁽²⁾,

HAS ADOPTED THIS DECISION:

Article 1

The guidelines for the monitoring and reporting of greenhouse gas emissions from the activities listed in Annex I to Directive 2003/87/EC, referred to in Article 14 thereof, are set out in the Annexes to this Decision.

These guidelines are based on the principles set out in Annex IV to that Directive.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 29 January 2004.

For the Commission
Margot WALLSTRÖM
Member of the Commission

⁽¹⁾ OJ L 275, 25.10.2003, p. 32.

⁽²⁾ OJ L 167, 9.7.1993, p. 31. Decision as last amended by Regulation (EC) No 1882/2003 of the European Parliament and of the Council (OJ L 284, 31.10.2003, p. 1).

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ANNEX I

General guidelines

1. INTRODUCTION

This Annex contains the general guidelines for the monitoring and reporting of emissions from the activities listed in Annex I to Directive 2003/87/EC, hereinafter 'the Directive', of greenhouse gases specified in relation to those activities. Additional guidelines on activity-specific emissions are set out in Annexes II to XI.

The Commission will review this Annex and Annexes II-XI by 31 December 2006, taking into account experiences with the application of these Annexes and any revisions to Directive 2003/87/EC, with a view to any revised Annexes taking effect from 1 January 2008.

2. DEFINITIONS

For the purposes of this Annex and Annexes II to XI the following definitions shall apply:

- (a) 'activities' means the activities listed in Annex I to the Directive;
- (b) 'activity-specific' means specific to an activity as carried out at one specific installation;
- (c) 'batch' means an amount of fuel or material transferred as one shipment or continuously over a specific period of time. It shall be representatively sampled and characterised in respect of its average energy and carbon content and other relevant aspects of its chemical composition;
- (d) 'biomass' means non-fossilised and biodegradable organic material originating from plants, animals and micro-organisms. This shall also include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilised and biodegradable organic fractions of industrial and municipal wastes. Biomass also includes gases and liquids recovered from the decomposition of non-fossilised and biodegradable organic material. When burned for energy purposes biomass is referred to as biomass fuel;
- (e) 'combustion emissions' means greenhouse gas emissions occurring during the exothermic reaction of a fuel with oxygen;
- (f) 'competent authority' means the appropriate competent authority or authorities for the implementation of the provisions set out in this Decision, designated in accordance with Article 18 of the Directive;
- (g) 'emissions' means the release of greenhouse gases into the atmosphere from sources in an installation, as defined in the Directive;
- (h) 'greenhouse gases' means the gases listed in Annex II to the Directive;
- (i) 'greenhouse gas emissions permit' or 'permit' means a permit as referred to in Article 4 of the Directive and issued in accordance with Articles 5 and 6 of the Directive;
- (j) 'installation' means a stationary technical unit where one or more activities listed in Annex I to the Directive are carried out and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution, as defined in the Directive;
- (k) 'level of assurance' means the degree to which the verifier is confident in the verification conclusions that it has been proved whether or not the information reported for an installation taken as a whole is free from material misstatement;
- (l) 'materiality' means the professional judgment of the verifier as to whether an individual or aggregation of omissions, misrepresentations or errors that affects the information reported for an installation will reasonably influence the intended users' decisions. As a broad guide, a verifier will tend to class a misstatement in the total emissions figure as being material if it leads to aggregate omissions, misrepresentations or errors in the total emissions figure being greater than five percent;
- (m) 'monitoring methodology' means the methodology used for the determination of emissions, including the choice between calculation or measurement and the choice of tiers;

- (n) 'operator' means any person who operates or controls an installation or, where this is provided for in national legislation, to whom decisive economic power over the technical functioning of the installation has been delegated, as defined in the Directive;
- (o) 'process emissions' means greenhouse gas emissions other than 'combustion emissions' occurring as a result of intentional and unintentional reactions between substances or their transformation, including the chemical or electrolytic reduction of metal ores, the thermal decomposition of substances, and the formation of substances for use as product or feedstock;
- (p) 'reporting period' means the time period for which emissions have to be monitored and reported as set out in Article 14(3) of the Directive, being a calendar year;
- (q) 'source' means a separately identifiable point or process in an installation from which greenhouse gases are emitted;
- (r) 'tier' means a specific methodology for determining activity data, emission factors and oxidation or conversion factors. Several tiers form a hierarchy of methodologies from which a selection shall be made in accordance with these guidelines;
- (s) 'verifier' means a competent, independent, accredited verification body with responsibility for performing and reporting on the verification process, in accordance with the detailed requirements established by the Member State pursuant to Annex V to the Directive.

3. MONITORING AND REPORTING PRINCIPLES

To ensure the accurate and verifiable monitoring and reporting of greenhouse gas emissions under the Directive, monitoring and reporting shall be based on the following principles:

Completeness. Monitoring and reporting for an installation shall cover all process and combustion emissions from all sources belonging to activities listed in Annex I to the Directive and of all greenhouse gases specified in relation to those activities.

Consistency. Monitored and reported emissions shall be comparable over time, using the same monitoring methodologies and data sets. Monitoring methodologies can be changed in accordance with the provisions of these guidelines if the accuracy of the reported data is improved. Changes in monitoring methodologies shall be subject to approval from the competent authority and shall be fully documented.

Transparency. Monitoring data, including assumptions, references, activity data, emission factors, oxidation factors and conversion factors shall be obtained, recorded, compiled, analysed and documented in a manner that enables the reproduction of the determination of emissions by the verifier and the competent authority.

Accuracy. It shall be ensured that the emission determination is systematically neither over nor under true emissions, as far as can be judged, and that uncertainties are reduced as far as practicable and quantified where required under these guidelines. Due diligence shall be exercised to ensure that the calculation and measurement of emissions exhibit the highest achievable accuracy. The operator shall provide reasonable assurance of the integrity of reported emissions. Emissions shall be determined using the appropriate monitoring methodologies set out in these guidelines. All metering or other testing equipment used to report monitoring data shall be appropriately applied, maintained and calibrated, and checked. Spreadsheets and other tools used to store and manipulate monitoring data shall be free from error.

Cost effectiveness. In selecting a monitoring methodology, the improvements from greater accuracy shall be balanced against the additional costs. Hence, monitoring and reporting of emissions shall aim for the highest achievable accuracy, unless this is technically not feasible or will lead to unreasonably high costs. The monitoring methodology itself shall describe the instructions to the operator in a logical and simple manner, avoiding duplication of effort and taking into account the existing systems in place at the installation.

Materiality. An emission report and related disclosures shall be free from material misstatement, avoid bias in the selection and presentation of information, and provide a credible and balanced account of an installation's emissions.

Faithfulness. A verified emissions report shall be capable of being depended upon by users to represent faithfully that which it either purports to represent or could reasonably be expected to represent.

Improvement of performance in monitoring and reporting emissions. The process of verifying the emission reports shall be an effective and reliable tool in its support of quality assurance and quality control procedures, providing information upon which an operator can act to improve its performance in monitoring and reporting emissions.

4. MONITORING

4.1. **Boundaries**

The monitoring and reporting process for an installation shall include all emissions from all sources belonging to activities listed in Annex I to the Directive, carried out at the installation, of greenhouse gases specified in relation to those activities.

Article 6(2)(b) of the Directive requires that greenhouse gas emissions permits shall contain a description of the activities and emission from the installation. Therefore, all sources of greenhouse gas emissions from activities listed in Annex I to the Directive that are to be monitored and reported shall be listed in the permit. Article 6(2)(c) of the Directive requires that greenhouse gas emissions permits shall contain monitoring requirements, specifying monitoring methodology and frequency.

Emissions from internal combustion engines for transportation purposes shall be excluded from the emission estimates.

The monitoring of emissions shall include emissions from regular operations and abnormal events including start-up and shut-down and emergency situations over the reporting period.

If the separate or combined production capacities or outputs of one or several activities belonging to the same activity subheading in Annex I to the Directive exceed the respective threshold defined in Annex I to the Directive in one installation or on one site, all emissions from all sources of all activities listed in Annex I to the Directive in the respective installation or site shall be monitored and reported.

Whether an additional combustion installation, such as a combined heat and power installation, is regarded as part of an installation carrying out another Annex I activity or as a separate installation depends on local circumstances and shall be established in the installation's greenhouse gas emission permit.

All emissions from an installation shall be assigned to that installation, regardless of exports of heat or electricity to other installations. Emissions associated with the production of heat or electricity imported from other installations shall not be assigned to the importing installation.

4.2. **Determination of greenhouse gas emissions**

The complete, transparent and accurate monitoring of greenhouse gas emissions requires decisions to be taken when determining appropriate monitoring methodologies. This includes deciding between measurement and calculation as well as selecting specific tiers for the determination of activity data, emission factors and oxidation or conversion factors. The sum of approaches used by an operator for an installation for the determination of its emissions is referred to as a monitoring methodology.

Article 6(2)(c) of the Directive requires that greenhouse gas emissions permits shall contain monitoring requirements, specifying monitoring methodology and frequency. Each monitoring methodology shall be approved by the competent authority in accordance with the criteria set out in this section and its subsections. The Member State or its competent authorities shall ensure that the monitoring methodology to be applied by installations shall be specified either under the conditions of the permit or, where consistent with the Directive, in general binding rules.

The competent authority shall approve a detailed description of the monitoring methodology prepared by the operator before the start of the reporting period, and again after any change to the monitoring methodology applied to an installation.

This description shall contain:

- the exact definition of the installation and activities carried out by the installation to be monitored,
- information on responsibilities for monitoring and reporting within the installation,
- a list of sources for each activity carried out within the installation,
- a list of fuel and material streams to be monitored for each activity,
- a list of tiers to be applied for activity data, emission factors, oxidation and conversion factors for each of the activities and fuels types/materials,
- a description of the type, specification and exact location of the metering devices to be used for each of the sources and fuels types/materials,
- a description of the approach to be used for the sampling of fuel and materials for the determination of net calorific value, carbon content, emission factors, and biomass content for each of the sources and fuel types/materials,
- a description of the intended sources or analytical approaches for the determination of the net calorific values, carbon content or biomass fraction for each of the sources and fuels types/materials,
- a description of continuous emission measurement systems to be used for the monitoring of a source, i.e. the points of measurement, frequency of measurements, equipment used, calibration procedures and data collection and storage procedures (if applicable),
- a description of the quality assurance and quality control procedures for data management,
- where applicable, information on relevant links with activities undertaken under the Community eco-management and audit scheme (EMAS).

The monitoring methodology shall be changed if this improves the accuracy of the reported data, unless this is technically not feasible or will lead to unreasonably high costs. All proposed changes in monitoring methodologies or the underlying data sets shall be clearly stated, justified, fully documented and submitted to the competent authority. All changes in methodologies or the underlying data sets shall be subject to approval from the competent authority.

The operator shall without undue delay propose changes to the monitoring methodology when:

- accessible data has changed, allowing for higher accuracy in the determination of emissions,
- a previously non-existent emission has started,
- errors were detected in data resulting from the monitoring methodology,
- the competent authority has requested a change.

A competent authority may require the operator to change its monitoring methodology for the next reporting period if the reporting installation's monitoring methodologies are no longer in conformity with the rules laid down in these guidelines.

A competent authority may also require the operator to change its monitoring methodology for the next reporting period if the monitoring methodology under the permit has been updated in accordance with a review to be undertaken before each period referred to in Article 11(2) of the Directive.

4.2.1. *Calculation and measurement*

Annex IV to the Directive permits a determination of emissions using either:

- a calculation-based methodology ('calculation')
- a measurement-based methodology ('measurement').

The operator may propose to measure emissions if he can demonstrate that:

- it reliably gives higher accuracy than the relevant calculation applying a combination of the highest tiers, and
- the comparison between measurement and calculation is based on an identical list of sources and emissions.

The use of measurement shall be subject to the approval of the competent authority. For each reporting period the operator shall corroborate the measured emissions by means of calculation in accordance with these guidelines. The rules for the selection of the tiers of the corroborating calculation shall be the same as those applied for a calculation approach, set out in point 4.2.2.1.4.

The operator may, with the approval of the competent authority, combine measurement and calculation for different sources belonging to one installation. The operator shall ensure and demonstrate that neither gaps nor double counting concerning emissions occur.

4.2.2. Calculation

4.2.2.1. Calculation of CO₂ emissions

4.2.2.1.1. Calculation formulae

Calculation of CO₂ emissions shall be based either on the following formula:

$$\text{CO}_2 \text{ emissions} = \text{activity data} * \text{emission factor} * \text{oxidation factor}$$

or on an alternative approach if defined in the activity-specific guidelines.

The expressions within this formula are specified for combustion emission and process emissions as follows:

Combustion emissions

Activity data shall be based on fuel consumption. The quantity of fuel used shall be expressed in terms of energy content as TJ. The emission factor shall be expressed as tCO₂/TJ. When energy is consumed not all of the carbon in the fuel oxidises to CO₂. Incomplete oxidation occurs due to inefficiencies in the combustion process that leave some of the carbon unburned or partly oxidised as soot or ash. Unoxidised carbon is taken into account in the oxidation factor which shall be expressed as a fraction. In the event that the oxidation factor is taken into account in the emission factor, a separate oxidation factor shall not be applied. The oxidation factor shall be expressed as a percentage. The resulting calculation formula is:

$$\text{CO}_2 \text{ emissions} = \text{fuel consumption [TJ]} * \text{emission factor [tCO}_2\text{/TJ]} * \text{oxidation factor}$$

The calculation of combustion emissions is further specified in Annex II.

Process emissions

Activity data shall be based on material consumption, throughput or production output and expressed in t or m³. The emission factor shall be expressed in [t CO₂/t or t CO₂/m³]. Carbon contained in input materials which is not converted to CO₂ during the process, is taken into account in the conversion factor which shall be expressed as a fraction. In the event that a conversion factor is taken into account in the emission factor, a separate conversion factor shall not be applied. The quantity of input material used shall be expressed in terms of mass or volume [t or m³]. The resulting calculation formula is:

$$\text{CO}_2 \text{ emissions} = \text{activity data [t or m}^3\text{]} * \text{emission factor [t CO}_2\text{/t or m}^3\text{]} * \text{conversion factor}$$

The calculation of process emissions is further specified in the activity-specific guidelines in Annexes II to XI where sometimes specific reference factors are given.

4.2.2.1.2. Transferred CO₂

CO₂ which is not emitted from the installation but transferred out of the installation as a pure substance, as a component of fuels or directly used as a feedstock in the chemical or paper industry, shall be subtracted from the calculated level of emissions. The respective amount of CO₂ shall be reported as a memo item.

CO₂ that is transferred out of the installation for the following uses may be considered as transferred CO₂:

- pure CO₂ used for the carbonation of beverages,
- pure CO₂ used as dry ice for cooling purposes,

- pure CO₂ used as fire extinguishing agent, refrigerant or as laboratory gas,
- pure CO₂ used for grains disinfestations,
- pure CO₂ used as solvent in the food or chemical industry,
- CO₂ used as feedstock in the chemical and pulp industry (e.g. for urea or carbonates),
- CO₂ which is part of a fuel being exported from that installation.

CO₂ being transferred to an installation as part of a mixed fuel (such as blast furnace gas or coke oven gas) shall be included in the emission factor for that fuel. Thereby, it shall be added to the emissions of the installation where the fuel is combusted and deducted from the installation of origin.

4.2.2.1.3. CO₂ capture and storage

The Commission is stimulating research into the capture and storage of CO₂. This research will be important for the development and adoption of guidelines on the monitoring and reporting of CO₂ capture and storage, where covered under the Directive, in accordance with the procedure referred to in Article 23(2) of the Directive. Such guidelines will take into account the methodologies developed by the UNFCCC. Member States interested in the development of such guidelines are invited to submit their research findings to the Commission in order to promote the timely adoption of such guidelines.

Before such guidelines are adopted, Member States may submit to the Commission interim guidelines for the monitoring and reporting of the capture and storage of CO₂ where covered under the Directive. Subject to the approval of the Commission, in accordance with the procedures referred to in Article 23(2) of the Directive, the capture and storage of CO₂ may be subtracted from the calculated level of emissions from installations covered under the Directive in accordance with those interim guidelines.

4.2.2.1.4. Tiers of approaches

The activity-specific guidelines set out in Annexes II to XI contain specific methodologies for determining the following variables: activity data, emission factors, oxidation or conversion factors. These different approaches are referred to as tiers. The increasing numbering of tiers from 1 upwards reflects increasing levels of accuracy, with the highest numbered tier as the preferred tier. Equivalent tiers are referred to with the same tier number and a specific alphabetic character (e.g. Tier 2a and 2b). For those activities where alternative calculation methods are provided within these guidelines (e.g. in Annex VII: 'Method A — Carbonates' and 'Method B — Clinker production') an operator may only change from one method to the other if he can demonstrate to the satisfaction of the competent authority that such change will lead to a more accurate monitoring and reporting of the emissions of the relevant activity.

The highest tier approach shall be used by all operators to determine all variables for all sources within an installation for monitoring and reporting purposes. Only if it is shown to the satisfaction of the competent authority that the highest tier approach is technically not feasible or will lead to unreasonably high costs, may a next lower tier be used for that variable within a monitoring methodology.

Therefore, the selected tier shall reflect the highest level of accuracy that is technically feasible and does not lead to unreasonably high costs. The operator may apply different approved tiers to the variables: activity data, emission factors, oxidation or conversion factors used within a single calculation. The choice of tiers shall be subject to approval by the competent authority (see section 4.2).

During the period 2005 to 2007, Member States should apply as a minimum the tiers as set out in table 1 below, unless this is technically not feasible. Columns A contain tier values for major sources from installations with total annual emissions equal to or less than 50 ktonnes. Columns B contain tier values for major sources from installations with total annual emissions of more than 50 ktonnes but less than and including 500 ktonnes. Columns C contain tier values for major sources from installations with total annual emissions of more than 500 ktonnes. The size thresholds contained in the table refer to total annual emissions from the entire installation.

Annex/Activity	Activity data			Net calorific value			Emission factor			Composition data			Oxidation factor			Conversion factor		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Fuel as process input	2	2	3	2	2	3	1	2	2	1	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
V: MO roasting and sintering																		
Mass balance	2	2	3	1	1	1	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Carbonate input	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
VI: Iron and steel																		
Mass balance	2	2	3	1	1	1	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Fuel as process input	2	2	3	2	2	3	1	2	2	1	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII: Cement																		
Carbonates	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
Clinker output	1	2a/2b	2a/2b	n.a.	n.a.	n.a.	1	2	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
CKD	1	2	2	n.a.	n.a.	n.a.	1	2	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
VIII: Lime																		
Carbonates	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
Alkali oxide	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
IX: Glass																		
Carbonates	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1

Annex/Activity	Activity data			Net calorific value			Emission factor			Composition data			Oxidation factor			Conversion factor		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Alkali oxide	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
X: Ceramic																		
Carbonates	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
Alkali oxide	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
Scrubbing	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1
XI: Pulp and paper																		
Standard method	1	2	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	1	1

With the approval of the competent authority, the operator may apply lower tiers for the variables used to calculate emissions from minor sources, including minor streams of fuels or materials than the tiers applied for the variables used to calculate emissions from major sources or major streams of fuels or materials within an installation. Major sources, including major streams of fuels and materials are those which, if ranked in order of their decreasing magnitude, cumulatively contribute at least 95 % to the total annual emissions of the installation. Minor sources are those emitting 2,5 ktonnes or less per year or that contribute 5 % or less to the total annual emissions of an installation, whichever is the highest in terms of absolute emissions. For those minor sources jointly emitting 0,5 ktonnes or less per year or that contribute less than 1 % of total annual emissions of that installation, whichever is the highest in terms of absolute emissions, the operator of an installation may apply a *de minimis* approach for monitoring and reporting using his own no-tier estimation method, subject to the approval of the competent authority.

For pure biomass fuels, lower tier approaches may be applied unless the respective calculated emissions are to be used for the subtraction of biomass carbon from carbon dioxide emissions derived by means of continuous emission measurement.

The operator shall without undue delay propose changes to the tiers applied when:

- accessible data has changed, allowing for higher accuracy in the determination of emissions,
- errors were detected in data resulting from the monitoring methodology,
- the competent authority has requested a change.

For installations with a total of more than 500 ktonnes of annual CO₂ equivalent emissions the competent authority shall notify the Commission by 30 September of each year, starting in 2004, if the application of a combination of highest tier approaches for major sources within that installation for the forthcoming reporting period is found to be technically not feasible or is expected to lead to unreasonably high costs. On the basis of this information received from the competent authorities, the Commission will consider whether a revision of the rules on the selection of tiers is appropriate.

If the highest tier methodology, or the variable-specific agreed tier is temporarily not feasible for technical reasons, an operator may apply the highest achievable tier until such time as the conditions for application of the former tier have been restored. The operator shall without undue delay provide proof of the necessity for a change of tiers to the competent authority and details of the interim monitoring methodology. The operator shall take all necessary action to allow the prompt restoration of the original tier for monitoring and reporting purposes.

Changes of tiers shall be fully documented. The treatment of minor data gaps which result from downtimes of metering equipment shall follow good professional practice and the provisions of the Integrated pollution prevention and control (IPPC) reference document on the general principles of monitoring of July 2003 ⁽¹⁾.

When tiers are changed within a reporting period the results for the affected activity shall be calculated and reported as separate sections of the annual report to the competent authority for the respective parts of the reporting period.

4.2.2.1.5. Activity data

Activity data represents information on material flow, consumption of fuel, input material or production output expressed as energy content [TJ] determined as net calorific value for fuels and mass or volume for input or output materials [t or m³].

Where activity data for the calculation of process emissions cannot be measured directly before entering the process and no specific requirements are listed in any of the tiers of the respective activity-specific guidelines (Annexes II to XI), activity data shall be determined via an assessment of stock changes:

$$\text{Material C} = \text{Material P} + (\text{Material S} - \text{Material E}) - \text{Material O}$$

⁽¹⁾ Available through: <http://eippcb.jrc.es/>

where:

Material C: Material processed during the reporting period

Material P: Material purchased during the reporting period

Material S: Material stock at the beginning of the reporting period

Material E: Material stock at the end of the reporting period

Material O: Material used for other purposes (transportation or resold)

In cases in which it is technically not feasible or would lead to unreasonably high costs to determine 'Material S' and 'Material E' by measurement e.g. metering, the operator may estimate these two quantities based on data from previous years and correlation with output for the reporting period. The operator shall then corroborate these estimates with supporting documented calculations and respective financial statements. All other requirements on tier selection shall remain unaffected by this provision, e.g. 'Material P' and 'Material O' and respective emission or oxidation factors shall be determined according to the activity-specific guidelines in Annexes II to XI.

To assist the selection of appropriate tiers for activity data, table 2 below gives an overview of ranges of typical uncertainties found for different types of metering devices used to determine mass fluxes of fuels, material flow, input materials or production output. The table may be used to inform competent authorities and operators about the possibilities and limitations for applying appropriate tiers for the determination of activity data.

TABLE 2

Informative table with the uncertainty ranges typically found for different metering devices under stable operating conditions

Metering device	Media	Field of application	Range of typical uncertainties
Orifice meter	gas	various gases	± 1-3 %
Venturi tube meter	gas	various gases	± 1-3 %
Ultrasonic flow meter	gas	natural gas/miscellaneous gases	± 0,5-1,5 %
Rotary meter	gas	natural gas/miscellaneous gases	± 1-3 %
Turbine meter	gas	natural gas/miscellaneous gases	± 1-3 %
Ultrasonic flow meter	liquid	liquid fuels	± 1-2 %
Magnetic inductive meter	liquid	conductive fluids	± 0,5-2 %
Turbine meter	liquid	liquid fuels	± 0,5-2 %
Truck scale	solid	miscellaneous raw materials	± 2-7 %
Rail scale (trains — moving)	solid	coal	± 1-3 %
Rail scale (single car)	solid	coal	± 0,5-1,0 %
Ship — river (displacement)	solid	coal	± 0,5-1,0 %

Metering device	Media	Field of application	Range of typical uncertainties
Ship — ocean (displacement)	solid	coal	± 0,5-1,5 %
Belt scale with integrator	solid	miscellaneous raw materials	± 1-4 %

4.2.2.1.6. Emission factors

Emission factors are based on the carbon content of fuels or input materials and expressed as tCO₂/TJ (combustion emissions), or tCO₂/t or tCO₂/m³ (process emissions). Emission factors and provisions for the development of activity-specific emission factors are given in sections 8 and 10 of this Annex. An operator may use an emission factor for a fuel expressed as carbon content (tCO₂/t) rather than tCO₂/TJ for combustion emissions if he demonstrates to the competent authority that this leads to a permanently higher accuracy. In this case the operator shall nevertheless periodically determine the energy content to meet his reporting requirements as specified in section 5 of this Annex.

For the conversion of carbon into the respective value for CO₂ the factor ⁽²⁾ of 3,667 [t CO₂/t C] shall be used.

The more accurate tiers require the development of activity-specific factors in accordance with the requirements contained in section 10 of this Annex. The tier 1 approaches require the use of reference emission factors, which are listed in section 8 of this Annex.

Biomass is considered as CO₂-neutral. An emission factor of 0 [t CO₂/TJ or t or m³] shall be applied to biomass. An exemplary list of different types of materials accepted as biomass is given in section 9 of this Annex.

For fossil waste fuels no reference emission factors are provided in these guidelines, therefore specific emission factors shall be derived according to the provisions of section 10 of this Annex.

For fuels or materials containing both fossil and biomass carbon, a weighted emission factor shall be applied, based on the proportion of the fossil carbon in the fuel's overall carbon content. This calculation shall be transparent and documented in accordance with the rules and procedures of section 10 of this Annex.

All relevant information regarding the emission factors used, including information sources and results of analyses of fuel, input and output material shall be clearly recorded. More detailed requirements are set out in the activity-specific guidelines.

4.2.2.1.7. Oxidation/Conversion factors

If an emission factor does not reflect the proportion of the carbon that is not oxidised, then an additional oxidation/conversion factor shall be used.

The more accurate tiers require the development of activity-specific factors, therefore provisions for deriving these factors are set out in section 10 of this Annex.

If different fuels or material are used within an installation and activity-specific oxidation factors are calculated, the operator may determine one aggregate oxidation factor for the activity and apply it to all fuels or material, or attribute incomplete oxidation to one major stream of fuel or material and use a value of 1 for the others.

All relevant information regarding the oxidation/conversion factors used, including information sources and results of analyses of fuel, input and output material, shall be clearly recorded.

4.2.2.2. Calculation of non-CO₂ greenhouse gas emissions

General guidelines for the calculation of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

⁽²⁾ Based on the ratio of atomic masses of carbon (12) and oxygen (16) as used in the Revised 1996 IPCC guidelines for national greenhouse gas inventories: Reference manual, 1.13.

4.2.3. *Measurement*

4.2.3.1. Measurement of CO₂ emissions

As set out in section 4.2.1, greenhouse gas emissions may be determined using continuous emission measurement systems (CEMS) from each source using standardised or accepted methods once the operator has received approval from the competent authority before the reporting period that using a CEMS achieves greater accuracy than the calculation of emissions using the most accurate tier approach. For each reporting period thereafter, emissions determined using CEMS shall be corroborated by a supporting calculation of emissions, with the rules for the selection of the tiers being the same as those applied for a calculation approach, set out in paragraph 4.2.2.1.4.

Measurement procedures for CO₂ concentrations as well as for the mass or volume flow of off-gases through each stack shall use relevant CEN standards as soon as they are available. If CEN standards are not available, ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with draft standards or industry best practice guidelines.

Examples for relevant ISO standards are the following:

- ISO 10396:1993 'Stationary source emissions — Sampling for the automated determination of gas concentrations',
- ISO 10012:2003 'Measurement management systems — Requirements for measurement processes and measuring equipment'.

Once the CEMS has been installed it shall be periodically checked for functionality and performance, including:

- response time,
- linearity,
- interference,
- zero and span drift,
- accuracy against a reference method.

The biomass fraction of measured CO₂ emissions shall be subtracted based on the calculation approach and shall be reported as a memo item (see section 12 of this Annex).

4.2.3.2. Measurement of non-CO₂ emissions

General guidelines for the measurement of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

4.3. **Uncertainty assessment**

'Permissible uncertainty' within these guidelines shall be expressed as the 95 % confidence interval around the measured value, e.g. when characterising metering equipment for the tier system or the accuracy of a continuous measurement system.

4.3.1. *Calculation*

The operator shall have an understanding of the impact of uncertainty on the overall accuracy of his reported emission data.

Under the calculation-based methodology, the competent authority will have approved the combination of tiers for each source in an installation plus approved all other details of the monitoring methodology for that installation as contained within the installation's permit. In doing so, the competent authority has authorised the uncertainty directly resulting from correct application of the approved monitoring methodology, and the evidence of that approval is the content of the permit.

The operator shall state the approved combination of tiers for each source in an installation in his annual emissions report to the competent authority for each activity and relevant stream of fuel or material. Stating the combination of tiers in the emissions report shall constitute reporting uncertainty for the purposes of the Directive. Hence there is no further requirement to report on uncertainty if the calculation-based methodology is applied.

The permissible uncertainty determined for metering equipment within the tier system shall comprise the specified uncertainty of metering equipment, uncertainty associated to the calibration and any additional uncertainty connected to how the metering equipment is used in practice. The stated threshold values within the tier system refer to the uncertainty associated to the value for one reporting period.

The operator, via the quality assurance and control process, shall manage and reduce the remaining uncertainties of the emissions data in his emissions report. During the verification process, the verifier shall check the correct application of the approved monitoring methodology, and shall assess the management and reduction of remaining uncertainties via the operator's quality assurance and control procedures.

4.3.2. *Measurement*

As set out in section 4.2.1, an operator can justify the use of a measurement based methodology if it reliably gives higher accuracy than the relevant calculation-based methodology applying a combination of the highest tiers. In order to provide this justification to the competent authority, the operator shall report the quantitative results of a more comprehensive uncertainty analysis considering the following sources of uncertainty

Concentration measurements for the continuous emission measurement:

- the specified uncertainty of continuous measurement equipment,
- uncertainties associated to the calibration,
- additional uncertainty connected to how the monitoring equipment is used in practice.

In mass and volume metering for the determination of the waste gas stream for the continuous emission monitoring and the corroborating calculation:

- the specified uncertainty of metering equipment,
- uncertainties associated to the calibration,
- additional uncertainty connected to how the metering equipment is used in practice.

In the determination of the calorific values, emission and oxidation factors or composition data for the corroborating calculation:

- the specified uncertainty from the applied calculation method or system,
- additional uncertainty connected to how the calculation method is used in practice.

On the basis of the operator's justification, the competent authority may approve the operator's use of a continuous emission measurement system for certain sources in an installation plus approve all other details of the monitoring methodology for those sources as to be contained within the installation's permit. In doing so, the competent authority has authorised the uncertainty directly resulting from correct application of the approved monitoring methodology, and the evidence of that approval is the content of the permit.

The operator shall state the uncertainty figure resulting from this initial comprehensive uncertainty analysis in his annual emissions report to the competent authority for the relevant sources until such point that the competent authority reviews the choice of measurement over calculation and requests that the uncertainty figure be recalculated. Stating this uncertainty figure in the emissions report shall constitute reporting uncertainty for the purposes of the Directive.

The operator, via the quality assurance and control process, shall manage and reduce the remaining uncertainties of the emissions data in his emissions report. During the verification process, the verifier shall check the correct application of the approved monitoring methodology, and shall assess the management and reduction of remaining uncertainties via the operator's quality assurance and control procedures.

4.3.3. Illustrative uncertainty figures

Table 3 gives an indicative overview of overall uncertainty typically achievable with respect to determination of CO₂ emissions from installations of different magnitudes of emissions levels. The information in this table should be considered by the competent authority when evaluating or approving the monitoring methodology of a given installation using calculation methods or using continuous emissions measurement systems.

TABLE 3

Informative table with typical overall uncertainties associated to the determination of CO₂ emissions from an installation or activity in an installation for individual fuel or material streams of different magnitudes

Description	Examples	E: CO ₂ -emission in ktonnes per year		
		E > 500	100 < E < 500	E < 100
Gaseous and liquid fuels with constant quality	natural gas	2,5	3,5	5
Liquid fuels and gaseous fuels with varying composition	gas oil; blast furnace gas	3,5	5	10
Solid fuels with varying composition	coal	3	5	10
Solid fuels with strongly varying composition	waste	5	10	12,5
Process emissions from solid raw materials	limestone, dolomite	5	7,5	10

5. REPORTING

Annex IV to the Directive sets out the reporting requirements for installations. The reporting format set out in section 11 of this Annex shall be used as a basis for reporting of the quantitative data. The report shall be verified in accordance with the detailed requirements established by the Member State pursuant to Annex V to the Directive. The operator shall submit the verified report to the competent authority by 31 March each year for emissions during the preceding year.

Emission reports held by the competent authority shall be made available to the public by that authority subject to the rules laid down in Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC⁽³⁾. With regard to the application of the exception laid down in Article 4 (2) (d) of that Directive, operators may indicate in their report which information they consider commercially sensitive.

Each operator shall include the following information in the report for an installation:

1. data identifying the installation, as specified in Annex IV to the Directive, and its unique permit number;

⁽³⁾ OJ L 41, 14.2.2003, p. 26.

2. for all sources the emission totals, chosen approach (measurement or calculation), chosen tiers and method (if applicable), activity data ⁽⁴⁾, emission factors ⁽⁵⁾, and oxidation/conversion factors ⁽⁶⁾. If a mass balance is applied operators shall report the mass flow, carbon and energy content for each fuel and material stream into and out of the installation and their stocks;
3. temporal or permanent changes of tiers, reasons for these changes, starting date for changes, and starting and ending dates of temporal changes;
4. any other changes in the installation during the reporting period that may be relevant for the emissions report.

Information to be provided under points 3 and 4 and supplementary information regarding point 2 is not suitable for presentation in the tabulated form of the reporting format and shall therefore be included in the annual emission report as plain text.

The following items, which are not accounted for in terms of emissions, shall be reported as memo items:

- amounts of biomass combusted [TJ] or employed in processes [t or m³],
- CO₂ emissions [t CO₂] from biomass where measurement is used to determine emissions,
- CO₂ transferred from an installation [t CO₂], and in what type of compounds it was transferred.

Fuels and resulting emissions shall be reported using the IPCC standard fuel categories (see section 8 of this Annex) which are based on the definitions of the International Energy Agency (<http://www.iea.org/stats/defs/defs.htm>). In the event that the Member State relevant to the operator has published a list of fuel categories including definitions and emission factors consistent with its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change these categories and their emissions factors shall be used if approved under the relevant monitoring methodology.

In addition, waste types and emissions resulting from their use as fuels or input materials shall be reported. The waste types shall be reported using the classification of the 'European List of Wastes' (Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste ⁽⁷⁾): (<http://europa.eu.int/comm/environment/waste/legislation/a.htm>). The respective six-digit codes shall be added to the names of the relevant waste types used in the installation.

Emissions occurring from different sources of a single installation belonging to the same type of activity may be reported in an aggregate manner for the type of activity.

Emissions shall be reported as rounded tonnes of CO₂ (for example 1 245 978 tonnes). Activity data, emission factors and oxidation or conversion factors shall be rounded to include only significant digits both for emission calculations and reporting purposes, for example only a total of five digits (for example 1,2369) for a value which exhibits an uncertainty of ± 0,01 %.

In order to achieve consistency between data reported under the Directive and data reported by Member States under the UN Framework Convention on Climate Change and other emission data reported for the European pollutant emission register (EPER), each activity carried out by an installation shall be labelled applying the codes from the following two reporting schemes:

- (1) the common reporting format for national greenhouse gas inventory systems as approved by the respective bodies of the United Nations Framework Convention on Climate Change (see section 12.1 of this Annex);
- (2) the IPPC code of Annex A3 of the European pollutant emission register (EPER) (see section 12.2 of this Annex).

⁽⁴⁾ Activity data for combustion activities shall be reported as energy (net calorific value) and mass. Biomass fuels or input materials also have to be reported as activity data.

⁽⁵⁾ Emission factors for combustion activities shall be reported as CO₂ emission per energy content.

⁽⁶⁾ Conversion and oxidation factors shall be reported as dimensionless fractions.

⁽⁷⁾ OJ L 226, 6.9.2000, p. 3. Most recently amended by Council Decision 2001/573/EC (OJ L 203, 28.7.2001, p. 18).

6. RETENTION OF INFORMATION

An operator of an installation shall document and archive monitoring data for the installation's emissions from all sources belonging to activities listed in Annex I to the Directive of greenhouse gases specified in relation to those activities.

The documented and archived monitoring data shall be sufficient to allow for the verification of the annual emissions report of an installation's emissions submitted by the operator pursuant to Article 14(3) to the Directive, in accordance with the criteria set out in Annex V to the Directive.

Data that are not part of the annual emissions report shall not be required to be reported or made public otherwise.

To allow reproducibility of the determination of emissions by the verifier or another third party, an operator of an installation shall retain for at least 10 years after the submission of the report pursuant to Article 14(3) of the Directive for each reporting year:

For the calculation approach:

- the list of all sources monitored,
- the activity data used for any calculation of the emissions for each source of greenhouse gases, categorised by process and fuel type,
- documents justifying the selection of the monitoring methodology and the documents justifying temporal or non-temporal changes of monitoring methodologies and tiers approved by the competent authority,
- documentation of the monitoring methodology and results from the development of activity-specific emission factors and biomass fractions for specific fuels, and oxidation or conversion factors, and respective proofs of approval from the competent authority,
- documentation of the process of collection of activity data for the installation and its sources,
- the activity data, emission, oxidation or conversion factors submitted to the competent authority for the national allocation plan for years preceding the time period covered by the trading scheme,
- documentation of the responsibilities in connection to the emissions monitoring,
- the annual emissions report, and
- any other information that is identified as required for the verification of the annual emissions report.

The following additional information shall be retained if the measurement approach is applied:

- documentation justifying the selection of measurement as a monitoring methodology,
- the data used for the uncertainty analysis of emissions from each source of greenhouse gases, categorised by process and fuel type,
- a detailed technical description of the continuous measurement system including the documentation of the approval from the competent authority,
- raw and aggregated data from the continuous measurement system, including documentation of changes over time, the logbook on tests, down-times, calibrations, servicing and maintenance,
- documentation of any changes of the measurement system.

7. QUALITY ASSURANCE AND CONTROL

7.1. General requirements

The operator shall establish, document, implement and maintain an effective data management system for the monitoring and reporting of greenhouse gas emissions in accordance with these guidelines. The operator shall put in place this data management system before the start of the reporting period, in order that all data is recorded and controlled appropriately in preparation for verification. The information stored within the data management system shall include the information listed under section 6.

The required quality assurance and control procedures may be implemented in the context of the EU EcoManagement and audit scheme (EMAS) or other environmental management systems, including ISO 14001:1996 ('Environmental management systems — Specification with guidance for use').

Quality assurance and control procedures shall address the procedures needed for monitoring and reporting of greenhouse gases and the application of these procedures within the installation and shall include, *inter alia*:

- identification of greenhouse gas sources covered by the scheme under Annex I to the Directive,
- the sequence and interaction of monitoring and reporting processes,
- responsibilities and competence,
- the methods of calculations or measurement which are used,
- the measuring equipment used (if applicable),
- reporting and records,
- internal reviews of both reported data and the quality system,
- corrective and preventive action.

Where an operator chooses to outsource any process that affects the quality assurance and control procedures, the operator shall ensure control over and transparency of such processes. The relevant control and transparency measures of such outsourced processes shall be identified within the quality assurance and control procedures.

7.2. Measuring techniques and devices

The operator shall ensure that relevant measuring equipment is calibrated, adjusted and checked at regular intervals including prior to use, and checked against measurement standards traceable to international measurement standards. In addition, the operator shall assess and record the validity of the previous measuring results when the equipment is found not to conform to requirements. When the equipment is found not to conform to requirements, the operator shall promptly take necessary remedial action. Records of the results of calibration and authentication shall be retained.

If the operator is working with a continuous emission measurement system, the operator shall comply with the orders of the EN 14181 ('Stationary source emissions — Quality assurance of automated measuring systems') and of the EN ISO 14956:2002 ('Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required uncertainty') for the instruments and the operator.

Alternatively, independent and accredited test laboratories may be entrusted with the measurements, evaluation of data, monitoring and reporting. In this case the test laboratories shall in addition be accredited against the EN ISO 17025:2000 ('General requirements for the competence of testing and calibration laboratories').

7.3. Data management

The operator shall perform data management quality assurance and control processes on its data to prevent omissions, misrepresentations and errors. Such processes shall be designed by the operator based on the complexity of the data set. The data management quality assurance and control processes shall be recorded and made available to the verifier.

Simple and effective data quality assurance and quality control can be performed at the operational level by comparisons of monitored values using vertical and horizontal approaches.

A vertical approach compares emissions data monitored for the same installation in different years. A monitoring error is probable if differences between annual data cannot be explained by:

- changes in activity levels,
- changes concerning fuels or input material,
- changes concerning the emitting processes (e.g. energy efficiency improvements).

A horizontal approach compares values resulting from different operational data collection systems, including:

- comparison of data on fuel or input material consumed by specific sources with fuel purchasing data and data on stock changes,
- comparison of total data on fuel or input material consumption data with fuel purchasing data and data on stock changes,
- comparison of emission factors that have been calculated or obtained from the fuel supplier, to national or international reference emission factors of comparable fuels,
- comparison of emission factors based on fuel analyses to national or international reference emission factors of comparable fuels,
- comparison of measured and calculated emissions.

7.4. **Verification and materiality**

The operator shall submit the emissions report, a copy of its permit for each of its installations, plus any other relevant information to the verifier. The verifier shall assess whether the monitoring methodology applied by the operator complies with the installation's monitoring methodology as approved by the competent authority, the principles for monitoring and reporting presented in section 3, and the guidelines laid down in this and subsequent Annexes. On the basis of this assessment the verifier shall conclude as to whether the data within the emissions report contains omissions, misrepresentations or errors that lead to material misstatement of the reported information.

As part of the verification process, the verifier shall in particular:

- understand each activity undertaken by the installation, the sources of emissions within the installation, the metering equipment used to monitor or measure activity data, the origin and application of emission factors and oxidation/conversion factors, and the environment in which the installation operates,
- understand the operator's data management system and overall organisation with respect to monitoring and reporting, and obtain, analyse and check the data contained within the data management system,
- establish an acceptable materiality level in the context of the nature and complexity of the installation's activities and sources,
- analyse the data risks which could lead to a material misstatement within the emissions report, based on the verifier's professional knowledge and the information submitted by the operator,
- draw up a verification plan which is commensurate with this risk analysis and the scope and complexity of the operator's activities and sources, and which defines the sampling methods to be used with respect to that operator's installations,
- carry out the verification plan by gathering data in accordance with the defined sampling methods, plus all relevant additional evidence, upon which the verifier's verification conclusion will be based,
- check that the application of the monitoring methodology specified in the permit has delivered an accuracy level consistent with the defined tiers,
- request the operator to provide any missing data or complete missing sections of audit trails, explain variations in the emissions data, or revise calculations, before reaching a final verification conclusion.

Throughout the verification process, the verifier shall determine misstatements by assessing whether:

- the quality assurance and control processes described in 7.1, 7.2 and 7.3 have been implemented,
- there is clear and objective evidence obtained through the gathering of data to support the determination of misstatements.

The verifier shall assess the materiality both of any individual misstatement and of the aggregate of uncorrected misstatements, taking into account any omission, misrepresentation or error that that could lead to misstatement, for example a data management system that produces non-transparent, biased or inconsistent figures. The level of assurance shall be commensurate with the materiality threshold determined for that installation.

At the end of the verification process, the verifier shall make a judgment with respect to whether the emissions report contains any material misstatement. If the verifier concludes that the emissions report does not contain any material misstatement, the operator can submit the emissions report to the competent authority in accordance with Article 14 (3) of the Directive. If the verifier concludes that the emissions report contains a material misstatement, the operator's report has not been verified as satisfactory. In accordance with Article 15 of the Directive, Member States shall ensure that an operator whose report has not been verified as satisfactory by 31 March each year for emissions during the preceding year cannot make further transfers of allowances until a report from that operator has been verified as satisfactory. Member States shall lay down applicable penalties in accordance with Article 16 of the Directive.

The total emissions figure for an installation in an emissions report that has been verified as satisfactory shall be used by the competent authority to check whether a sufficient number of allowances have been surrendered by the operator in respect of that same installation.

Member States shall ensure that divergences of opinion between operators, verifiers and competent authorities do not affect proper reporting and are settled in accordance with the Directive, these guidelines, the detailed requirements established by the Member States pursuant to Annex V to the Directive and relevant national procedures.

8. EMISSION FACTORS

This section contains reference emission factors for the tier 1 level that permit the use of non-activity-specific emission factors for the combustion of fuel. If a fuel does not belong to an existing fuel category the operator shall use his expert judgement to assign the fuel used to a related fuel category, subject to the approval of the competent authority.

TABLE 4

Fossil fuel emission factors — related to net calorific value (NCV), excluding oxidation factors

Fuel	CO ₂ emission factor (tCO ₂ /T)	Source of emission factor
(A) Liquid fossil		
Primary fuels		
Crude oil	73,3	IPCC, 1996 ⁽⁸⁾
Orimulsion	80,7	IPCC, 1996
Natural gas liquids	63,1	IPCC, 1996
Secondary fuels/products		
Gasoline	69,3	IPCC, 1996
Kerosene ⁽⁹⁾	71,9	IPCC, 1996
Shale oil	77,4	National Communication Estonia, 2002
Gas/diesel oil	74,1	IPCC, 1996
Residual fuel oil	77,4	IPCC, 1996

⁽⁸⁾ Revised 1996 IPCC guidelines for national greenhouse gas inventories: Reference manual, 1.13.

⁽⁹⁾ Kerosene, other than jet kerosene.

Fuel	CO ₂ emission factor (tCO ₂ /TJ)	Source of emission factor
Liquid petroleum gas	63,1	IPCC, 1996
Ethane	61,6	IPCC, 1996
Naphta	73,3	IPCC, 1996
Bitumen	80,7	IPCC, 1996
Lubricants	73,3	IPCC, 1996
Petroleum coke	100,8	IPCC, 1996
Refinery feedstocks	73,3	IPCC, 1996
Other oil	73,3	IPCC, 1996
(B) Solid fossil		
Primary fuels		
Anthracite	98,3	IPCC, 1996
Coking coal	94,6	IPCC, 1996
Other bitumen coal	94,6	IPCC, 1996
Sub-bitumen coal	96,1	IPCC, 1996
Lignite	101,2	IPCC, 1996
Oil shale	106,7	IPCC, 1996
Peat	106,0	IPCC, 1996
Secondary fuels		
BKB and patent fuel	94,6	IPCC, 1996
Coke oven/gas coke	108,2	IPCC, 1996
(C) Gaseous fossil		
Carbon monoxide	155,2	Based on NCV of 10,12 TJ/t ⁽¹⁰⁾
Natural gas (dry)	56,1	IPCC, 1996
Methane	54,9	Based on NCV of 50,01 TJ/t ⁽¹¹⁾
Hydrogen	0	Carbon-free substance

⁽¹⁰⁾ J. Falbe and M. Regitz, Römpp Chemie Lexikon, Stuttgart, 1995.

⁽¹¹⁾ J. Falbe and M. Regitz, Römpp Chemie Lexikon, Stuttgart, 1995.

9. LIST OF CO₂-NEUTRAL BIOMASS

This exemplary but not exhaustive list contains a number of materials, which are considered biomass for the application of these guidelines and shall be weighted with an emission factor of 0 [t CO₂/T] or t or m³]. Peat and fossil fractions of the materials listed below shall not be considered biomass.

1. Plants and parts of plants, *inter alia*:

- straw,
- hay and grass,
- leaves, wood, roots, stumps, bark,
- crops, e.g. maize and triticale.

2. Biomass wastes, products and by-products, *inter alia*:

- industrial waste wood (waste wood from woodworking and wood processing operations and waste wood from operations in the wood materials industry),
- used wood (used products made from wood, wood materials) and products and by-products from wood processing operations
- wood-based waste from the pulp and paper industries, e.g. black liquor,
- forestry residues,
- animal, fish and food meal, fat, oil and tallow,
- primary residues from the food and beverage production,
- manure,
- agricultural plant residues,
- sewage sludge,
- biogas produced by digestion, fermentation or gasification of biomass,
- harbour sludge and other waterbody sludges and sediments,
- landfill gas.

3. Biomass fractions of mixed materials, *inter alia*:

- the biomass fraction of flotsam from waterbody management,
- the biomass fraction of mixed residues from food and beverage production,
- the biomass fraction of composites containing wood,
- the biomass fraction of textile wastes,
- the biomass fraction of paper, cardboard, pasteboard,
- the biomass fraction of municipal and industrial waste,
- the biomass fraction of processed municipal and industrial wastes.

4. Fuels whose components and intermediate products have all been produced from biomass, *inter alia*:

- bioethanol,
- biodiesel,
- etherised bioethanol,
- biomethanol,
- biodimethylether,
- bio-oil (a pyrolysis oil fuel) and biogas.

10. DETERMINATION OF ACTIVITY-SPECIFIC DATA AND FACTORS

10.1. **Determination of net calorific values and emission factors for fuels**

The specific procedure to determine the activity-specific emission factor including the sampling procedure for a specific fuel type shall be agreed with the competent authority before the start of the respective reporting period in which it will be applied.

The procedures applied to sample the fuel and to determine its net calorific value, carbon content and emission factor shall be based on relevant CEN standards (such as on the sample frequency, sampling procedures, determination of gross and net calorific value, and carbon contents for the different fuel types) as soon as they are available. If CEN standards are not available, ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with draft standards or industry best practice guidelines.

Examples for relevant CEN standards are as follows:

- EN ISO 4259:1996 'Petroleum products — Determination and application of precision data in relation to methods of test'.

Examples for relevant ISO standards are as follows:

- ISO 13909-1,2,3,4:2001 Hard coal and coke — Mechanical sampling,
- ISO 5069-1,2:1983: Brown coals and lignites; Principles of sampling,
- ISO 625:1996 Solid mineral fuels — Determination of carbon and hydrogen — Liebig method,
- ISO 925:1997 Solid mineral fuels — Determination of carbonate carbon content — Gravimetric method,
- ISO 9300-1990: Measurement of gas flow by means of critical flow Venturi nozzles,
- ISO 9951-1993/94: Measurement of gas flow in closed conduits — Turbine meters.

Supplemental national standards for the characterisation of fuels are as follows:

- DIN 51900-1:2000 'Testing of solid and liquid fuels — Determination of gross calorific value by the bomb calorimeter and calculation of net calorific value — Part 1: Principles, apparatus, methods',
- DIN 51857:1997 'Gaseous fuels and other gases — Calculation of calorific value, density, relative density and Wobbe index of pure gases and gas mixtures',
- DIN 51612:1980 Testing of liquefied petroleum gases; calculation of net calorific value,
- DIN 51721:2001 'Testing of solid fuels — Determination of carbon and hydrogen content' (also applicable for liquid fuels).

The laboratory used to determine the emission factor, carbon content and net calorific value shall be accredited according to EN ISO 17025 ('General requirements for the competence of testing and calibration laboratories').

It is important to note that to achieve appropriate accuracy of the activity-specific emission factor (in addition to the precision of the analytical procedure for the determination of the carbon content and the net calorific value) the sampling frequency, the sampling procedure and the sample preparation are critical. They depend greatly on the state and homogeneity of the fuel/material. The required number of samples will be larger for very heterogeneous materials such as municipal solid waste and be much smaller for most commercial gaseous or liquid fuels.

The determination of the carbon content, net calorific values and emission factors for batches of fuel shall follow generally accepted practice for representative sampling. The operator shall provide evidence that the derived carbon content, calorific values and emission factors are representative and free of bias.

The respective emission factor shall be used only for the batch of fuel for which it was intended to be representative.

The full documentation of the procedures used in the respective laboratory for the determination of the emission factor and the full set of results shall be retained and made available to the verifier of the emissions report.

10.2. **Determination of activity-specific oxidation factors**

The specific procedure to determine the activity-specific oxidation factor including the sampling procedure for a specific fuel type and installation shall be agreed with the competent authority before the start of the respective reporting period in which it will be applied.

The procedures applied to determine a representative activity-specific oxidation factor (e.g. via the carbon content of soot, ashes, effluents and other wastes or by-products) for a specific activity shall be based on relevant CEN standards as soon as they are available. If CEN standards are not available, ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with draft standards or industry best practice guidelines.

The laboratory used to determine the oxidation factor or the underlying data shall be accredited according to EN ISO 17025 ('General requirements for the competence of testing and calibration laboratories').

The determination of activity-specific oxidation factors from batches of material shall follow generally accepted practice for representative sampling. The operator shall provide evidence that the derived oxidation factors are representative and free of bias.

The full documentation of the procedures used by the organisation for the determination of the oxidation factors and the full set of results shall be retained and made available to the verifier of the emissions report.

10.3. **Determination of process emission factors and composition data**

The specific procedure to determine the activity-specific emission factor including the sampling procedure for a specific material shall be agreed with the competent authority before the start of the respective reporting period in which it will be applied.

The procedures applied to sample and determine the composition of the relevant material or derive a process emission factor shall be based on relevant CEN standards as soon as they are available. If CEN standards are not available ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with draft standards or industry best practice guidelines.

The laboratory used to determine the composition or emission factor shall be accredited according to EN ISO 17025 ('General requirements for the competence of testing and calibration laboratories').

The determination of the process emission factors and composition data for batches of materials shall follow generally accepted practice for representative sampling. The operator shall provide evidence that the derived process emission factor or composition data are representative and free of bias.

The respective value shall be used only for the batch of material for which it was intended to be representative.

The full documentation of the procedures used by the organisation for the determination of the emission factor or composition data and the full set of results shall be retained and made available to the verifier of the emissions report.

10.4. **Determination of a biomass fraction**

The term 'biomass fraction' for the purpose of these guidelines refers to the percentage of mass combustible biomass carbon according to the biomass definition (see sections 2 and 9 of this Annex) out of the total mass of carbon in a fuel mixture.

The specific procedure to determine the biomass fraction of a specific fuel type including the sampling procedure shall be agreed with the competent authority before the start of the reporting period in which it will be applied.

The procedures applied to sample the fuel and to determine the biomass fraction shall be based on relevant CEN standards as soon as they are available. If CEN standards are not available ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with draft standards or industry best practice guidelines ⁽¹²⁾.

Methods applicable to determine the biomass fraction in a fuel could range from the manual sorting of components of mixed materials, to differential methods determining heating values of a binary mixture and its two pure components to an isotopic analysis of carbon-14, depending on the specific nature of the respective fuel mixture.

The laboratory used to determine the biomass fraction shall be accredited according to EN ISO 17025 ('General requirements for the competence of testing and calibration laboratories').

The determination of the biomass fraction in batches of materials shall follow generally accepted practice for representative sampling. The operator shall provide evidence that the derived values are representative and free of bias.

The respective value shall be used only for the batch of material for which it was intended to be representative.

The full documentation of the procedures used in the respective laboratory for the determination of the biomass fraction and the full set of results shall be retained and made available to the verifier of the emissions report.

If the determination of the biomass fraction in a mixed fuel is technically not feasible or would lead to unreasonably high costs the operator shall either assume a 0 % biomass share (i.e. complete fossil origin of all carbon in that particular fuel) or propose an estimation method for approval by the competent authority.

11. REPORTING FORMAT

The following tables shall be used as a basis for reporting and may be adapted corresponding to the number of activities, type of installation, fuels and processes monitored.

11.1. Identification of installation

Identification of installation	Response
1. Name of parent company	
2. Name of subsidiary company	
3. Operator of installation	
4. Installation:	
4.1. Name	
4.2. Permit number ⁽¹³⁾	
4.3. Reporting under EPER required?	Yes/No
4.4. EPER identification number ⁽¹⁴⁾	
4.5. Address/city of the installation	

⁽¹²⁾ An example is the Dutch BRL-K 10016 ('The share of biomass in secondary fuels') developed by KIWA.

⁽¹³⁾ The identification number will be provided by the competent authority in the permitting process.

⁽¹⁴⁾ Only to be filled in if installation is required to report under EPER and there is not more than one EPER-activity under the installation's permit. The information is not obligatory and used for additional identification purposes beyond the name and address data given.

Identification of installation	Response
4.6. Postcode/country	
4.7. Coordinates of the location	
5. Contact person:	
5.1. Name	
5.2. Address/city/postcode/country	
5.3. Telephone	
5.4. Fax	
5.5. E-mail	
6. Reporting year	
7. Type of Annex I activities carried out ⁽¹⁵⁾	
Activity 1	
Activity 2	
Activity N	

11.2. Overview activities and emissions within an installation

Emissions of Annex I activities						
Categories	IPCC CRF-category ⁽¹⁶⁾	IPPC code of EPER category	Approach used? Calculation/measurement	Uncertainty (measurement approach) ⁽¹⁷⁾	Tiers changed? Yes/No	Emissions t/CO ₂
Activities						
Activity 1						
Activity 2						
Activity N						
Total						

⁽¹⁵⁾ E.g. 'Mineral oil refineries'.

⁽¹⁶⁾ E.g. '1. Industrial Processes, A Mineral Products, 1. Lime Production'.

⁽¹⁷⁾ Only to be filled in if emissions have been determined by measurement.

Memo Items	Transferred CO ₂		Biomass employed for combustion	Biomass employed in processes	Biomass emissions
	Amount transferred	Transferred material			
Unit	[tCO ₂]		[TJ]	[t or m ³]	[tCO ₂] ⁽¹⁸⁾
Activity 1					
Activity 2					
Activity N					

11.3. Combustion emissions (Calculation)

Activity N				
Type of Annex I activity:				
Description of activity:				
Fossil fuels				
Fuel 1				
Fossil fuel				
Type of fuel:				
		Unit	Data	Tier applied
	Activity data	t or m ³		
		TJ		
	Emission factor	tCO ₂ /TJ		
	Oxidation factor	%		
	Total emissions	tCO ₂		
Fuel N				
Fossil fuel				
Type of fuel:				
		Unit	Data	Tier applied
	Activity data	t or m ³		

⁽¹⁸⁾ Only to be filled in if emissions have been determined by measurement.

		TJ		
	Emission factor	tCO ₂ /TJ		
	Oxidation factor	%		
	Total emissions	tCO ₂		
Biomass and mixed fuels				
Fuel M				
Biomass/mixed fuels				
Type of fuel:				
Fraction of biomass (0-100 % of carbon content):				
		Unit	Data	Tier applied
	Activity data	t or m ³		
		TJ		
	Emission factor	tCO ₂ /TJ		
	Oxidation factor	%		
	Total emissions	tCO ₂		
Activity total				
Total emissions (tCO₂)⁽¹⁹⁾				
Total biomass used (TJ)⁽²⁰⁾				

11.4. Process emissions (Calculation)

Activity N	
Type of Annex I activity:	
Description of activity:	
Processes using only fossil input material	
Process 1	
Type of process:	

⁽¹⁹⁾ Equals the sum of emissions from fossil fuels and the fossil fraction of mixed fuels.⁽²⁰⁾ Equals the energy content of the pure biomass and the biomass fraction of mixed fuels.

Description of activity data:

Calculation method applied (only if specified in guidelines):

		Unit	Data	Tier applied
	Activity data	t or m ³		
	Emission factor	tCO ₂ /t or tCO ₂ /m ³		
	Conversion factor	%		
	Total emissions	tCO ₂		
Process N				

Type of process:

Description of activity data

Calculation method applied (only if specified in guidelines):

		Unit	Data	Tier applied
	Activity data	t or m ³		
	Emission factor	tCO ₂ /t or tCO ₂ /m ³		
	Conversion factor	%		
	Total emissions	tCO ₂		

Processes using biomass/mixed input material

Process M

Description of process:

Description of input material:

Fraction of biomass (% of carbon content):

Calculation method applied (only if specified in guidelines):

		Unit	Data	Tier applied
	Activity data	t or m ³		

	Emission factor	tCO ₂ /t or tCO ₂ /m ³		
	Conversion factor	%		
	Total emissions	tCO ₂		
Activity total				
Total emissions	(tCO ₂)			
Total biomass used	(t or m ³)			

12. REPORTING CATEGORIES

Emissions shall be reported according to the categories of the IPCC reporting format and the IPPC code of Annex A3 of the EPER Decision (see section 12.2 of this Annex). The specific categories of both reporting formats are shown below. Where an activity could be classified under two or more categories the selected classification shall reflect the primary purpose of the activity.

12.1. IPCC reporting format

The table below is an excerpt of the common reporting format (CRF) part of the UNFCCC reporting guidelines on annual inventories⁽²¹⁾. In the CRF emissions are attributed to seven major categories:

- energy,
- industrial processes,
- solvent and other products use,
- agriculture,
- land-use change and forestry,
- waste,
- other.

Categories 1, 2 and 6 of the following table with their relevant subcategories are reproduced below:

1. Sectoral report for energy

A. Fuel combustion activities (Sectoral approach)

1. Energy industries

a. Public electricity and heat production

b. Petroleum refining

c. Manufacture of solid fuels and other energy industries

2. Manufacturing industries and construction

⁽²¹⁾ UNFCCC (1999): FCCC/CP/1999/7.

a. Iron and steel

b. Non-ferrous metals

c. Chemicals

d. Pulp, paper and print

e. Food processing, beverages and tobacco

f. Other (*please specify*)

4. Other sectors

a. Commercial/institutional

b. Residential

c. Agriculture/forestry/fisheries

5. Other (*please specify*)

a. Stationary

b. Mobile

B. Fugitive emissions from fuels

1. Solid fuels

a. Coal mining

b. Solid fuel transformation

c. Other (*please specify*)

2. Oil and natural gas

a. Oil

b. Natural gas

c. Venting and flaring

Venting

Flaring

d. Other (*please specify*)

2. Sectoral report for industrial processes

A. Mineral products

1. Cement production

2. Lime production

3. Limestone and dolomite use

4. Soda ash production and use

5. Asphalt roofing

6. Road paving with asphalt

7. Other (*please specify*)

B. Chemical industry

1. Ammonia production

2. Nitric acid production

3. Adipic acid production

4. Carbide production

5. Other (*please specify*)

C. Metal production

1. Iron and steel production

2. Ferroalloys production

3. Aluminium production

4. SF₆ used in aluminium and magnesium foundries

5. Other (please specify)

Memo items

CO₂ emissions from biomass

12.2. IPPC source category code of EPER Decision

The table below is an excerpt of Annex A3 to Commission Decision 2000/479/EC of 17 July 2000 on the implementation of a European pollutant emission register (EPER) according to Article 15 of Council Directive 96/61/EC concerning integrated pollution prevention and control ⁽²⁾.

Excerpt of Annex A3 to the EPER Decision

1.	Energy industries
1.1.	Combustion installations > 50 MW
1.2.	Mineral oil and gas refineries
1.3.	Coke ovens
1.4.	Coal gasification and liquefaction plants
2.	Production and processing of metals
2.1/2.2/2.3/2.4/2.5/2.6.	Metal industry and metal ore roasting or sintering installations; Installations for the production of ferrous and non-ferrous metals
3.	Mineral industry
3.1/3.3/3.4/3.5.	Installations for the production of cement klinker (> 500 t/day), lime (> 50 t/day), glass (> 20 t/day), mineral substances (> 20 t/day) of ceramic products (> 75 t/day)
3.2.	Installations for the production of asbestos or asbestos-based products
4.	Chemical industry and chemical installations for the production of
4.1.	Basic organic chemicals
4.2/4.3.	Basic inorganic chemicals or fertilisers

⁽²⁾ OJ L 192, 28.7.2000, p. 36.

4.4/4.6.	Biocides and explosives
4.5.	Pharmaceutical products
5.	Waste management
5.1/5.2.	Installations for the disposal or recovery of hazardous waste (> 10 t/day) or municipal waste (> 3 t/hour)
5.3/5.4.	Installations for the disposal of non-hazardous waste (> 50 t/day) and landfills (> 10 t/day)
6.	Other Annex I activities
6.1.	Industrial plants for pulp from timber or other fibrous materials and paper or board production (> 20 t/day)
6.2.	Plants for the pretreatment of fibres or textiles (> 10 t/day)
6.3.	Plants for tanning of hides and skins (> 12 t/day)
6.4.	Slaughterhouses (> 50 t/day), plants for the production of milk (> 200 t/day), other animal raw materials (> 75 t/day) or vegetable raw materials (> 300 t/day)
6.5.	Installations for the disposal or recycling of animal carcasses and animal waste (> 10 t/day)
6.6.	Installations for poultry (> 40 000), pigs (> 2 000) or sows (> 750)
6.7.	Installations for surface treatment or products using organic solvents (> 200 t/year)
6.8.	Installations for the production of carbon or graphite

ANNEX II

Guidelines for combustion emissions from activities as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

The activity-specific guidelines contained in this Annex shall be used to monitor greenhouse gas emissions from combustion installations with a rated thermal input exceeding 20 MW (except hazardous or municipal waste installations) as listed in Annex I to the Directive and to monitor combustion emissions from other activities as listed in Annex I to the Directive where referred to in Annexes III to XI to these guidelines.

The monitoring of greenhouse gas emissions from combustion processes shall include emissions from the combustion of all fuels at the installation as well as emissions from scrubbing processes for example to remove SO₂. Emissions from internal combustion engines for transportation purposes shall not be monitored and reported. All greenhouse gas emissions from the combustion of fuels at the installation shall be assigned to the installation, regardless of exports of heat or electricity to other installations. Emissions associated with the production of heat or electricity that is imported from other installations shall not be assigned to the importing installation.

2. DETERMINATION OF CO₂ EMISSIONS

Sources of CO₂ emissions from combustion installations and processes include:

- boilers
- burners
- turbines
- heaters
- furnaces
- incinerators
- kilns
- ovens
- dryers
- engines
- flares
- scrubbers (process emissions)
- any other equipment or machinery that uses fuel, excluding equipment or machinery with combustion engines that is used for transportation purposes.

2.1. **Calculation of CO₂ emissions**2.1.1. *Combustion emissions*

2.1.1.1. General combustion activities

CO₂ emissions from combustion sources shall be calculated by multiplying the energy content of each fuel used by an emission factor and an oxidation factor. For each fuel the following calculation shall be carried out for each activity:

$$\text{CO}_2 \text{ emissions} = \text{Activity data} * \text{Emission factor} * \text{Oxidation factor}$$

Where:

(a) Activity data

Activity data is expressed as the net energy content of the fuel consumed (T) during the reporting period. The energy content of the fuel consumption shall be calculated by means of the following formula:

$$\text{Energy content of fuel consumption [T]} = \text{fuel consumed [t or m}^3\text{]} * \text{net calorific value of fuel [T]/t or T]/m}^3\text{]}^{(23)}$$

Where:

(a1) Fuel consumed

Tier 1

Fuel consumption is metered without intermediate storage before combustion in the installation resulting in a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process.

Tier 2a

Fuel consumption is metered without intermediate storage before combustion in the installation applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 5,0$ % for the metering process

Tier 2b

Fuel purchase metered applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 4,5$ % for the metering process. Fuel consumption is calculated using a mass balance approach based on the quantity of fuel purchased and the difference in the quantity held in stock over a period of time using the following formula:

$$\text{Fuel C} = \text{Fuel P} + (\text{Fuel S} - \text{Fuel E}) - \text{Fuel O}$$

where:

Fuel C: Fuel combusted during the reporting period
 Fuel P: Fuel purchased during the reporting period
 Fuel S: Fuel stock at the beginning of the reporting period
 Fuel E: Fuel stock at the end of the reporting period
 Fuel O: Fuel used for other purposes (transportation or re-sold)

Tier 3a

Fuel consumption is metered without intermediate storage before combustion in the installation applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 3b

Fuel purchase metered applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,0$ % for the metering process. Fuel consumption is calculated using a mass balance approach based on the quantity of fuel purchased and the difference in the quantity held in stock over a period of time using the following formula:

$$\text{Fuel C} = \text{Fuel P} + (\text{Fuel S} - \text{Fuel E}) - \text{Fuel O}$$

where:

Fuel C: Fuel combusted during the reporting period
 Fuel P: Fuel purchased during the reporting period
 Fuel S: Fuel stock at the beginning of the reporting period
 Fuel E: Fuel stock at the end of the reporting period
 Fuel O: Fuel used for other purposes (transportation or re-sold)

⁽²³⁾ In case volume units are used the operator shall consider any conversion that may be required to account for differences in pressure and temperature of the metering device and the standard conditions for which the net calorific value was derived for the respective fuel type.

Tier 4a

Fuel consumption is metered without intermediate storage before combustion in the installation applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 1,5$ % for the metering process.

Tier 4b

Fuel purchase metered applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 1,0$ % for the metering process. Fuel consumption is calculated using a mass balance approach based on the quantity of fuel purchased and the difference in the quantity held in stock over a period of time using the following formula:

$$\text{Fuel C} = \text{Fuel P} + (\text{Fuel S} - \text{Fuel E}) - \text{Fuel O}$$

where:

Fuel C: Fuel combusted during the reporting period
Fuel P: Fuel purchased during the reporting period
Fuel S: Fuel stock at the beginning of the reporting period
Fuel E: Fuel stock at the end of the reporting period
Fuel O: Fuel used for other purposes (transportation or re-sold)

It should be noted that different fuel types will result in significantly different permissible uncertainties for the metering process with gaseous and liquid fuels generally being metered more accurately than solid fuels. There are however many exceptions within each of the classes (depending on the type and properties of the fuel, the delivery path (ship, rail, truck, conveyor belt, pipeline) and circumstances specific to the installation) which preclude a simple attribution of fuels to tiers.

(a2) Net calorific value

Tier 1

The operator applies country specific net calorific values for the respective fuel as listed in Appendix 2.1 A.3 '1990 country specific net calorific values' of the 2000 IPCC 'Good practice guidance and uncertainty management in national greenhouse gas inventories' (<http://www.ipcc.ch/pub/guide.htm>).

Tier 2

The operator applies country specific net calorific values for the respective fuel as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

Tier 3

The net calorific value representative for each batch of fuel in an installation is measured by the operator, a contracted laboratory or the fuel supplier in accordance with the provisions of section 10 of Annex I.

(b) Emission factor

Tier 1

Reference factors for each fuel are used as specified in section 8 of Annex I.

Tier 2a

The operator applies country specific emission factors for the respective fuel as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

Tier 2b

The operator derives emission factors for each batch of fuel based on one of the following established proxies:

1. density measurement of specific oils or gases common e.g. to the refinery or steel industry, and
2. net calorific value for specific coals types,

in combination with an empirical correlation as determined by an external laboratory according to the provisions of section 10 of Annex I. The operator shall ensure that the correlation satisfies the requirements of good engineering practice and that it is applied only to values of the proxy which fall into the range for which it was established.

Tier 3

Activity-specific emission factors representative for the respective batches are determined by the operator, an external laboratory or the fuel supplier according to the provisions of section 10 of Annex I.

(c) Oxidation Factor

Tier 1

A reference oxidation/reference value of 0,99 (corresponding to a 99 % conversion of carbon to CO₂) is assumed for all solid fuels and of 0,995 for all other fuels.

Tier 2

For solid fuels activity-specific factors are derived by the operator based on carbon contents of ashes, effluents and other wastes and by-products and other non-fully oxidised emissions of carbon according to the provisions specified in section 10 of Annex I.

2.1.1.2. Flares

Emissions from flares shall include routine flaring and operational flaring (trips, start-up and shutdown) as well as emergency relieves.

CO₂ emissions shall be calculated from the amount of gas flared [m³] and the carbon content of the flared gas [t CO₂/m³] (including any inorganic carbon).

$$\text{CO}_2 \text{ emissions} = \text{activity data} * \text{emission factor} * \text{oxidation factor}$$

Where:

(a) Activity data

Tier 1

Amount of flare gas [m³] used during reporting period, derived by volume metering with a maximum permissible error of ± 12,5 % for the metering process.

Tier 2

Amount of flare gas [m³] used during reporting period, derived by volume metering with a maximum permissible uncertainty of ± 7,5 % for the metering process.

Tier 3

Amount of flare gas [m³] used during reporting period, derived by volume metering with a maximum permissible uncertainty of ± 2,5 % for the metering process.

(b) Emission factor

Tier 1

Using a reference emission factor of 0,00785 t CO₂/m³ (at standard conditions) derived from the combustion of pure butane used as a conservative proxy for flare gases.

Tier 2

Emission factor [$\text{t CO}_2/\text{m}^3_{\text{flare gas}}$] calculated from the carbon content of the flared gas applying the provisions of section 10 of Annex I.

(c) Oxidation Factor

Tier 1

Oxidation rate of 0,995.

2.1.2. Process emissions

Process CO_2 emissions from the use of carbonate for SO_2 scrubbing from the waste gas stream shall be calculated on the basis of carbonate purchased (calculation method tier 1a) or gypsum produced (calculation method tier 1b). These two calculation methods are equivalent. Calculation shall be as follows:

$$\text{CO}_2\text{-emissions [t]} = \text{activity data} * \text{emission factor} * \text{conversion factor}$$

With:

Calculation method A 'Carbonate based'

Calculation of emissions is based on the amount of carbonate employed:

(a) Activity data

Tier 1

[t] of dry carbonate as process input per year metered by operator or supplier with a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process.

(b) Emission factor

Tier 1

Use of stoichiometric ratios of conversions of carbonates [$\text{t CO}_2/\text{t dry carbonate}$] as shown in table 1. This value shall be adjusted for the respective moisture and gangue content of the applied carbonate material.

TABLE 1

Stoichiometric emission factors

Carbonate	Emission factor [$\text{t CO}_2/\text{t Ca-}, \text{Mg-}$ or other Carbonate]	Remarks
CaCO_3	0,440	
MgCO_3	0,522	
In general: $X_y(\text{CO}_3)_z$	Emission factor = $[\text{M}_{\text{CO}_2}] / \{Y * [\text{M}_x] + Z * [\text{M}_{\text{CO}_3}]\}$	X = alkali earth or alkali metal M _x = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO_2 = 44 [g/mol] M _{CO₃} = molecular weight of CO_3^{2-} = 60 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of CO_3^{2-} = 1

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Calculation method B 'gypsum based'

Calculation of emissions is based on the amount of gypsum produced:

(a) Activity data

Tier 1

[t] of dry gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) as process output per year metered by operator or processor of gypsum with a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process.

(b) Emission factor

Tier 1

Stoichiometric ratio of dehydrated gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) and CO_2 in the process: 0,2558 t CO_2 /t gypsum

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.2. **Measurement of CO_2 emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF EMISSIONS OF NON- CO_2 GREENHOUSE GASES

Specific guidelines for the determination of emissions of non- CO_2 greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX III

Activity-specific guidelines for mineral oil refineries as listed in Annex I to the Directive

1. BOUNDARIES

The monitoring of greenhouse gas emissions from an installation shall include all emissions from combustion and production processes as occurring in refineries. Emissions from processes carried out in adjacent installations of the chemical industry not included in Annex I to the Directive, which are not part of the refining production chain shall not be accounted for.

2. DETERMINATION OF CO₂ EMISSIONS

Potential CO₂-emissions sources include:

(a) energy related combustion:

- boilers,
- process heaters/treaters,
- internal combustion engines/turbines,
- catalytic and thermal oxidisers,
- coke calcining kilns,
- firewater pumps,
- emergency/standby generators,
- flares,
- incinerators,
- crackers;

(b) process

- hydrogen production installations,
- catalytic regeneration (from catalytic cracking and other catalytic processes),
- cokers (flexi-coking, delayed coking).

2.1. Calculation of CO₂ emissions

Operator may calculate emissions:

- (a) for every fuel type and process of the installation; or
- (b) using the mass balance approach if the operator can demonstrate that it is more accurate for the installation as a whole than a calculation for each fuel type or process; or
- (c) using the mass balance approach on a well defined subset of fuel types or processes and individual calculations for the remaining fuel types and processes of the installation if the operator can demonstrate that it is more accurate for the whole installation than a calculation for each fuel type or process.

2.1.1. Mass balance approach

The mass balance approach shall analyse all carbon in inputs, accumulations, inclusion in products and exports to account for the installation's emissions of greenhouse gases, using the following equation:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\text{input-products-export} - \text{stock changes}) * \text{conversion factor CO}_2\text{/C}$$

With:

- Input [tC]: all carbon entering the boundaries of the installation,
- Products [tC]: all carbon in products and materials, including by-products, leaving the boundaries of the mass balance,
- Export [tC]: carbon exported from the boundaries of the mass balance, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases into the atmosphere,
- Stock changes [tC]: stock increases of carbon within the boundaries of the installation.

The calculation shall then be as follows:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\sum (\text{activity data}_{\text{input}} * \text{carbon content}_{\text{input}}) - \sum (\text{activity data}_{\text{products}} * \text{carbon content}_{\text{products}}) - \sum (\text{activity data}_{\text{export}} * \text{carbon content}_{\text{export}}) - \sum (\text{activity data}_{\text{stock changes}} * \text{carbon content}_{\text{stock changes}})) * 3,664$$

With:

(a) Activity data

The operator shall analyse and report the mass flows into and from the installation and respective stock changes for all relevant fuels and materials separately.

Tier 1

For a subset of fuels and materials, mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 2

For a subset of fuels and materials, mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 5,0$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 3

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 4

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 1,0$ % for the metering process.

(b) Carbon content

Tier 1

When calculating the mass balance the operator shall follow the provisions of section 10 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

(c) Energy content

Tier 1

For the purpose of consistent reporting, the energy content of each of the fuel and material streams (expressed as net-calorific value of the respective streams) shall be calculated.

2.1.2. Combustion emissions

Combustion emissions shall be monitored in accordance with Annex II.

2.1.3. Process emissions

Specific processes leading to CO₂-emissions include:

1. Catalytic cracker regeneration and other catalyst regeneration

The coke deposited on the catalyst as a by-product of the cracking process is burned in the regenerator in order to restore the activity of the catalyst. Further refinery processes employ a catalyst which needs to be regenerated, e.g. catalytic reforming.

The amount of CO₂ emitted in this process shall be calculated in accordance with Annex II, with the amount of coke combusted as activity data and the carbon content of the coke as basis for the calculation of the emission factor.

$$\text{CO}_2 \text{ emissions} = \text{activity data} * \text{emission factor} * \text{conversion factor}$$

With:

(a) Activity data

Tier 1

Amount of coke [t] burned from catalyst during reporting period, based on industry best practice guidelines for the specific process.

Tier 2

Amount of coke [t] burned from catalyst during reporting period, as calculated from the heat and material balance over the catalytic cracker.

(b) Emission factor

Tier 1

Activity-specific emission factor [t CO₂/t coke] based on the carbon content of the coke derived in accordance with the provisions of section 10 in Annex I.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2. Cokers

CO₂-vents from the coke burners of fluid cokers and flexi cokers shall be calculated as follows:

$$\text{CO}_2 \text{ emissions} = \text{activity data} * \text{emission factor}$$

With:

(a) Activity data

Tier 1

Amount of coke [t] produced during reporting period, derived by weighing with a maximum permissible uncertainty of ± 5,0 % for the metering process.

Tier 2

Amount of coke [t] produced during reporting period, derived by weighing with a maximum permissible uncertainty of ± 2,5 % for the metering process.

(b) Emission factor

Tier 1

Specific emission factor [t CO₂/t coke based on industry best practice guidelines for the specific process.

Tier 2

Specific emission factor [t CO₂/t coke] derived based on the measured CO₂ content in off-gases with the provisions of section 10 of Annex I.

3. Refinery hydrogen production

The CO₂-emitted stems from the carbon content of the feed gas. An input-based calculation of CO₂-emissions shall be carried out.

$$\text{CO}_2 \text{ emissions} = \text{activity data}_{\text{input}} * \text{emission factor}$$

With:

(a) Activity data

Tier 1

Amount of hydrocarbon feed [t feed] processed during the reporting period, derived by volume metering with a maximum permissible uncertainty of ± 7,5 % for the metering process.

Tier 2

Amount of hydrocarbon feed [t feed] processed during the reporting period, derived by volume metering with a maximum permissible uncertainty of ± 2,5 % for the metering process.

(b) Emission factor

Tier 1

Use a reference value of 2,9 t CO₂ per t feed processed conservatively based on ethane.

Tier 2

Use of an activity-specific emission factor [CO₂/t feed] calculated from the carbon content of the feed gas, determined according to section 10 of Annex I.

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF EMISSIONS OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX IV

Activity-specific guidelines for coke ovens as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

Coke ovens can be part of steel works with a direct technical connection to sintering installations and installations for the production of pig iron and steel including continuous casting, causing an intensive energy and material exchange (for example blast furnace gas, coke oven gas, coke) to take place in regular operation. If the installation's permit according to Article 4, 5 and 6 of the Directive encompasses the entire steel works and not solely the coke oven, the CO₂-emissions may also be monitored for the integrated steel works as a whole, using the mass balance approach specified in section 2.1.1 of this Annex.

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

In coke ovens, CO₂ emissions result from the following sources:

- raw materials (coal or petrol coke),
- conventional fuels (e.g. natural gas),
- process gases (e.g. blast furnace gas (BFG)),
- other fuels,
- waste gas scrubbing.

2.1. Calculation of CO₂ Emissions

In case the coke oven is part of an integrated steelworks, the operator may calculate emissions:

- (a) for the integrated steelworks as a whole, using the mass balance approach; or
- (b) for the coke oven as individual activity of the integrated steelworks.

2.1.1. Mass balance approach

The mass balance approach shall analyse all carbon in inputs, accumulations, inclusion in products and exports to account for the installation's emissions of greenhouse gases, using the following equation:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\text{input-products-export} - \text{stock changes}) * \text{conversion factor CO}_2\text{/C}$$

With:

- Input [tC]: all carbon entering the boundaries of the installation,
- Products [tC]: all carbon in products and materials, including by-products, leaving the boundaries of the mass balance,
- Export [tC]: carbon exported from the boundaries of the mass balance, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases into the atmosphere,
- Stock changes [tC]: stock increases of carbon within the boundaries of the installation.

The calculation shall then be as follows:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\sum (\text{activity data}_{\text{input}} * \text{carbon content}_{\text{input}}) - \sum (\text{activity data}_{\text{products}} * \text{carbon content}_{\text{products}}) - \sum (\text{activity data}_{\text{export}} * \text{carbon content}_{\text{export}}) - \sum (\text{activity data}_{\text{stock changes}} * \text{carbon content}_{\text{stock changes}})) * 3,664$$

With:

(a) Activity data

The operator shall analyse and report the mass flows into and from the installation and respective stock changes for all relevant fuels and materials separately.

Tier 1

For a subset of fuels and materials mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 2

For a subset of fuels and materials mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 5,0$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 3

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 4

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 1,0$ % for the metering process.

(b) Carbon content

Tier 1

When calculating the mass balance the operator shall follow the provisions of section 10 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

(c) Energy content

Tier 1

For the purpose of consistent reporting the energy content of each of the fuel and material streams (expressed as net-calorific value of the respective streams) shall be calculated.

2.1.2. Combustion emissions

Combustion processes taking place at coke ovens where fuels (e.g. coke, coal, and natural gas) are not used as reducing agents or do not stem from metallurgical reactions shall be monitored and reported in accordance with Annex II.

2.1.3. Process emissions

During carbonisation in the coke chamber of the coke oven, coal is converted under the exclusion of air to coke and crude coke oven gas (crude COG). The main carbon containing input material/input streams is coal, but may also be coke slack, petrol coke, oil and process gases such as blast furnace gas. The crude coke oven gas, as part of the process output, contains many carbon containing components, amongst others carbon dioxide (CO₂), carbon monoxide (CO), methane (CH₄), hydrocarbons (C_xH_y).

Total CO₂ emission from coke ovens shall be calculated as follows:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = \sum (\text{activity data}_{\text{INPUT}} * \text{emission factor}_{\text{INPUT}}) - \sum (\text{activity data}_{\text{OUTPUT}} * \text{emission factor}_{\text{OUTPUT}})$$

With:

(a) Activity data

Activity data_{INPUT} can comprise coal as raw material, coke slack, petrol coke, oil, blast furnace gas, coke oven gas and alike. Activity data_{OUTPUT} can comprise: coke, tar, light oil, coke oven gas and alike.

(a1) Fuel employed as process input

Tier 1

The mass flow of fuels into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 7,5 % for the metering process.

Tier 2

The mass flow of fuels into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 5,0 % for the metering process.

Tier 3

The mass flow of the fuel into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 2,5 % for the metering process.

Tier 4

The mass flow of the fuel into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 1,0 % for the metering process.

(a2) Net calorific value

Tier 1

The operator applies country-specific net calorific values for the respective fuel as listed in Appendix 2.1 A.3 '1990 country specific net calorific values' of the 2000 IPCC 'Good practice guidance and uncertainty management in national greenhouse gas inventories' (<http://www.ipcc.ch/pub/guide.htm>).

Tier 2

The operator applies country-specific net calorific values for the respective fuel as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

Tier 3

The net calorific value representative for each batch of fuel in an installation is measured by the operator, a contracted laboratory or the fuel supplier in accordance with the provisions of section 10 of Annex I.

(b) Emission factor

Tier 1

Use of reference factors from the table below or section 8 of Annex I:

TABLE 1

Emission factors for process gases (including CO₂ component in fuel) ⁽²⁴⁾

emission factor [t CO ₂ /TJ]		source of data
Coke oven gas (COG)	47,7	IPCC
Blast furnace gas (BFG)	241,8	IPCC

Tier 2

Specific emission factors are determined in accordance with the provisions of section 10 of Annex I.

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

⁽²⁴⁾ Values are based on IPCC factors expressed in tC/TJ, multiplied with a CO₂/C conversion factor of 3,664.

ANNEX V

Activity-specific guidelines for metal ore roasting and sintering installations as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

Metal ore roasting and sintering installations can form an integral part of steel works with a direct technical connection to coke ovens and installations for the production of pig iron and steel including continuous casting. Thus an intensive energy and material exchange (e.g. blast furnace gas, coke oven gas, coke, limestone) takes place in regular operation. If the installation's permit according to Articles 4, 5 and 6 of the Directive encompasses the entire steel works and not solely the roasting or sintering installation, the CO₂ emissions may also be monitored for the integrated steel works as a whole. In such cases the mass balance approach (section 2.1.1 of this Annex) may be used.

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

In metal ore roasting and sintering installations, CO₂ emissions result from the following sources:

- raw materials (calcination of limestone and dolomite),
- conventional fuels (natural gas and coke/coke breeze),
- process gases (e.g. coke oven gas(COG) and blast furnace gas(BFG)),
- process residues used as input material including filtered dust from the sintering plant, the converter and the blast furnace,
- other fuels,
- waste gas scrubbing.

2.1. Calculation of CO₂ emissions

Operator may calculate emissions using either the mass balance approach or for every source of the installation.

2.1.1. *Mass balance approach*

The mass balance approach shall analyse all carbon in inputs, accumulations, inclusion in products and exports to account for the installation's emissions of greenhouse gases, using the following equation:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\text{input-products-export} - \text{stock changes}) * \text{conversion factor CO}_2\text{/C}$$

With:

- Input [tC]: all carbon entering the boundaries of the installation,
- Products [tC]: all carbon in products and materials, including by-products, leaving the boundaries of the mass balance,
- Export [tC]: carbon exported from the boundaries of the mass balance, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases into the atmosphere,
- Stock changes [tC]: stock increases of carbon within the boundaries of the installation.

The calculation shall then be as follows:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\sum (\text{activity data}_{\text{input}} * \text{carbon content}_{\text{input}}) - \sum (\text{activity data}_{\text{products}} * \text{carbon content}_{\text{products}}) - \sum (\text{activity data}_{\text{export}} * \text{carbon content}_{\text{export}}) - \sum (\text{activity data}_{\text{stock changes}} * \text{carbon content}_{\text{stock changes}})) * 3,664$$

With:

(a) Activity data

The operator shall analyse and report the mass flows into and from the installation and respective stock changes for all relevant fuels and materials separately.

Tier 1

For a subset of fuels and materials mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 2

For a subset of fuels and materials mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 5,0$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 3

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 4

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 1,0$ % for the metering process.

(b) Carbon content

When calculating the mass balance the operator shall follow the provisions of section 10 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

(c) Energy content

For the purpose of consistent reporting, the energy content of each of the fuel and material streams (expressed as net-calorific value of the respective streams) shall be calculated.

2.1.2. *Combustion emissions*

Combustion processes that take place at metal ore roasting and sintering installations shall be monitored and reported in accordance with Annex II.

2.1.3. *Process emissions*

During calcination on the grate CO_2 is released from the input materials, i.e. the raw mix (commonly from calcium carbonate) and from reemployed process residues. For each type of input material used the amount of CO_2 shall be calculated as follows:

$$\text{CO}_2\text{-emissions} = \{\text{activity data}_{\text{process input}} * \text{emission factor} * \text{conversion factor}\}$$

(a) Activity data

Tier 1

Amounts [t] of carbonate input material [t_{CaCO_3} , t_{MgCO_3} or $t_{\text{CaCO}_3\text{-MgCO}_3}$] and process residues used as input material employed in the process as weighed by operator or supplier with a maximum permissible uncertainty of less than $\pm 5,0$ % for the metering process.

Tier 2

Amounts [t] of carbonate input material [t_{CaCO_3} , t_{MgCO_3} or $t_{\text{CaCO}_3\text{-MgCO}_3}$] and process residues used as input material employed in the process as weighed by operator or supplier with a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

(b) Emission factor

Tier 1

For carbonates: use of stoichiometric ratios given in the following table 1:

TABLE 1

Stoichiometric emission factors

Emission factor	
CaCO ₃	0,440 t CO ₂ /t CaCO ₃
MgCO ₃	0,522 t CO ₂ /t MgCO ₃

These values shall be adjusted for the respective moisture and gangue content of the applied carbonate material.

For process residues: activity-specific factors shall be determined according to the provisions of section 10 of Annex I.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Tier 2

Activity-specific factors determined according to the provisions of section 10 of Annex I, determining the amount of carbon in the sinter produced and in filtered dust. In case filtered dust is reemployed in the process, the amount of carbon [t] contained shall not be accounted for in order to avoid double counting.

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX VI

Activity-specific guidelines for installation for the production of pig iron and steel including continuous casting as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

The guidelines in this Annex encompass emissions from installations for the production of pig iron and steel, including continuous casting. They refer to primary (blast furnace (BF) and basic oxygen furnace (BOF)) and secondary (electric arc furnace (EAF)) steel production.

Installations for the production of pig iron and steel including continuous casting are generally integral parts of steel works with a technical connection to coke ovens and sinter installations. Thus an intensive energy and material exchange (e.g. blast furnace gas, coke oven gas, coke, limestone) takes place in regular operation. If the installation's permit according to Article 4, 5 and 6 of the Directive encompasses the entire steel works and not solely the blast furnace, the CO₂ emissions may also be monitored for the integrated steel works as a whole. In such cases the mass balance approach as presented in section 2.1.1 of this Annex may be used.

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

In installations for the production of pig iron and steel including continuous casting, CO₂-emissions result from the following sources:

- raw materials (calcination of limestone or dolomite),
- conventional fuels (natural gas, coal and coke),
- reducing agents (coke, coal, plastics, etc.),
- process gases (coke oven gas/COG, blast furnace gas/BFG and basic oxygen furnace gas/BOFG),
- consumption of graphite electrodes,
- other fuels,
- waste gas scrubbing.

2.1. Calculation of CO₂ emissions

Operator may calculate emissions using either the mass balance approach or for every source of the installation.

2.1.1. Mass balance approach

The mass balance approach shall analyse all carbon in inputs, accumulations, inclusion in products and exports to account for the installation's emissions of greenhouse gases, using the following equation:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\text{input-products-export} - \text{stock changes}) * \text{conversion factor CO}_2\text{/C}$$

With:

- Input [tC]: all carbon entering the boundaries of the installation,
- Products [tC]: all carbon in products and materials, including by-products, leaving the boundaries of the mass balance,

- Export [tC]: carbon exported from the boundaries of the mass balance, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases into the atmosphere,
- Stock changes [tC]: stock increases of carbon within the boundaries of the installation.

The calculation shall then be as follows:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\sum (\text{activity data}_{\text{input}} * \text{carbon content}_{\text{input}}) - \sum (\text{activity data}_{\text{products}} * \text{carbon content}_{\text{products}}) - \sum (\text{activity data}_{\text{export}} * \text{carbon content}_{\text{export}}) - \sum (\text{activity data}_{\text{stock changes}} * \text{carbon content}_{\text{stock changes}})) * 3,664$$

With:

(a) Activity data

The operator shall analyse and report the mass flows into and from the installation and respective stock changes for all relevant fuels and materials separately.

Tier 1

For a subset of fuels and materials, mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 7,5$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 2

For a subset of fuels and materials, mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 5,0$ % for the metering process. All other fuel and material mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 3

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 4

Mass flows into and from the installation are determined applying metering devices resulting in a maximum permissible uncertainty of less than $\pm 1,0$ % for the metering process.

(b) Carbon content

Tier 1

When calculating the mass balance the operator shall follow the provisions of section 10 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

(c) Energy content

Tier 1

For the purpose of consistent reporting, the energy content of each of the fuel and material streams (expressed as net-calorific value of the respective streams) shall be calculated.

2.1.2. *Combustion emissions*

Combustion processes taking place at installations for the production of pig iron and steel including continuous casting where fuels (e.g. coke, coal, and natural gas) are not used as reducing agents or do not stem from metallurgical reactions shall be monitored and reported in accordance with Annex II.

2.1.3. Process emissions

Installations for the production of pig iron and steel including continuous casting are normally characterised by a sequence of facilities (e.g. blast furnace, basic oxygen furnace, hot rolling mill) and these facilities frequently have technical connections to other installations (e.g. coke oven, sinter installation, power installation). Within such installations a number of different fuels are used as reducing agents. Generally these installations also produce process gases of different compositions, e.g. coke oven gas/COG, blast furnace gas/BFG, basic oxygen furnace gas/BOFG).

Total CO₂ emissions from pig iron and steel installations including continuous casting shall be calculated as follows:

$$\text{CO}_2\text{-emission [t CO}_2\text{]} = \sum (\text{activity data}_{\text{INPUT}} * \text{emission factor}_{\text{INPUT}}) - \sum (\text{activity data}_{\text{OUTPUT}} * \text{emission factor}_{\text{OUTPUT}})$$

With:

(a) Activity data

(a1) Fuel employed

Tier 1

The mass flow of the fuel into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 7,5 % for the metering process.

Tier 2

The mass flow of the fuel into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 5,0 % for the metering process.

Tier 3

The mass flow of the fuel into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 2,5 % for the metering process.

Tier 4

The mass flow of the fuel into and from the installation is determined applying metering devices resulting in a maximum permissible uncertainty of less than ± 1,0 % for the metering process.

(a2) Net calorific value (if applicable)

Tier 1

The operator applies country specific net calorific values for the respective fuel as listed in Appendix 2.1 A.3 '1990 country-specific net calorific values' of the 2000 IPCC 'Good practice guidance and uncertainty management in national greenhouse gas inventories' (<http://www.ipcc.ch/pub/guide.htm>).

Tier 2

The operator applies country specific net calorific values for the respective fuel as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

Tier 3

The net calorific value representative for each batch of fuel in an installation is measured by the operator, a contracted laboratory or the fuel supplier in accordance with the provisions of section 10 of Annex I.

(b) Emission factor

The emission factor for the activity data_{OUTPUT} refers to the amount of non-CO₂ carbon in process output, which is expressed as tCO₂/t output to enhance comparability.

Tier 1

Reference factors for input and output material from see tables 1 and 2 below and section 8 of Annex I).

TABLE 1

Reference emission factors for input material⁽²⁵⁾

Emission factor		Source of emission factor
Coke oven gas	47,7 t CO ₂ /TJ	IPCC
Blast furnace gas	241,8 t CO ₂ /TJ	IPCC
Basic oxygen furnace gas (BOFG)	186,6 t CO ₂ /TJ	WBCSD/WRI
Graphite electrodes	3,60 t CO ₂ /t electrode	IPCC
PET	2,24 t CO ₂ /t PET	WBCSD/WRI
PE	2,85 t CO ₂ /t PE	WBCSD/WRI
CaCO ₃	0,44 t CO ₂ /t CaCO ₃	Stoichiometric ratio
CaCO ₃ -MgCO ₃	0,477 t CO ₂ /t CaCO ₃ -MgCO ₃	Stoichiometric ratio

TABLE 2

Reference emission factor for output material (based on carbon content)

Emission factor [t CO ₂ /t]		Source of emission factor
Ore	0	IPCC
Pig iron, pig iron scrap, iron products	0,1467	IPCC
Steel scrap, steel products	0,0147	IPCC

Tier 2

Specific emission factors (t CO₂/t_{INPUT} or t_{OUTPUT}) for input and output materials, developed in accordance with the provisions of section 10 of Annex I.

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ EMISSIONS

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

⁽²⁵⁾ Values are based on IPCC factors expressed in tC/TJ, multiplied with a CO₂/C conversion factor of 3,664.

ANNEX VII

Activity-specific guidelines for installations for the production of cement clinker as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

In cement installations, CO₂ emissions result from the following sources:

- calcination of limestone in the raw materials,
- conventional fossil kiln fuels,
- alternative fossil-based kiln fuels and raw materials,
- biomass kiln fuels (biomass wastes),
- non kiln fuels,
- waste gas scrubbing.

2.1. **Calculation of CO₂ emissions**2.1.1. *Combustion emissions*

Combustion processes involving different types of fuels (e.g. coal, petcoke, fuel oil, natural gas and the broad range of waste fuels) that take place at installations for the production of cement clinker shall be monitored and reported in accordance with Annex II. Emissions from the combustion of the organic content of (alternative) raw materials shall also be calculated according to Annex II.

In cement kilns the incomplete combustion of fossil fuels is negligible, due to the very high combustion temperatures, long residence time in kilns and minimal residual carbon found in clinker. Carbon in all kiln fuels shall therefore be accounted for as fully oxidized (oxidation factor = 1,0).

2.1.2. *Process emissions*

During calcination in the kiln, CO₂ from carbonates is released from the raw mix. Calcination CO₂ is directly linked with clinker production.

2.1.2.1. CO₂ from clinker production

Calcination CO₂ shall be calculated based on the amounts of clinker produced and the CaO and MgO contents of clinker. The emission factor shall be corrected for already calcined Ca and Mg entering the kiln, for instance through fly ash or alternative fuels and raw materials with a relevant CaO content (e.g. sewage sludge).

Emissions shall be calculated based on the carbonate content of the process input (calculation method A) or on the amount of clinker produced (calculation method B). These approaches are considered equivalent.

Calculation method A: carbonates

Calculation shall be based on the carbonate content of process input. CO₂ shall be calculated with the following formula:

$$\text{CO}_2\text{-emissions}_{\text{clinker}} = \text{Activity data} * \text{Emission factor} * \text{Conversion factor}$$

With:

(a) Activity data

Tier 1

Amount of pure carbonates (e.g. limestone) contained in the raw meal [t] as process input employed during the reporting period, determined by weighing the raw meal with a maximum permissible uncertainty of less than $\pm 5,0$ %. The determination of the amount of carbonates from the composition of relevant raw material is characterised by industry best practice guidelines.

Tier 2

Amount of pure carbonates (e.g. limestone) contained in the raw meal [t] as process input employed during the reporting period, determined by weighing the raw meal with a maximum permissible uncertainty of less than $\pm 2,5$ %. The determination of the amount of carbonates from the composition of relevant raw material is determined by the operator according to section 10 of Annex I.

(b) Emission factor

Tier 1

Stoichiometric ratios of carbonates in process input as shown in table 1 below.

TABLE 1
Stoichiometric emission factors

Carbonates	Emission factor
CaCO ₃	0,440 [t CO ₂ /CaCO ₃]
MgCO ₃	0,522 [t CO ₂ /MgCO ₃]

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Calculation method B: clinker production

This calculation method is based on the amount of clinker produced. CO₂ shall be calculated with the following formula:

$$\text{CO}_2\text{-emissions}_{\text{clinker}} = \text{Activity data} * \text{Emission factor} * \text{Conversion factor}$$

If emission estimates are based on clinker output, CO₂ released from the calcination of cement kiln dust (CKD) need to be considered for installations where such dust is discarded. Emissions from clinker production and from cement kiln dust shall be calculated separately and added up to the emission total:

$$\text{CO}_2\text{-emissions}_{\text{process_total}} [\text{t}] = \text{CO}_2\text{-emissions}_{\text{clinker}} [\text{t}] + \text{CO}_2\text{-emissions}_{\text{dust}} [\text{t}]$$

Emissions related to clinker output

(a) Activity data

Amount of clinker [t] produced in the reporting period.

Tier 1

Amount of clinker produced [t] derived by weighing with a permissible uncertainty of less than ± 5 % for the metering process.

Tier 2a

Amount of clinker produced [t] derived by weighing with a permissible uncertainty of less than $\pm 2,5$ % for the metering process.

Tier 2b

Clinker output [t] from cement production, as weighed with a permissible uncertainty of less than $\pm 1,5$ % for the metering process, is calculated using the following formula (material balance taking into account dispatch of clinker, clinker supplies as well as clinker stock variation):

$$\text{clinker produced [t]} = (\text{cement produced [t]} * \text{clinker/cement ratio [t clinker/t cement]})$$

$$- - (\text{clinker supplied [t]}) + (\text{clinker dispatched [t]})$$

$$- - (\text{clinker stock variation [t]})$$

The cement/clinker ratio shall be calculated and applied separately for the different cement types produced in the specific installation. The amounts of clinker dispatched and supplied shall be determined with a permissible uncertainty of less than $\pm 2,5$ % for the metering process. The uncertainty of the determination of stock changes over the reporting period shall exhibit an uncertainty of less than ± 10 %.

(b) Emission factor

Tier 1

Emission factor: 0,525 t CO₂/t clinker

Tier 2

The emission factor is calculated from a CaO- and MgO-balance, assuming that part of these were not derived from conversion of carbonates but were already contained in the process input. The composition of the clinker and the relevant raw materials is to be determined following the provisions of section 10 on Annex I.

The emission factor shall be calculated with the following equation:

$$\text{Emission factor [t CO}_2\text{/t clinker]} = 0,785 * (\text{Output}_{\text{CaO}} [\text{t CaO/t clinker}] - \text{Input}_{\text{CaO}} [\text{t CaO/t input material}]) + 1,092 * (\text{Output}_{\text{MgO}} [\text{t MgO/t clinker}] - \text{Input}_{\text{MgO}} [\text{t MgO/t input material}])$$

This equation uses the stoichiometric fraction of CO₂/CaO and CO₂/MgO shown in table 2 below.

TABLE 2

Stoichiometric emission factors for CaO and MgO (net production)

Oxides	Emission factor
CaO	0,785 [t CO ₂ /CaO]
MgO	1,092 [t CO ₂ /MgO]

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Emissions related to discarded dust

CO₂ from discarded bypass dust or cement kiln dust (CKD) shall be calculated based on discarded amounts of dust and the emission factor for clinker, corrected for partial calcination of CKD. Discarded bypass dust, as opposed to CKD, is considered fully calcined. Emissions shall be calculated as follows:

$$\text{CO}_2\text{-emissions}_{\text{dust}} = \text{Activity data} * \text{Emission factor} * \text{Conversion factor}$$

With:

(a) Activity data

Tier 1

Amount of CKD or bypass dust [t] discarded during reporting period derived by weighing with a permissible uncertainty of less than ± 10 % for the metering process.

Tier 2

Amount of CKD or bypass dust [t] discarded during reporting period derived by weighing with a permissible uncertainty of less than ± 5,0 % for the metering process.

(b) Emission factor

Tier 1

Use of the reference value of 0,525 t CO₂ per ton clinker also for CKD.

Tier 2

An emission factor [t CO₂/t CKD] shall be calculated based on the degree of CKD calcination. The relation between the degree of CKD calcination and the CO₂ emissions per ton of CKD is non-linear. It shall be approximated with the following formula:

$$EF_{CKD} = \frac{\frac{EF_{C_{li}}}{1 + EF_{C_{li}}} * d}{1 - \frac{EF_{C_{li}}}{1 + EF_{C_{li}}} * d}$$

where

EF_{CKD} = emission factor of partially calcined cement kiln dust [t CO₂/t CKD]

EF_{C_{li}} = installation specific emission factor of clinker ([CO₂/t clinker])

d = degree of CKD calcination (released CO₂ as % of total carbonate CO₂ in the raw mix).

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. **DETERMINATION OF NON-CO₂ GREENHOUSE GASES**

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX VIII

Activity-specific guidelines for installations for the production of lime as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

In installations for the production of lime, CO₂ emissions result from the following sources:

- calcination of limestone and dolomite in the raw materials,
- conventional fossil kiln fuels,
- alternative fossil-based kiln fuels and raw materials,
- biomass kiln fuels (biomass wastes),
- other fuels,
- waste gas scrubbing.

2.1. Calculation of CO₂ emissions

2.1.1. Combustion emissions

Combustion processes involving different types of fuels (e.g. coal, petcoke, fuel oil, natural gas and the broad range of waste fuels) that take place at installations for the production of lime shall be monitored and reported in accordance with Annex II. Emissions from the combustion of the organic content of (alternative) raw materials shall also be calculated according to Annex II.

2.1.2. Process emissions

During calcination in the kiln, CO₂ from carbonates is released from the raw materials. Calcination CO₂ is directly linked with the lime production. On installation level, calcination CO₂ can be calculated in two ways: based on the amount of carbonates from the raw material (mainly limestone, dolomite) converted in the process (calculation method A), or based on the amount of alkali oxides in the lime produced (calculation method B). The two approaches are considered to be equivalent.

Calculation method A: carbonates

Calculation shall be based on the amount of carbonates consumed. The following formula shall be used:

$$\text{CO}_2\text{-emission [t CO}_2\text{]} = \sum \{(\text{Activity data}_{\text{Carbonate-INPUT}} - \text{Activity data}_{\text{Carbonate-OUTPUT}}) * \text{emission factor} * \text{conversion factor}\}$$

With:

(a) Activity data

Activity data_{Carbonate-INPUT} and activity data_{Carbonate-OUTPUT} are the amounts [t] of CaCO₃, MgCO₃ or other alkali earth or alkali carbonates employed during the reporting period.

Tier 1

Amount of pure carbonates (e.g. limestone) [t] in process input and the product during the reporting period, determined by weighing with maximum permissible uncertainty of less than ± 5,0 % for the metering process of the raw material. The composition of relevant raw material and the product is characterised by industry best practice guidelines.

Tier 2

Amount of pure carbonates (e.g. limestone) [t] in process input and the product during the reporting period, determined by weighing with maximum permissible uncertainty of less than $\pm 2,5$ % for the metering process of the raw material. The composition of relevant raw material and the product is determined by the operator according to section 10 of Annex I.

(b) Emission factor

Tier 1

Stoichiometric ratios of carbonates in process input and output as shown in table 1.

TABLE 1
Stoichiometric emission factors

Carbonate	Emission factor [t CO ₂ /t Ca-, Mg- or other carbonate]	Remarks
CaCO ₃	0,440	
MgCO ₃	0,522	
In general: X _Y (CO ₃) _Z	Emission factor = [M _{CO₂}] / {Y * [M _X] + Z * [M _{CO₃²⁻}]}	X = alkali earth or alkali metal M _X = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO ₂ = 44 [g/mol] M _{CO₃²⁻} = molecular weight of CO ₃ ²⁻ = 60 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of CO ₃ ²⁻ = 1

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Calculation method B: alkali earth oxides

CO₂ shall be calculated based on the amounts of CaO, MgO and other alkali earth /alkali oxide contents in the lime produced. Already calcined Ca and Mg entering the kiln, for instance through fly ash or alternative fuels and raw materials with a relevant CaO or MgO content shall be considered.

The following calculation formula shall be used:

$$\text{CO}_2\text{-emission [t CO}_2\text{]} = \sum \{[(\text{activity data}_{\text{Alkali oxides OUTPUT}} - \text{activity data}_{\text{Alkali oxides INPUT}}) * \text{emission factor} * \text{conversion factor}]\}$$

With:

(a) Activity data

The term 'activity data_{O OUTPUT} - activity data_{O INPUT}' is the total amount [t] of CaO, MgO or other alkali earth or alkali oxides converted from respective carbonates during the reporting period.

Tier 1

Mass of CaO, MgO or other alkali earth or alkali oxides [t] in the product and the process input during the reporting period derived by weighing by the operator with a maximum permissible uncertainty of $\pm 5,0$ % for the metering process and industry best practice guidelines on the composition of the respective product types and raw materials.

Tier 2

Mass of CaO, MgO or other alkali earth or alkali oxides [t] in the product and in the process input during the reporting period derived by weighing by the operator with a maximum permissible uncertainty of $\pm 2,5$ % for the metering process and composition analyses following the provision of section 10 of Annex I.

(b) Emission factor

Tier 1

Stoichiometric ratios of oxides in process input and output as shown in table 2.

TABLE 2

Stoichiometric emission factors

Carbonate	Emission factor [t CO ₂] / [t Ca-, Mg- or other Oxide]	Remarks
CaO	0,785	
MgO	1,092	
In general: $X_y(O)_z$	Emission factor = $[M_{CO_2}] / \{Y * [M_x] + Z * [M_o]\}$	X = alkali earth or alkali metal M _x = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO ₂ = 44 [g/mol] M _o = molecular weight of O = 16 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of O = 1

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX IX

Activity-specific guidelines for installations for the manufacture of glass as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

In glass installations, CO₂ emissions result from the following sources:

- melting of alkali- and alkali earth metal carbonates in the raw material,
- conventional fossil kiln fuels,
- alternative fossil-based kiln fuels and raw materials,
- biomass kiln fuels (biomass wastes),
- other fuels,
- carbon containing additives including coke and coal dust,
- waste gas scrubbing.

2.1. Calculation of CO₂ Emissions

2.1.1. Combustion emissions

Combustion processes that take place at installations for the manufacture of glass shall be monitored and reported in accordance with Annex II.

2.1.2. Process emissions

CO₂ is released during melting in the kiln, from carbonates contained in the raw materials, and from the neutralisation of HF, HCl and SO₂ in the exhaust gases with limestone or other carbonates. Emissions from the decomposition of carbonates in the melting process and from scrubbing shall both be part of the installation's emissions. They shall be added up to the emission total but be reported separately if possible.

CO₂ from carbonates in the raw materials released during melting in the kiln, is directly linked with the glass production and can be calculated in two ways: based on the converted quantity of carbonates from raw material -mainly soda, lime/limestone, dolomite and other alkali and alkali earth carbonates supplemented by recycle glass (cullet) — (calculation method A), or based on the amount of alkali oxides in the glass produced (calculation method B). The two calculation methods are considered equivalent.

Calculation method A: carbonates

Calculation shall be based on the amount of carbonates consumed. The following formula shall be used:

$$\text{CO}_2\text{-emissions [t CO}_2\text{]} = (\sum \{\text{activity data}_{\text{Carbonate}} * \text{emission factor}\} + \sum \{\text{additive} * \text{emission factor}\}) * \text{conversion factor}$$

With:

(a) Activity data

Activity data_{Carbonate} is the amount [t] of CaCO₃, MgCO₃, Na₂CO₃, BaCO₃ or other alkali earth or alkali carbonates in raw materials (soda, lime/limestone, dolomite) processed during the reporting period as well as the amount of carbon containing additives.

Tier 1

The mass of CaCO_3 , MgCO_3 , Na_2CO_3 , BaCO_3 or other alkali earth or alkali carbonates and the mass of carbon containing additives [t] in the process input during the reporting period derived by weighing of the respective raw materials by the operator or the supplier with a maximum permissible uncertainty of $\pm 2,5 \%$ for the metering process and composition data from industry best practice guidelines for the specific product category.

Tier 2

The mass of CaCO_3 , MgCO_3 , Na_2CO_3 , BaCO_3 or other alkali earth or alkali carbonates and the mass of carbon containing additives [t] in the process input during the reporting period derived by weighing of the respective raw material by the operator or the supplier with a maximum permissible uncertainty of $\pm 1,0 \%$ for the metering process and composition analyses following the provision of section 10 of Annex I.

(b) Emission factor

Tier 1

Carbonates

Stoichiometric ratios of carbonates in process input and output as in table 1.

TABLE 1
Stoichiometric emission factors

Carbonate	Emission factor [t CO_2 /t Ca-, Mg- Na-, Ba- or other carbonate]	Remarks
CaCO_3	0,440	
MgCO_3	0,522	
Na_2CO_3	0,415	
BaCO_3	0,223	
In general: $\text{X}_y(\text{CO}_3)_z$	Emission factor = $[\text{M}_{\text{CO}_2}] / \{Y * [\text{M}_x] + Z * [\text{M}_{\text{CO}_3}]\}$	X = alkali earth or alkali metal M _x = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO_2 = 44 [g/mol] M _{CO₃} = molecular weight of CO_3^{2-} = 60 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of CO_3^{2-} = 1

These values shall be adjusted according to moisture and gangue content of the applied carbonate materials.

Additives

Specific emission factor derived following the provisions of section 10 of Annex I.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Calculation method B: alkali oxides

CO₂ emissions shall be calculated based on the amounts of glass produced and the CaO, MgO, Na₂O, BaO and other alkali earth /alkali contents of the glass (activity data_{O OUTPUT}). The emission factor shall be corrected for Ca, Mg, Na and Ba and other alkali earth /alkali entering the kiln not as carbonates, for instance through recycling glass or alternative fuels and raw materials with a relevant CaO, MgO, Na₂O or BaO and other alkali earth /alkali oxides content (activity data_{O INPUT}).

The following calculation formula shall be used:

$$\text{CO}_2\text{-emission [t CO}_2\text{]} = \left(\sum \{(\text{activity data}_{\text{O OUTPUT}} - \text{activity data}_{\text{O INPUT}}) * \text{emission factor}\} + \sum \{\text{additive} * \text{emission factor}\} \right) * \text{conversion factor}$$

With:

(a) Activity data

The term 'Activity data_{O OUTPUT} - activity data_{O INPUT}' is the mass [t] of CaO, MgO, Na₂O, BaO or other alkali earth or alkali oxides converted from carbonates during the reporting period.

Tier 1

Amount [t] of CaO, MgO, Na₂O, BaO or other alkali earth or alkali oxides employed during the reporting period in the process input and in the products as well as the amount of carbon containing additives derived by metering of input materials and products at installation level with a permissible uncertainty of less than ± 2,5 % for the metering process and composition data from industry best practice guidelines for the specific product category and raw materials.

Tier 2

Amount [t] of CaO, MgO, Na₂O, BaO or other alkali earth or alkali oxides employed during the reporting period in the process input and in the products as well as the amount of carbon containing additives derived by metering of input materials and products at installation level with a permissible uncertainty of less than ± 1,0 % for the metering process and composition analyses following the provision of section 10 of Annex I.

(b) Emission factor

Tier 1

Carbonates

Stoichiometric ratios of oxides in process input and output as shown in table 2

TABLE 2
Stoichiometric emission factors

Oxide	Emission factor [t CO ₂ /t Ca-, Mg-, Na, Ba- or other Oxide]	Remarks
CaO	0,785	
MgO	1,092	
Na ₂ O	0,710	
BaO	0,287	

Oxide	Emission factor [t CO ₂ /t Ca-, Mg-, Na, Ba- or other Oxide]	Remarks
In general: $X_y(O)_z$	Emission factor = $[M_{CO_2}] / \{Y * [M_x] + Z * [M_o]\}$	X = alkali earth or alkali metal M _x = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO ₂ = 44 [g/mol] M _o = molecular weight of O = 16 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of O = 1

Additives

Specific emission factors derived following the provisions of section 10 of Annex I.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX X

Activity-specific guidelines for installations for the manufacture of ceramic products as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

No specific boundary issues.

2. DETERMINATION OF CO₂ EMISSIONS

In installations for the manufacture of ceramic products, CO₂ emissions result from the following sources:

- calcination of limestone/dolomite in the raw material,
- limestone for reducing air pollutants,
- conventional fossil kiln fuels,
- alternative fossil-based kiln fuels and raw materials,
- biomass kiln fuels (biomass wastes),
- other fuels,
- organic material in the clay raw material,
- additives used to induce porosity, e.g. sawdust or, polystyrol,
- waste gas scrubbing.

2.1. **Calculation of CO₂ emissions**2.1.1. *Combustion emissions*

Combustion processes that take place at installations for the manufacture of ceramic products shall be monitored and reported in accordance with Annex II.

2.1.2. *Process emissions*

CO₂ is released during calcinations of the raw materials in the kiln, and from the neutralisation of HF, HCl and SO₂ in the exhaust gases with limestone or other carbonates. Emissions from the decomposition of carbonates in the calcination process and from scrubbing shall both be part of the installation's emissions. They shall be added up to the emission total but reported separately if possible. Calculation shall be as follows:

$$\text{CO}_2\text{-emissions}_{\text{total}} [\text{t}] = \text{CO}_2\text{-emissions}_{\text{input material}} [\text{t}] + \text{CO}_2\text{-emissions}_{\text{scrubbing}} [\text{t}]$$

2.1.2.1. CO₂ from input material

CO₂ from carbonates and from carbon contained in other input materials shall be calculated using either a calculation method based on the amount of carbonates from raw material (mainly limestone, dolomite) converted in the process (calculation method A), or a methodology based on the alkali oxides in ceramics produced (calculation method B). The two approaches are considered equivalent.

Calculation method A: carbonates

Calculation is based on the carbonate input, including the amount of limestone employed to neutralise HF, HCl and SO₂ in the exhaust gases as well as from carbon contained in the amount of additives. Double counting through the internal recycling of dust shall be avoided.

The following calculation formula shall be used:

$$\text{CO}_2 \text{ emission [t CO}_2\text{]} = \left(\sum \{ \text{Activity data}_{\text{Carbonate}} * \text{emission factor} \} + \sum \{ \text{Activity data}_{\text{additives}} * \text{emission factor} \} \right) * \text{conversion factor}$$

With:

(a) Activity data

Activity data_{Carbonate} is the amount [t] of CaCO₃, MgCO₃ or other alkali earth or alkali carbonates employed during the reporting period through the raw materials (limestone, dolomite) and their CO₃²⁻ concentration as well as the amount [t] of carbon containing additives.

Tier 1

The mass of CaCO₃, MgCO₃ or other alkali earth or alkali carbonates [t] as well as the amount [t] of carbon containing additives in the process input during the reporting period derived by weighing by the operator or the supplier with a maximum permissible uncertainty of ± 2,5 % for the metering process and composition data from industry best practice guidelines for the specific product category.

Tier 2

The mass of CaCO₃, MgCO₃ or other alkali earth or alkali carbonates [t] as well as the amount [t] of carbon containing additives in the process input during the reporting period derived by weighing by the operator or the supplier with a maximum permissible uncertainty of ± 1,0 % for the metering process and composition analyses following the provision of section 10 of Annex I.

(b) Emission factor

Tier 1

Carbonates

Stoichiometric ratios of carbonates in process input and output as shown in table 1.

TABLE 1
Stoichiometric emission factors

Carbonate	Emission factor [t CO ₂ /t Ca-, Mg- or other Carbonate]	Remarks
CaCO ₃	0,440	
MgCO ₃	0,522	
In general: X _y (CO ₃) _z	Emission factor = [M _{CO₂}] / {Y * [M _x] + Z * [M _{CO₃²⁻}]}	X = alkali earth or alkali metal M _x = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO ₂ = 44 [g/mol] M _{CO₃²⁻} = molecular weight of CO ₃ ²⁻ = 60 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of CO ₃ ²⁻ = 1

These values shall be adjusted according to moisture and gangue content of the applied carbonate materials.

Additives

Specific emission factors derived following the provisions of section 10 of Annex I.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

Calculation method B: alkali oxides

Calcination CO₂ is calculated based on the amounts of ceramics produced and the CaO, MgO and other (earth) alkali oxide contents of the ceramics (activity data_{O OUTPUT}). The emission factor is corrected for already calcined Ca, Mg and for other alkali earth/alkali contents entering the kiln (activity data_{O INPUT}), for instance alternative fuels and raw materials with a relevant CaO or MgO content. Emissions from HF, HCl or SO₂ reduction shall be calculated based on the carbonate input according to the procedures laid out in calculation method A.

The following calculation formula shall be used:

$$\text{CO}_2 \text{ emission [t CO}_2\text{]} = \sum \{[(\text{activity data}_{\text{O OUTPUT}} - \text{activity data}_{\text{O INPUT}}) * \text{emission factor} * \text{conversion factor}]\} + (\text{CO}_2 \text{ emissions from HF, HCl reduction})$$

With:

(a) Activity data

The term 'activity data_{O OUTPUT} - activity data_{O INPUT}' is the amounts [t] of CaO, MgO or other alkali earth or alkali oxides converted from carbonates during the reporting period.

Tier 1

Mass of CaO, MgO or other alkali earth or alkali oxides [t] in the process input and in the products during the reporting period derived by weighing by the operator with a maximum permissible uncertainty of ± 2,5 % for the metering process and industry best practice guidelines on the composition of the respective product types and raw materials.

Tier 2

Mass of CaO, MgO or other alkali earth or alkali oxides [t] in the process input and in the products during the reporting period derived by weighing by the operator with a maximum permissible uncertainty of ± 1,0 % for the metering process and composition analyses following the provision of section 10 of Annex I.

(b) Emission factor

Tier 1

Stoichiometric ratios of oxides in process input and output shall be used (see Table 2).

TABLE 2

Stoichiometric emission factors

Carbonate	Emission factors [t CO ₂ /t Ca-, Mg- or other Oxide]	Remarks
CaO	0,785	
MgO	1,092	

Carbonate	Emission factors [t CO ₂ /t Ca-, Mg- or other Oxide]	Remarks
In general: $X_y(O)_z$	Emission factor = $[M_{CO_2}] / \{Y * [M_x] + Z * [M_o]\}$	X = alkali earth or alkali metal M _x = molecular weight of X in [g/mol] M _{CO₂} = molecular weight of CO ₂ = 44 [g/mol] M _o = molecular weight of O = 16 [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of O = 1

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.1.2.2. CO₂ from exhaust gas scrubbing

CO₂ from exhaust gas scrubbing shall be calculated based on the amount of CaCO₃ input.

The following calculation formula shall be used

$$\text{CO}_2 \text{ emission [t CO}_2\text{]} = \text{Activity data} * \text{emission factor} * \text{conversion factor}$$

With:

(a) Activity data

Tier 1

The amount [t] of dry CaCO₃ employed during the reporting period determined by weighing by operator or the supplier with permissible uncertainty of less than ± 2,5 % for the metering process.

Tier 2

The amount [t] of dry CaCO₃ employed during the reporting period determined by weighing by operator or the supplier with permissible uncertainty of less than ± 1,0 % for the metering process.

(b) Emission factor

Tier 1

Stoichiometric ratios of CaCO₃ as shown in table 1.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.

ANNEX XI

Activity-specific guidelines for pulp and paper producing installations as listed in Annex I to the Directive

1. BOUNDARIES AND COMPLETENESS

If the installation exports fossil fuel-derived CO₂, for instance to an adjacent precipitated calcium carbonate (PCC) installation, these exports shall not be included in the installation's emissions.

If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated as part of the installation's process emissions, they shall be calculated in accordance with Annex II.

2. DETERMINATION OF CO₂ EMISSIONS

Pulp and paper mill processes with the potential to emit CO₂ emissions include:

- power boilers, gas turbines, and other combustion devices producing steam or power for the mill,
- recovery boilers and other devices burning spent pulping liquors,
- incinerators,
- lime kilns and calciners,
- waste gas scrubbing,
- gas-or other fossil fuel-fired dryers (such as infrared dryers).

Wastewater treatment and landfills, including anaerobic wastewater treatment or sludge digestion operations and landfills used to dispose of mill wastes, are not listed in Annex I to the Directive. Consequently their emissions fall outside the scope of the Directive.

2.1. Calculation of CO₂ emissions

2.1.1. Combustion emissions

Emissions from combustion processes that take place at pulp and paper installations shall be monitored in accordance with Annex II.

2.1.2. Process emissions

Emissions are caused by the use of carbonates as make-up chemicals in pulp mills. Although losses of sodium and calcium from the recovery system and causticising area are usually made up using non-carbonate chemicals, small amounts of calcium carbonate (CaCO₃) and sodium carbonate (Na₂CO₃), which do result in CO₂ emissions are sometimes used. The carbon contained in these chemicals is usually of fossil origin, although in some cases (e.g., Na₂CO₃ purchased from soda-based semi-chem mills) it can be derived from biomass.

It is assumed that the carbon in these chemicals is emitted as CO₂ from the lime kiln or recovery furnace. These emissions are determined by assuming that all of the carbon in CaCO₃ and Na₂CO₃ used in the recovery and causticising areas is released to the atmosphere.

Calcium make-up is required because of losses from the causticising area, most of which are in the form of calcium carbonate.

CO₂ emissions shall be calculated as follows:

$$\text{CO}_2 \text{ emissions} = \sum \{(\text{Activity data}_{\text{Carbonate}} * \text{Emission factor} * \text{Conversion factor})\}$$

With:

(a) Activity data

Activity data_{Carbon} are the amounts of CaCO₃ and Na₂CO₃ employed in the process.

Tier 1

Amounts [t] of CaCO₃ and Na₂CO₃ employed in the process as weighed by operator or supplier with a maximum permissible uncertainty of less than ± 2,5 % for the metering process.

Tier 2

Amounts [t] of CaCO₃ and Na₂CO₃ employed in the process as weighed by operator or supplier with a maximum permissible uncertainty of less than ± 1,0 % for the metering process.

(b) Emission factor

Tier 1

Stoichiometric ratios $[t_{CO_2}/t_{CaCO_3}]$ and $[t_{CO_2}/t_{Na_2CO_3}]$ for non-biomass carbonates as indicated in table 1. Biomass carbonates are weighted with an emission factor of 0 [t CO₂/t Carbonate].

TABLE 1

Stoichiometric emission factors

Carbonate type and origin	Emission factor [t CO ₂ /t Carbonate]
Pulp mill make-up CaCO ₃	0,440
Pulp mill make-up Na ₂ CO ₃	0,415
CaCO ₃ biomass origin	0,0
Na ₂ CO ₃ biomass origin	0,0

These values shall be adjusted according to moisture and gangue content of the applied carbonate materials.

(c) Conversion factor

Tier 1

Conversion factor: 1,0

2.2. **Measurement of CO₂ emissions**

The measurement guidelines contained in Annex I shall be applied.

3. DETERMINATION OF NON-CO₂ GREENHOUSE GASES

Specific guidelines for the determination of emissions of non-CO₂ greenhouse gas emissions may be elaborated at a later stage, in accordance with the relevant provisions of the Directive.