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COMMISSION DECISION

of 18 July 2007

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(2007) 3416)

(Text with EEA relevance)

(2007/589/EC)

(OJ L 229, 31.8.2007, p. 1)

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►M2	Commission Decision 2009/339/EC of 16 April 2009	L 103	10	23.4.2009
►M3	Commission Decision 2010/345/EU of 8 June 2010	L 155	34	22.6.2010
►M4	Commission Decision 2011/540/EU of 18 August 2011	L 244	1	21.9.2011

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(2007/589/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 the guidelines laid down in this Decision are fundamental for the operation of the greenhouse gas emission allowance trading scheme established in Directive 2003/87/EC.

(2) During the first compliance cycle of the greenhouse gas emissions trading scheme, covering the year 2005, operators, verifiers and competent authorities of Member States have gathered first experience of monitoring, verifying and reporting pursuant to Commission Decision 2004/156/EC 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 ([2]).

(3) Following the review of Decision 2004/156/EC, it was apparent that the guidelines laid down in that Decision required several changes in order to render them more clear and cost-efficient. Due to the substantial number of amendments it is appropriate to replace Decision 2004/156/EC.

(4) It is appropriate to facilitate the application of the guidelines for installations with average verified reported emissions of less than 25 000 tonnes of fossil CO_2 per year during the previous trading period, as well as to achieve further harmonization and clarify technical issues.

([1]) OJ L 275, 25.10.2003, p. 32. Directive as amended by Directive 2004/101/EC (OJ L 338, 13.11.2004, p. 18).

([2]) OJ L 59, 26.2.2004, p. 1.

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(5) Where applicable, account has been taken of the guidance on the monitoring of greenhouse gases as developed by Intergovernmental Panel on Climate Change (IPCC), the International Standardisation Organisation (ISO), the Greenhouse Gas Protocol Initiative of the World Business Council on Sustainable Development (WBCSD) and the World Resources Institute (WRI).

(6) The information provided by operators pursuant to this Decision should facilitate the cross-attribution of emissions reported under Directive 2003/87/EC with emissions reported to the European Pollutants Release and Transfer Register (EPRTR) established by Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC ([1]) as well as with emissions reported in national inventories using the different source categories of the Intergovernmental Panel on Climate Change (IPCC).

(7) By increasing the overall cost-effectiveness of monitoring methodologies, without compromising the accuracy of reported emission data and the overall integrity of the monitoring systems, operators and competent authorities should generally be able to meet their obligations under Directive 2003/87/EC at significantly reduced costs. This applies in particular to plants using pure biomass fuels and to small emitters.

(8) The reporting requirements have been aligned with those under Article 21 of Directive 2003/87/EC.

(9) The requirements for the monitoring plan have been clarified and made more stringent in order to better reflect its importance in ensuring sound reporting and robust verification results.

(10) Table 1 specifying minimum requirements set out in Annex I should be for permanent use. The specific entries in that Table have been reviewed based on information collected by Member States, operators and verifiers, taking into account the changes made to the provisions regarding combustion emissions from activities listed in Annex I to Directive 2003/87/EC and to the activity specific guidelines and should now reflect an appropriate balance between cost-effectiveness and accuracy.

(11) A fall-back approach with minimum uncertainty thresholds has been introduced in order to provide an alternative route for the monitoring of emissions from very specific or complex installations exempting those installations from the application of the tier-based approach and enabling the design of a fully customized monitoring methodology.

(12) The provisions concerning transferred and inherent CO_2 entering or leaving installations covered by Directive 2003/87/EC as pure substance or fuel have been clarified and made more stringent, in order to improve the consistency with the reporting requirements of Member States under the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

([1]) OJ L 33, 4.2.2006, p. 1.

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(13) The list of reference emission factors has been expanded and updated using information from the 2006 Guidelines of the Intergovernmental Panel on Climate Change, hereinafter 'the IPCC guidelines'. The list has also been extended with reference values for net calorific values for a wide range of fuels based on the IPCC Guidelines.

(14) The Section on control and verification has been reviewed and revised in order to improve conceptual and linguistic consistency with guidance developed by the European Cooperation for Accreditation (EA), the European Committee for Standardisation (CEN) and ISO.

(15) As regards the determination of fuel and material properties, the requirements for the use of results from analytical laboratories and online gas analysers have been clarified taking into account the experience from the implementation of the respective requirements across Member States during the first trading period. Additional requirements on sampling methods and frequencies have also been provided.

(16) To improve the cost-effectiveness for installations with annual emissions of less than 25 000 tonnes of fossil CO_2 certain exemptions from the specific requirements applying to installations in general have been added.

(17) The use of oxidation factors for the purposes of the monitoring methodology has been made optional for combustion processes. A mass-balance approach has been added for installations producing carbon black and for gas processing terminals. The uncertainty requirements for the determination of emissions from flares have been lowered in order to reflect the specific technical conditions of these facilities.

(18) The mass-balance approach should not be part of the activity-specific guidelines for mineral oil refineries as listed in Annex I to Directive 2003/87/EC due to the problems reported during the first reporting in respect to the achievable accuracy. Guidance for catalytic cracker regeneration, other catalyst regeneration and flexi-cokers emissions has been revised to reflect the specific technical conditions of those facilities.

(19) The provisions and thresholds for the application of the mass-balance approach have been made stricter for installations producing coke, sinter, iron and steel. Emission factors from the IPCC guidelines have been added.

(20) The terminology and methodologies for installations producing cement clinker and for installations producing lime have been aligned with commercial practices of the sectors covered by this Decision. The use of activity data, emission factor and conversion factor has been made consistent with the other activities covered under Directive 2003/87/EC.

(21) Additional emission factors have been provided in Annex IX for installations from the glass industry.

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(22) The uncertainty requirements for emissions from the calcination of raw materials for installations from the ceramics industry have been made less stringent to better reflect situations in which clays origin directly from quarries. The purely output-based method should no longer be used because of its limited applicability as observed during the first reporting cycle.

(23) Specific guidelines for the determination of greenhouse gas emissions by continuous emission measurement systems should be added to facilitate a consistent use of measurement-based monitoring approaches commensurate to Articles 14 and 24 and Annex IV of Directive 2003/87/EC.

(24) Recognition of activities relating to carbon capture and storage is not provided for in this Decision, but will depend on an amendment of Directive 2003/87/EC or on the inclusion of those activities pursuant to Article 24 of that Directive.

(25) The guidelines contained in the Annexes to this Decision set out the revised detailed criteria for the monitoring and reporting of greenhouse gas emissions resulting from the activities listed in Annex I of Directive 2003/87/EC. These are specified in relation to those activities, based on the principles for monitoring and reporting set out in Annex IV of that Directive that should apply as of 1 January 2008.

(26) 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 of that Directive.

(27) It is envisaged that a further review of the guidelines laid down in this Decision will be carried out within two years of its date of applicability.

(28) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 8 of Decision 93/389/EEC ([1]),

HAS ADOPTED THIS DECISION:

▼M4

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, and of activities included pursuant to Article 24(1) of that Directive, are set out in Annexes I to XIV and XVI to XXIV to this Decision.

The guidelines for the monitoring and reporting of tonne-kilometre data from aviation activities for the purpose of an application pursuant to Article 3e or 3f of Directive 2003/87/EC are set out in Annex XV. Those guidelines are based on the principles set out in Annex IV to that Directive.

([1]) 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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Article 2

Decision 2004/156/EC is repealed from the date referred to in Article 3.

Article 3

This Decision shall apply from 1 January 2008.

Article 4

This Decision is addressed to the Member States.

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[1] OJ L 140, 5.6.2009, p. 114.

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ANNEX I

GENERAL GUIDELINES

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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/ECof greenhouse gases specified in relation to those activities. Additional guidelines on activity-specific emissions are set out in ►M4 Annexes II to XI and Annexes XIII to XXIV ◄.

2. **DEFINITIONS**

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For the purposes of this Annex and ►M4 Annexes II to XXIV ◄ the definitions of Directive 2003/87/EC shall apply. However, for the purposes of this Annex, 'operator' means operator as referred to in Article 3(f) of Directive 2003/87/EC and aircraft operator as referred to in point (o) of that Article.

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1. In addition the following basic definitions shall apply:

(a) 'activities' means the activities listed in Annex I to Directive 2003/87/EC;

(b) 'competent authority' means the competent authority or authorities designated in accordance with Article 18 of the Directive 2003/87/EC;

▼M2

(c) 'emission source' means a separately identifiable part (point or process) of an installation from which relevant greenhouse gases are emitted or, for aviation activities, an individual aircraft;

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(d) 'source stream' means a specific fuel type, raw material or product giving rise to emissions of relevant greenhouse gases at one or more emission sources as a result of its consumption or production;

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(e) 'monitoring methodology' means the sum of approaches used by an operator or aircraft operator to determine the emissions of a given installation or aviation activity;

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(f) 'monitoring plan' means a detailed, complete and transparent documentation of the monitoring methodology of a specific ►M2 installation or aircraft operator ◄, including documentation of the data acquisition and data handling activities, and the system to control the trueness thereof;

▼M2

(g) 'tier' means a specific element of a methodology for determining activity data, emission factors, annual emission, annual average hourly emission and oxidation or conversion factors, as well as for payload;

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(h) 'annual' means a period of time covering a calendar year from 1 January to 31 December;

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(i) 'reporting period' means one calendar year during which emissions or tonne-kilometre data have to be monitored and reported;

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(j) ‘trading period’ means a multiple year phase of the emission trading scheme (e.g. 2005-2007 or 2008-2012) for which a national allocation plan is issued by the Member State in accordance with Article 11(1) and (2) of the Directive 2003/87/EC ►M2 for aviation activities trading period means the period referred to in Article 3c(1) and (2) of that Directive. ◄

2. The following definitions shall apply in relation to emissions, fuels and materials:

(a) ‘combustion emissions’ means greenhouse gas emissions occurring during the exothermic reaction of a fuel with oxygen;

(b) ‘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;

(c) ‘inherent CO_2’ means CO_2 which is part of a fuel;

(d) ‘conservative’ means that a set of assumptions is defined in order to ensure that no under-estimation of annual emissions occurs;

(e) ‘batch’ means an amount of fuel or material representatively sampled and characterised and transferred as one shipment or continuously over a specific period of time;

(f) ‘commercially traded fuels’ means fuels of specified composition which are frequently and freely traded, if the specific batch has been traded between economically-independent parties, including all commercial standard fuels, natural gas, light and heavy fuel oil, coal, petroleum coke;

(g) ‘commercially traded materials’ means materials of specified composition which are frequently and freely traded, if the specific batch has been traded between economically independent parties;

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(h) ‘commercial standard fuel’ means the internationally standardised commercial fuels which exhibit a 95 % confidence interval of not more than ± 1 % for their specified calorific value, including gas oil, light fuel oil, gasoline, lamp oil, kerosene, ethane, propane, butane, jet kerosene (jet A1 or jet A), jet gasoline (Jet B) and aviation gasoline (AvGas).

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3. The following definitions shall apply in relation to measurement:

(a) ‘accuracy’ means the closeness of the agreement between the result of a measurement and the true value of the particular quantity (or a reference value determined empirically using internationally accepted and traceable calibration materials and standard methods), taking into account both, random and systematic factors;

(b) ‘uncertainty’ means a parameter, associated with the result of the determination of a quantity, that characterises the dispersion of the values that could reasonably be attributed to the particular quantity, including the effects of systematic as well as of random factors and expressed in per cent and describes a confidence interval around the mean value comprising 95 % of inferred values taking into account any asymmetry of the distribution of values;

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(c) ‘arithmetic mean’ means the sum of all the members of a set of values divided by the number of items in the set;

(d) ‘measurement’ means a set of operations having the object of determining the value of a quantity;

(e) ‘measurement instrument’ means a device intended to be used to make measurements, alone or in conjunction with supplementary device(s);

(f) ‘measurement system’ means a complete set of measurement instruments and other equipment, like sampling and data processing equipment, used for the determination of variables like the activity data, the carbon content, the calorific value or the emission factor of the CO_2 emissions;

(g) ‘calibration’ means the set of operations, which establish, under specified conditions, the relations between values indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values of a quantity realised by a reference standard;

(h) ‘continuous emission measurement’ means a set of operations having the objective of determining the value of a quantity by means of periodic (several per hour) measurements, applying either *in-situ* measurements in the stack or extractive procedures with a measurement instrument located close to the stack; it does not include measurement approaches based on the collection of individual samples from the stack;

(i) ‘standard conditions’ means temperature of 273,15 K (i.e. 0 °C) and pressure conditions of 101 325 Pa defining normal cubic meters (Nm^3) ;

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(j) ‘measurement point’ means the emission source for which continuous emission measurement systems (CEMS) are used for emission measurement, or the cross-section of a pipeline system for which the CO_2 flow is determined using continuous measurement systems.

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4. The following definitions relating to calculation-based methodologies and measurement-based methodologies for CO_2 emissions shall apply:

(a) ‘unreasonable costs’ means costs of a measure disproportionate to its overall benefits as established by the competent authority. In respect to the choice of tier levels, the threshold may be defined as the value of the allowances corresponding to an improvement of the level of accuracy. For measures increasing the quality of reported emissions but without direct impact on accuracy, unreasonable cost may correspond to a fraction exceeding an indicative threshold of 1 % of the average value of the available emissions data reported for the previous trading period. ►M2 For installations or aircraft operators without this history, data from representative installations or aircraft operators carrying out the same or comparable activities are used as reference and scaled according to their capacity; ◄

(b) ‘technically feasible’ means that technical resources capable of meeting the needs of a proposed system can be acquired by the operator in the required time;

▼M2

(c) '*de minimis* source streams' means a group of minor source streams selected by the operator and jointly emitting 1 kilotonne of fossil CO_2 or less per year, or that contribute less than 2 % (up to a total maximum contribution of 20 kilotonnes of fossil CO_2 per year) of total annual emissions of fossil CO_2 of that installation or aircraft operator before subtraction of transferred CO_2, whichever is the highest in terms of absolute emissions;

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(d) 'major source streams' means a group of source streams which do not belong to the group of 'minor source streams';

▼M2

(e) 'minor source streams' means those source streams selected by the operator to jointly emit 5 kilotonnes of fossil CO_2 or less per year or to contribute less than 10 % (up to a total maximum contribution of 100 kilotonnes of fossil CO_2 per year), to the total annual emissions of fossil CO_2 of an installation or aircraft operator before subtraction of transferred CO_2, whichever is the highest in terms of absolute emissions;

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(f) 'biomass' means non-fossilised and biodegradable organic material originating from plants, animals and micro-organisms, including 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, including gases and liquids recovered from the decomposition of non-fossilised and biodegradable organic material;

(g) 'pure' relating to a substance means that a material or fuel consists of at least 97 % (related to mass) of the specified substance or element — corresponding to the commercial classification of 'purum'. For biomass this relates to the fraction of biomass carbon in the total amount of carbon in the fuel or material;

(h) 'energy-balance method' means a method to estimate the amount of energy used as fuel in a boiler, calculated as sum of utilisable heat and all relevant losses of energy by radiation, transmission and via the flue gas.

5. the following definitions relating to control and verification shall apply:

(a) 'control risks' means the susceptibility of a parameter in the Annual Emissions Report to material misstatements that will not be prevented or detected and corrected on a timely basis by the control system;

(b) 'detection risk' means the risk that the verifier will not detect a material misstatement or a material non-conformity;

(c) 'inherent risk' means the susceptibility of a parameter in the annual emissions report to material misstatements, assuming that there were no related control activities;

(d) 'verification risk' means the risk that the verifier expresses an inappropriate verification opinion. Verification risk is a function of inherent risks, control risks, and the detection risk;

▼M2

(e) 'reasonable assurance' means a high but not absolute level of assurance, expressed positively in the verification opinion, whether the emissions report subject to verification is free from material misstatement and whether the installation or aircraft operator does not have material non-conformities;

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(f) ‘materiality level’ means the quantitative threshold or cut-off point to be used to determine the appropriate verification opinion on the emission data reported in the annual emissions report;

▼M2

(g) ‘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 in the annual emission report for an installation or aircraft operator is free from material misstatement;

(h) ‘Non-conformity’ means any act or omission of an act by the installation or aircraft operator being under verification, either intentional or unintentional, that is contrary to the requirements in the monitoring plan approved by the competent authority under the installation’s permit or under Article 3g of Directive 2003/87/EC;

(i) ‘Material non-conformity’ means a non-conformity to the requirements in the monitoring plan approved by the competent authority under the installation’s permit or under Article 3g of Directive 2003/87/EC, that could lead to a different treatment of the installation or aircraft operator by the competent authority;

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(j) ‘material misstatement’ means a misstatement (omissions, misrepresentations and errors, not considering the permissible uncertainty) in the annual emissions report that, to the professional judgment of the verifier, could affect the treatment of the annual emissions report by the competent authority, e.g. when the misstatement exceeds the materiality level;

(k) ‘accreditation’ in the context of verification means the issuing of a statement by an accreditation body based on its decision following a detailed assessment related to a verifier conveying formal demonstration of its competence and independence to carry out verification in accordance with specified requirements;

(l) ‘verification’ means the activities carried out by a verifier to be able to provide a verification opinion as described in Article 15 and Annex V of the Directive 2003/87/EC;

(m) ‘verifier’ means a competent, independent, accredited verification body or person 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 of the Directive 2003/87/EC.

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6. The following definitions shall apply in relation to emissions and tonne-kilometre data from aviation activities:

(a) ‘aerodrome of departure’ means the aerodrome at which a flight constituting an aviation activity listed in Annex I of Directive 2003/87/EC begins;

(b) ‘aerodrome of arrival’ means the aerodrome at which a flight constituting an aviation activity listed in Annex I of Directive 2003/87/EC ends;

(c) ‘aerodrome pair’ means a pair constituted by an aerodrome of departure and an aerodrome of arrival;

▼M2

(d) ‘mass and balance documentation’ means the documentation as specified in international or national implementation of the Standards and Recommended Practices (SARPs) as laid down in Annex 6 (Operation of Aircraft) to the Chicago Convention ([1]), including as specified in Council Regulation (EEC) No 3922/91 (EU-OPS), as amended by Commission Regulation (EC) No 859/2008 of 20 August 2008, in Annex III Subpart J, or equivalent international regulations;

(e) ‘passengers’ means the persons onboard the aircraft during a flight excluding its crew members;

(f) ‘payload’ means the total mass of freight, mail, passengers and baggage carried onboard the aircraft during a flight;

(g) ‘distance’ means the great circle distance between the aerodrome of departure and the aerodrome of arrival plus an additional fixed factor of 95 km;

(h) ‘tonne-kilometre’ means a tonne of payload carried a distance of one kilometre.

▼M3

7. The following definitions shall apply in relation to greenhouse gas emissions from greenhouse gas capture, transport and geological storage activities:

(a) ‘geological storage of CO_2’ means ‘geological storage of CO_2’ within the meaning of Article 3(1) of Directive 2009/31/EC;

(b) ‘storage site’ means ‘storage site’ within the meaning of Article 3(3) of Directive 2009/31/EC;

(c) ‘storage complex’ means ‘storage complex’ within the meaning of Article 3(6) of Directive 2009/31/EC;

(d) ‘CO_2 transport’ means the transport of CO_2 by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC;

(e) ‘transport network’ means ‘transport network’ within the meaning of Article 3(22) of Directive 2009/31/EC;

(f) ‘CO_2 capture’ means the activity of capturing from gas streams CO_2 which would otherwise be emitted, for the purposes of transport and geological storage in a storage site permitted under Directive 2009/31/EC;

(g) ‘capture installation’ means an installation which carries out CO_2 capture;

(h) ‘fugitive emissions’ means irregular or unintended emissions from sources which are not localised, or too diverse or too small to be monitored individually, such as emissions from otherwise intact seals, valves, intermediate compressor stations and intermediate storage facilities;

(i) ‘vented emissions’ means emissions deliberately released from the installation by provision of a defined point of emission;

(j) ‘water column’ means ‘water column’ within the meaning of Article 3(2) of Directive 2009/31/EC;

(k) ‘enhanced hydrocarbon recovery’ means the recovery of hydrocarbons in addition to those extracted by water injection or other means;

(l) ‘leakage’ in the context of geological storage means ‘leakage’ within the meaning of Article 3(5) of Directive 2009/31/EC.

([1]) Convention on International Civil Aviation and its Annexes signed in Chicago on 7 December 1944.

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3. **MONITORING AND REPORTING PRINCIPLES**

To ensure the accurate and verifiable monitoring and reporting of greenhouse gas emissions under Directive 2003/87/EC, monitoring and reporting shall be based on the following principles:

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Completeness. Monitoring and reporting for an ►M2 installation and aircraft operator ◄ shall cover all process and combustion emissions from all emission sources and source streams belonging to activities listed in Annex I to Directive 2003/87/EC and other relevant activities included pursuant to Article 24 of the Directive and of all greenhouse gases specified in relation to those activities while avoiding double-counting.

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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 in accordance with these guidelines.

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.

▼M2

Trueness. It shall be ensured that the emission determination is systematically neither over nor under true emissions. Sources of uncertainties shall be identified and reduced as far as practicable. Due diligence shall be exercised to ensure that the calculation and measurement of emissions exhibit highest achievable accuracy. The operator shall enable reasonable assurance of the integrity of reported emissions to be determined. 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. Reported emissions 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 or aircraft operator's emissions.

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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. ►M2 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 or used by the aircraft operator. ◄

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.

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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 OF GREENHOUSE GAS EMISSIONS

4.1. BOUNDARIES

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The monitoring and reporting process for an installation or aircraft operator shall include all relevant greenhouse gas emissions from all emission sources and/or source streams belonging to activities carried out at the installation or by an aircraft operator and listed in Annex I to Directive 2003/87/EC, as well as from activities and greenhouse gases included by a Member State pursuant to Article 24 of Directive 2003/87/EC. Aircraft operators shall furthermore ensure that documented procedures are in place which track any changes in the list of emission sources such as leasing or purchase of aircraft, thereby ensuring completeness of emission data and avoiding double counting.

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Article 6(2)(b) of Directive 2003/87/EC requires that greenhouse gas emissions permits shall contain a description of the activities and emissions from the installation. ►M2 Therefore, all emission sources and source streams from activities listed in Annex I to Directive 2003/87/EC that are to be monitored and reported shall be listed in the permit or, for aviation activities, covered by the monitoring plan. ◄ Article 6(2)(c) of Directive 2003/87/EC requires that greenhouse gas emissions permits shall contain monitoring requirements, specifying monitoring methodology and frequency.

▼M3

Where leakages from a storage complex pursuant to Directive 2009/31/EC are identified and lead to emissions, or release of CO2 to the water column, they shall be included as emission sources for the respective installation and shall be monitored accordingly as required under the provisions of Annex XVIII. The leakage may be excluded as an emission source subject to approval by the competent authority, when corrective measures pursuant to Article 16 of Directive 2009/31/EC have been taken and emissions or release into the water column from that leakage can no longer be detected.

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

▼B

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 Directive 2003/87/EC exceed the respective threshold defined in that Annex in one installation or on one site, all emissions from all emission sources and/or source streams of all activities listed in that Annex in the respective installation or site shall be monitored and reported.

▼B

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. CALCULATION AND MEASUREMENT-BASED METHODOLOGIES

▼M2

Annex IV to Directive 2003/87/EC allows a determination of emissions of installations using either:

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— a calculation-based methodology, determining emissions from source streams based on activity data obtained by means of measurement systems and additional parameters from laboratory analyses or standard factors;

— a measurement-based methodology, determining emissions from an emission source by means of continuous measurement of the concentration of the relevant greenhouse gas in the flue gas and of the flue gas flow.

The operator may propose to use a measurement based methodology if he can demonstrate that:

— it reliably results in a more accurate value of annual emissions of the installation than an alternative calculation based methodology, while avoiding unreasonable costs; and

— the comparison between measurement and calculation-based methodology is based on an identical set of emission sources and source streams.

The use of a measurement-based methodology 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-based methodology in accordance with the provisions of Section 6.3(c).

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

4.3. THE MONITORING PLAN

Pursuant to Article 6(2)(c) of Directive 2003/87/EC greenhouse gas emissions permits shall contain monitoring requirements, specifying monitoring methodology and frequency. ►M2 Pursuant to Article 3g of that Directive, aircraft operators shall submit to the competent authority a monitoring plan setting out measures to monitor and report emissions and tonne-kilometre data. ◄

The monitoring methodology is part of the monitoring plan which 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 Directive 2003/87/EC, in general binding rules.

▼M2

The competent authority shall check and approve the monitoring plan prepared by the operator before the start of the reporting period, and again after any substantial changes to the monitoring methodology are applied to an installation or by an aircraft operator. When required by an activity-specific Annex, the monitoring plan shall be submitted by a specific date using a standard template.

▼B

Subject to Section 16, the monitoring plan shall contain the following contents:

(a) the description of the installation and activities carried out by the installation to be monitored;

(b) information on responsibilities for monitoring and reporting within the installation;

(c) a list of emissions sources and source streams to be monitored for each activity carried out within the installation;

(d) a description of the calculation-based methodology or measurement-based methodology to be used;

▼M4

(e) a list and description of the tiers for activity data, carbon content (where mass balance or other approaches directly requiring the carbon content for emission calculation are applied), emission factors, oxidation and conversion factors for each of the source streams to be monitored;

▼B

(f) a description of the measurement systems, and the specification and exact location of the measurement instruments to be used for each of the source streams to be monitored;

▼M1

(g) evidence demonstrating compliance with the uncertainty thresholds for activity data and other parameters (where applicable) for the applied tiers for each source stream and/or emission source;

▼B

(h) if applicable, 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, oxidation and conversion factor and biomass content for each of the source streams;

(i) a description of the intended sources or analytical approaches for the determination of the net calorific values, carbon content, emission factor, oxidation factor, conversion factor or biomass fraction for each of the source streams;

(j) if applicable, a list and description of non-accredited laboratories and relevant analytical procedures including a list of all relevant quality assurance measures, e.g. inter-laboratory comparisons as described in Section 13.5.2;

▼B

(k) if applicable, a description of continuous emission measurement systems to be used for the monitoring of an emission source, i.e. the points of measurement, frequency of measurements, equipment used, calibration procedures, data collection and storage procedures and the approach for corroborating calculation and the reporting of activity data, emission factors and alike;

(l) if applicable, where the so-called 'fall-back approach' (Section 5.3) is applied: a comprehensive description of the approach and the uncertainty analysis, if not already covered by items (a) to (k) of this list;

▼M1

(m) a description of the procedures for data acquisition, handling activities and control activities as well as a description of the activities (see Section 10.1-3, and Annex XIII, Section 8);

▼B

(n) where applicable, information on relevant links with activities undertaken under the Community eco-management and audit scheme (EMAS) and other environmental management systems (e.g. ISO14001:2004), in particular on procedures and controls with relevance to greenhouse gas emissions monitoring and reporting ;

▼M3

(o) where applicable, the location of equipment for temperature and pressure measurement in a transport network;

(p) where applicable, procedures for preventing, detecting and quantification of leakage events from transport networks;

(q) in the case of transport networks, procedures effectively ensuring that CO_2 is transferred only to installations which have a valid greenhouse gas emission permit, or where any emitted CO_2 is effectively monitored and accounted for in accordance with section 5.7 of this Annex;

(r) where CO_2 is transferred according to section 5.7 of this Annex, an identification of the receiving and transferring installations. For installations holding a greenhouse gas emissions permit, this is the installation identification code as defined by the Regulation pursuant to Article 19 of Directive 2003/87/EC;

(s) where applicable, a description of continuous measurement systems used at the points of transfer of CO_2 between installations transferring CO_2 according to section 5.7 of this Annex;

(t) where applicable, quantification approaches for emissions or CO_2 release to the water column from potential leakages as well as the applied and possibly adapted quantification approaches for actual emissions or CO_2 release to the water column from leakages, as specified in Annex XVIII ;

▼M4

(u) where applicable, the dates when measurements for the determination of the installation specific emission factors for CF_4 and C_2F_6 have been carried out, and a schedule for future repetitions of this determination;

(v) where applicable, the protocol describing the procedure used to determine the installation specific emission factors for CF_4 and C_2F_6, showing also that the measurements have been and will be carried out for a sufficiently long time for measured values to converge, but at least for 72 hours;

(w) where applicable, the methodology for determining the collection efficiency for fugitive emissions at installations for primary aluminium production.

▼B

The monitoring methodology shall be changed if this improves the accuracy of the reported data, unless this is technically not feasible or would lead to unreasonably high costs.

▼M3

A substantial change to the monitoring methodology as part of the monitoring plan shall be subject to the approval of the competent authority if it concerns:

— a change of the categorisation of the installation as laid down in Table 1,

— a change between the calculation-based or the measurement-based methodology used to determine emissions,

— an increase of the uncertainty of the activity data or other parameters (where applicable) which implies a different tier level,

— the application or adaption of a quantification approach for emissions from leakage at storage sites.

▼B

All other changes and proposed changes in monitoring methodology or the underlying data sets shall be notified to the competent authority without undue delay after the operator has become aware of it or could in all reasonableness have become aware of it, unless otherwise specified in the monitoring plan.

Changes to the monitoring plan shall be clearly stated, justified and fully documented in internal records of the operator.

A competent authority shall require the operator to change its monitoring plan if its monitoring plan is no longer in conformity with the rules laid down in these Guidelines.

To exchange information between the competent authorities and the Commission on monitoring, reporting and verification under these guidelines and its coherent application Member States shall facilitate an annual quality assurance and evaluation process of monitoring, reporting and verification initiated by the Commission pursuant to Article 21(3) of Directive 2003/87/EC.

▼B

5. CALCULATION-BASED METHODOLOGIES FOR CO_2 EMISSIONS

5.1. CALCULATION FORMULAE

Calculation of CO_2 emissions shall be based either on the following formula:

$$CO_2 \text{ emissions} = \text{activity data} * \text{emission factor} * \text{oxidation factor}$$

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

▼M2

Activity data shall be based on fuel consumption. The quantity of fuel used shall be expressed in terms of energy content as TJ, unless otherwise indicated in these guidelines. The use of a net calorific value shall be deemed not to be necessary for some specific activities if their activity-specific Annexes indicate that emission factors expressed as t CO_2 per tonne of fuel can be used with a similar level of accuracy. The emission factor shall be expressed as t CO_2/TJ, unless otherwise indicated in these guidelines. When a fuel is consumed not all of the carbon in the fuel is oxidised to CO_2. Incomplete oxidation occurs due to inefficiencies in the combustion process that leave some of the carbon unburned or partly oxidised as soot or ash. Un-oxidised or partially oxidised carbon is taken into account in the oxidation factor which shall be expressed as a fraction. The oxidation factor shall be expressed as a fraction of one. The resulting calculation formula is:

▼B

$$CO_2 \text{ emissions} = \text{fuel flow [t or } Nm^3\text{]} * \text{net calorific value [TJ/t or } TJ/Nm^3\text{]} * \text{emission factor [t}CO_2/TJ\text{]} * \text{oxidation factor}$$

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 Nm^3. The emission factor shall be expressed in [tCO_2/t or tCO_2/Nm^3]. Carbon contained in input materials, which is not converted to CO_2 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 Nm^3]. The resulting calculation formula is:

▼M4

The calculation of process emissions is further specified in the activity-specific guidelines in the Annexes II to XI and XVI to XXIV. Not all calculation methods in Annexes II to XI and XVI to XXIV use a conversion factor.

▼B

The calculation of process emissions is further specified in the activity-specific guidelines in the ►M3 Annexes II to XI and XVI, XVII and XVIII ◄. Not all calculation methods in ►M3 Annexes II to XI and XVI, XVII and XVIII ◄ use a conversion factor.

▼B

5.2. TIERS OF APPROACHES

►M2 The activity-specific guidelines set out in ►M4 Annexes II to XI and XIV to XXIV ◄ contain specific methodologies for determining the following variables: activity data (consisting of the two variables fuel/material flow and net calorific value), emission factors, composition data, oxidation and conversion factors and payload. ◄ These different approaches are referred to as tiers. The increasing numbering of tiers from one upwards reflects increasing levels of accuracy, with the highest numbered tier as the preferred tier.

The operator may apply different approved tier levels to the different variables fuel/material flow, net calorific value, emission factors, composition data, oxidation or conversion factors used within a single calculation. The choice of tiers shall be subject to approval by the competent authority (see Section 4.3).

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 — kiln input based' and 'Method B — clinker output based') 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 source streams for all category B or C installations. 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. For installations with emissions of more than 500 kilotonnes of fossil CO_2 annually (i.e. the 'Category C installations'), the Member State shall notify to the Commission pursuant to Article 21 of Directive 2003/87/EC if the application of a combination of highest tier approaches for all major source streams does not take place.

Subject to Section 16 Member States shall ensure that operators apply for all major source streams, as a minimum the tiers as set out in Table 1 below, unless this is technically not feasible.

Both subject to approval by the competent authority, the operator may select as a minimum the Tier 1 level for the variables used to calculate emissions from minor source streams and apply approaches for monitoring and reporting using his own no-tier estimation method for *de minimis* source streams.

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,

▼B

— previously non-existent emission has started,

— the range of fuels or relevant raw materials has substantially changed,

— errors were detected in data resulting from the monitoring methodology,

— the competent authority has requested a change.

For biomass fuel and materials qualifying as pure, no-tier approaches may be applied for installations, or technically identifiable parts thereof, unless the respective value is to be used for the subtraction of biomass derived CO_2 from emissions determined by means of continuous emission measurement. These no-tier approaches include the energy-balance method. Emissions of CO_2 from fossil contaminants to fuels and materials qualifying as pure biomass shall be reported under the biomass source stream and may be estimated using no-tier approaches. Mixed fuels and materials containing biomass shall be characterised applying the provisions of Section 13.4 of this Annex, unless the source stream qualifies as *de minimis*.

▼M4

For commercial standard fuels minimum tier approaches as stated in Table 1 for Annex II on combustion activities can be applied also for other activities.

▼B

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 measurement systems shall follow good professional practice ensuring a conservative estimation of emissions, considering 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.

([1]) Available through: http://eippcb.jrc.es/

▼M4

Table 1

Minimum requirements

('n.a.' means 'not applicable')

Column A for 'category A installations' (means installations with average reported annual emissions over the previous trading period (or a conservative estimate or projection if reported emissions are not available or no longer applicable) equal to or less than 50 kilotonnes of $CO_{2\text{-eq}}$ not including biogenic CO_2 and before subtraction of transferred CO_2),

Column B for 'category B installations' (means installations with average reported annual emissions over the previous trading period (or a conservative estimate or projection if reported emissions are not available or no longer applicable) of greater than 50 kilotonnes and equal to or less than 500 kilotonnes of $CO_{2\text{-eq}}$ not including biogenic CO_2 and before subtraction of transferred CO_2),

and Column C for 'category C installations' (means installations with average reported annual emissions over the previous trading period (or a conservative estimate or projection if reported emissions are not available or no longer applicable) of greater than 500 kilotonnes of $CO_{2\text{-eq}}$ not including biogenic CO_2 and before subtraction of transferred CO_2).

	Activity Data						Emission Factor			Composition Data			Oxidation Factor			Conversion Factor		
	Fuel Flow			Net Calorific Value														
Annex/Activity	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
II: **Combustion**																		
Commercial standard fuels	2	3	4	2a/2b	2a/2b	2a/2b	2a/2b	2a/2b	2a/2b	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.
Other gaseous & liquid fuels	2	3	4	2a/2b	2a/2b	3	2a/2b	2a/2b	3	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.
Solid fuels	1	2	3	2a/2b	3	3	2a/2b	3	3	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.
Mass Balance Approach for Carbon Black Production and Gas Processing Terminals	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1	2	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Flares	1	2	3	n.a.	n.a.	n.a.	1	2a/b	3	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.
Scrubbing Carbonate	1	1	1	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Gypsum	1	1	1	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

▼M4

	Activity Data						Emission Factor			Composition Data			Conversion Factor		
	Material Flow			Net Calorific Value											
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
III: **Refineries**															
Catalytic Cracker Regeneration	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Hydrogen Production	1	2	2	n.a.	n.a.	n.a.	1	2	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IV: **Coke Ovens**															
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
Fuel as process input	1	2	3	2	2	3	2	3	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
V: **Metal Ore Roasting & Sintering**															
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	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.	1	1	1
VI: **Iron & Steel**															
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
Fuel as process input	1	2	3	2	2	3	2	3	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII: **Cement**															
Kiln Input Based	1	2	3	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	1	1	2
Clinker Output	1	1	2	n.a.	n.a.	n.a.	1	2	3	n.a.	n.a.	n.a.	1	1	2
CKD	1	1	2	n.a.	n.a.	n.a.	1	2	2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Non-Carbonate Carbon	1	1	2	n.a.	n.a.	n.a.	1	1	2	n.a.	n.a.	n.a.	1	1	2

▼M4

	Activity Data						Emission Factor			Composition Data			Conversion Factor		
	Material Flow			Net Calorific Value											
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
VIII: **Lime, Dolomite and Magnesite**															
Carbonates	1	2	3	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	1	1	2
Alkali Earth Oxide	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	1	1	2
IX: **Glass, Mineral Wool**															
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.
X: **Ceramic**															
Carbon Inputs	1	1	2	n.a.	n.a.	n.a.	1	2	3	n.a.	n.a.	n.a.	1.	1	2
Alkali Oxide	1	1	2	n.a.	n.a.	n.a.	1	2	3	n.a.	n.a.	n.a.	1	1	2
Scrubbing	1	1	1	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XI: **Pulp & Paper**															
Standard Method	1	1	1	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XIX: **Soda ash and sodium bicarbonate**															
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
XX: **Ammonia**															
Fuel as process input	2	3	4	2a/2b	2a/2b	3	2a/2b	2a/2b	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XXI: **Hydrogen and synthesis gas**															
Fuel as process input	2	3	4	2a/2b	2a/2b	3	2a/2b	2a/2b	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

▼M4

	Activity Data						Emission Factor			Composition Data			Conversion Factor		
	Material Flow			Net Calorific Value											
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
XXII: **Bulk organic chemicals**															
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
XXIII: **Metals production or processing**															
Mass balance	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
Process emissions	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	1	1	2
XXIV: **Aluminium production**															
Mass balance for CO_2 emissions	1	2	3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2	3	3	n.a.	n.a.	n.a.
PFC emissions (slope method)	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
PFC emissions (overvoltage method)	1	1	2	n.a.	n.a.	n.a.	1	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

▼M2

5.3. FALL-BACK APPROACHES FOR STATIONARY INSTALLATIONS

▼B

In cases for which it is technically not feasible or would lead to unreasonable costs to apply at least Tier 1 requirements for all (except the *de minimis*) source streams, the operator shall apply a so-called 'fall-back approach'. This exempts the operator from the application of Section 5.2 of this Annex and permits the design of a fully customized monitoring methodology. The operator shall demonstrate to the satisfaction of the competent authority that by applying this alternative monitoring methodology for the whole installation, the overall uncertainty thresholds given in Table 2 for the annual level of greenhouse gas emissions for the whole installation are met.

The uncertainty analysis shall quantify the uncertainties of all variables and parameters used for the calculation of the annual emission level taking into account the ISO — Guide to the Expression of Uncertainty in Measurement (1995) ([1]) and ISO 5168:2005. The analysis shall be carried out before approval of the monitoring plan by the competent authority on the basis of previous year data and shall be updated on an annual basis. This annual update shall be prepared together with the annual emissions report and be subject to verification.

Respective installations applying the fall-back approach are to be notified by Member States to the Commission pursuant to Article 21 of Directive 2003/87/EC. The operator shall determine and report in the annual emission report, data where available, or best estimates of activity data, net calorific values, emission factors, oxidation factors and other parameters — using laboratory analyses where appropriate. The respective approaches shall be laid down in the monitoring plan and be approved by the competent authority. Table 2 does not apply for installations determining their greenhouse gas emissions using continuous emission monitoring systems applying Annex XII.

Table 2

Fall-back overall uncertainty thresholds

Installation category	Uncertainty threshold to be met for total annual emission value
A	± 7,5 %
B	± 5,0 %
C	± 2,5 %

▼M2

5.4. ACTIVITY DATA OF STATIONARY INSTALLATIONS

▼B

Activity data represents information on material flow, consumption of fuel, input material or production output expressed as energy [TJ] (in exceptional cases also as mass or volume [t or Nm^3], see Section 5.5) in the case of fuels and mass or volume in the case of raw materials or products [t or Nm^3].

([1]) Guide to the Expression of Uncertainty in Measurement, ISO/TAG 4. Published by the International Standardisation Organisation (ISO) in 1993 (corrected and reprinted, 1995) in the name of the BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.

▼B

The determination of activity data by the operator can be based on the invoiced amount of fuel or material determined in compliance with Annex I and the approved tiers of ►M4 Annexes II to XXIV ◄.

Where activity data for the calculation of emissions cannot be determined directly, the activity data shall be determined via an assessment of stock changes:

Material C = Material P + (Material S - Material E) - Material O

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 re-sold)

In cases in which it is technically not feasible or would lead to unreasonably high costs to determine 'Material S' and 'Material E' by direct measurement, the operator may estimate these two quantities based on

— data from previous years and correlation with output for the reporting period,

or

— documented methods and respective data in audited financial statements for the reporting period.

In cases in which a determination of annual activity data for precisely a whole calendar year is technically not feasible or would lead to unreasonable costs, the operator may choose the next appropriate working day to separate a reporting year from the following one. The deviations which could apply to one or several source streams, shall be clearly recorded, form the basis of a value representative for the calendar year and be considered consistently for the subsequent year.

5.5. EMISSION FACTORS

▼M4

Emission factors for CO_2 emissions are based on the carbon content of fuels or input materials and expressed as tCO_2/TJ (combustion emissions), or tCO_2/t or tCO_2/Nm^3 (process emissions). For non-CO_2 greenhouse gases, appropriate emission factors are defined in the relevant activity-specific Annexes to these Guidelines.

▼M2

In order to achieve highest transparency and widest possible consistency with national greenhouse gas inventories, the use of emission factors for a fuel expressed as t CO_2/t rather than t CO_2/TJ for combustion emissions is restricted to cases where unreasonable costs would otherwise be incurred by the operator, and to cases defined in activity-specific Annexes of these guidelines.

▼B

For the conversion of carbon into the respective value for CO_2 the factor ([1]) of 3,664 [tCO_2/t C] shall be used.

Emission factors and provisions for the development of activity-specific emission factors are set out below in Section 11 and 13 of this Annex.

Biomass is considered as CO_2 neutral. An emission factor of 0 [tCO_2/TJ or t or Nm^3] shall be applied to biomass. An exemplary list of different types of materials accepted as biomass is given in Section 12 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 13 of this Annex.

Inherent CO_2 which is transferred into an installation under the EU-ETS as part of a fuel (e.g. blast furnace gas, coke oven gas or natural gas) shall be included in the emission factor for that fuel.

Subject to approval by the competent authority, inherent CO_2 originating from a source stream but subsequently being transferred out of an installation as part of a fuel may be deducted from the emissions of that installation — independently of whether it is supplied to another EU-ETS installation or not. In any case, it shall be reported as a memo item. Installations concerned are to be notified by Member States to the Commission under the obligations of Article 21 of Directive 2003/87/EC.

5.6. OXIDATION AND CONVERSION FACTORS

An oxidation factor for combustion emissions or a conversion factor for process emissions shall be used to reflect the proportion of carbon which is not oxidised or converted in the process. For oxidation factors the requirement to apply the highest tier is waived. If different fuels are used within an installation and activity specific oxidation factors are calculated, subject to approval by the competent authority, the operator may determine one aggregate oxidation factor for the activity and apply it to all fuels, or unless biomass is used, attribute incomplete oxidation to one major fuel stream and use a value of 1 for the others.

▼M3

5.7 TRANSFERRED CO_2

Subject to approval by the competent authority, the operator may subtract from the calculated level of emissions of the installation any CO_2 which is not emitted from the installation, but transferred out of the installation:

([1]) Based on the ratio of atomic masses of carbon (12,011) and oxygen (15,9994).

▼**M4**

— as pure substance, or directly used and bound in products or as feedstock, unless other requirements as set out in Annexes XIX to XXII apply, or

▼**M3**

— to another installation holding a greenhouse gas emissions permit, unless other requirements as set out in Annexes XVII or XVIII apply,

provided the subtraction is mirrored by a respective reduction for the activity and installation, which the respective Member State reports in its national inventory submission to the Secretariat of the United Nations Framework Convention on Climate Change. The respective amounts of CO_2 shall be reported for each installation CO_2 has been transferred to or received from as a memo item in the annual emission report of the transferring as well as the receiving installation.

In the case of transfer to another installation, the receiving installation must add to its calculated level of emissions the received CO_2, unless other requirements as set out in Annexes XVII ►**M4** to XXII ◄ apply.

Respective transferring as well as receiving installations shall be notified by Member States to the Commission pursuant to Article 21 of Directive 2003/87/EC. In case of transfer to an installation falling under that Directive, the transferring installation shall identify the receiving installation in its annual emission report by stating the receiving installation's installation identification code as defined by the Regulation pursuant to Article 19 of that Directive. The receiving installation shall identify the transferring installation through the same approach.

Potential cases of transferred CO_2 out of an installation include, inter alia:

— pure CO_2 used for the carbonation of beverages,

— pure CO_2 used as dry ice for cooling purposes,

— pure CO_2 used as fire extinguishing agent, refrigerant or as laboratory gas,

— pure CO_2 used for grains disinfestations,

— pure CO_2 used as solvent in the food or chemical industry,

— CO_2 used and bound in products or feedstocks in the chemical, pulp industry (e.g. for urea or precipitated carbonates),

— carbonates bound in spray-dried absorption product (SDAP) from semi-dry scrubbing of flue gases,

— CO_2 transferred to capture installations,

— CO_2 from capture installations transferred to transport networks,

— CO_2 from transport networks transferred to storage sites.

▼M3

Unless other requirements in the activity specific Annexes apply, the mass of annually transferred CO_2 or carbonate shall be determined with a maximum uncertainty of less than 1,5 % either directly by using volume or mass flow meters, weighing or indirectly from the mass of the respective product (e.g. carbonates or urea) where relevant and if appropriate.

In case the amounts of transferred CO_2 are measured both at the transferring and at the receiving installation, the amounts of respectively transferred and received CO_2 shall be identical. If the deviation between measured values is in a range, which can be explained by the uncertainty of the measurement systems, the arithmetic average of both measured values shall be used in both the transferring and receiving installations' emission reports. The emission report shall include a statement that this value has been aligned with the value of the respectively transferring or receiving installation. The measured value shall be included as memo item.

In case the deviation between the measured values cannot be explained by the uncertainty range of the measurement systems, the operators of the installations involved shall align the measured values by applying conservative adjustments (i.e. avoiding under-estimation of emissions). This alignment shall be verified by the verifiers of the transferring and receiving installations, and be subject to approval by the competent authority.

In instances, in which part of the transferred CO_2 was generated from biomass, or whenever an installation is only partially covered by Directive 2003/87/EC, the operator shall subtract only the respective fraction of mass of transferred CO_2 which originates from fossil fuels and materials in activities covered by the Directive. Respective attribution methods shall be conservative and are subject to approval by the competent authority.

In case a measurement approach is applied at the transferring installation, the total amount of transferred/received CO_2 resulting from biomass use shall be reported as a memo-item by both the transferring and receiving installation. The receiving installation shall not be required to conduct its own measurements for this purpose, but report the amount of biomass CO_2 as obtained by the transferring installation.

▼M2

6. MEASUREMENT BASED METHODOLOGIES FOR STATIONARY INSTALLATIONS

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6.1. GENERAL

▼M1

As set out in Section 4.2, greenhouse gas emissions may be determined by a measurement-based methodology using continuous emission measurement systems (CEMS) from all or selected emission sources 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. Specific approaches for measurement-based methodologies are laid down in Annexes XII and XIII. Installations applying CEMS as part of their monitoring system are to be notified by Member States to the Commission pursuant to Article 21 of Directive 2003/87/EC.

▼B

The procedures applied for the measurement of concentrations, as well as for mass or volume flows shall, where available, be according to a standardised method that limits sampling and measurement bias and has a known measurement uncertainty. CEN standards (i.e. those issued by the European Committee for Standardisation) shall be used, if available. If CEN standards are not available, suitable ISO standards (i.e. those issued by the International Standardisation Organisation) or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with suitable draft standards or industry best practice guidelines.

Relevant ISO standards include, *inter alia*:

— ISO 12039:2001 Stationary source emissions — Determination of carbon monoxide, carbon dioxide and oxygen — Performance characteristics and calibration of an automated measuring method,

— ISO 10396:2006 Stationary source emission — Sampling for the automated determination of gas concentrations,

— ISO 14164:1999 Stationary source emissions. Determination of the volume flow rate of gas streams in ducts — automated method.

The biomass fraction of measured CO_2 emissions shall be subtracted based on the calculation approach and shall be reported as a memo item (see Section 14 of this Annex).

6.2. TIERS FOR MEASUREMENT-BASED METHODOLOGIES

▼M1

The highest tier levels pursuant to Annexes XII and XIII shall be used by the operator of an installation for each emission source which is listed in the greenhouse gas emissions permit and for which relevant greenhouse gas emissions are determined by applying CEMS.

▼B

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 the relevant emission source. Therefore, the selected tier shall reflect for each emission source the highest level of accuracy that is technically feasible and does not lead to unreasonably high costs. The choice of tiers shall be subject to approval by the competent authority (see Section 4.3).

▼M1

For the reporting periods 2008–12 as a minimum Tier 2 in Annex XII for CO_2 emissions and the minimum tiers set out in Annex XIII for N_2O emissions shall be applied unless technically not feasible.

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6.3. FURTHER PROCEDURES AND REQUIREMENTS

▼M1

(a) ***Sampling rates***

Hourly averages (a valid hour of data) shall be computed for all elements of the emission determination (as applicable) — as laid out in Annexes XII and XIII — by using all data points available for that specific hour. In case of equipment being out of control or out of operation for part of the hour, the hourly average shall be calculated pro rata to the remaining data points for that specific hour. In case a valid hour of data cannot be computed for an element of emission determination, as less than 50 % of the maximum number of hourly data points are available, the hour is lost. For each instance where a valid hour of data cannot be computed, values for substitution according to the provisions of this Section shall be calculated.

▼B

(b) ***Missing data***

Where a valid hour of data cannot be provided for one or more elements of emission calculation due to the equipment being out of control (e.g. in case of calibration or interference errors) or out of operation, the operator shall determine values for substitution for each missing hour of data as shown below.

(i) **Concentrations**

In case a valid hour of data cannot be provided for a parameter directly measured as concentration (e.g. GHGs, O_2), a substitution value C^*_{subst} for that hour shall be calculated as follows:

$$C^*_{subst} = \overline{C} + \sigma_{C\_}$$

With:

$\overline{C}$ the arithmetic mean of the concentration of the specific parameter,

σ_{C} the best estimate of the standard deviation of the concentration of the specific parameter.

Arithmetic mean and standard deviation are to be calculated at the end of the reporting period from the whole set of emission data measured during the reporting period. If such a period is not applicable due to essential technical changes at the installation, a representative timeframe, if possible with a duration of one year, shall be agreed with the competent authority.

The calculation of arithmetic mean and standard deviation shall be presented to the verifier;

(ii) **Other parameters**

In case a valid hour of data cannot be provided for the parameters not directly measured as concentrations, substitute values of these parameters shall be obtained through a mass balance model or the energy balance approach of process. The remaining measured elements of emission calculation shall be used to validate the results.

The mass or energy balance model and underlying assumptions shall be clearly documented and presented to the verifier together with the calculated results.

(c) ***Corroborating calculation of emissions***

▼M1

Parallel to emission determination by a measurement-based methodology in accordance with Annexes XII and XIII, annual emissions of each considered GHG shall be determined by calculation based on one of the following options:

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(a) calculation of emissions as laid down in the respective Annexes for the respective activities. For the calculation of emissions, lower tiers (i.e. Tier 1 as a minimum) can generally be applied or;

(b) calculation of emissions as laid down in the 2006 IPCC Guidelines, e.g. Tier 1 methods may be used.

▼B

Deviations between the results from the measurement and the calculation approach can occur. The operator shall explore the correlation between results from the measurement and the calculation approach, taking into account that a generic deviation resulting from the two different approaches might exist. Taking this correlation into account, the operator shall use the results of the calculation approach to cross-check results from the measurement approach.

The operator shall determine and report in the annual emission report, relevant data where available or best estimates of activity data, net calorific values, emission factors, oxidation factors and other parameters used for the determination of emissions according to ►M3 Annexes II to XI and XVI ►M4 to XXIV ◄ ◄ — using laboratory analyses where appropriate. Respective approaches as well as the chosen method for the corroborating calculation shall be laid down in the monitoring plan and be approved by the competent authority.

▼M1

Where comparison with results of the calculation approach clearly indicates that results of the measurement approach are not valid, the operator shall use substitution values as described under this Section (excluding for monitoring in accordance with Annex XIII).

▼B

7. **UNCERTAINTY ASSESSMENT**

7.1. CALCULATION

This Section is subject to Section 16 of this Annex. The operator shall have an understanding of main sources of uncertainty when calculating emissions.

▼M2

Under the calculation based methodology following the provisions of section 5.2, the competent authority will have approved the combination of tiers for each source stream in an installation plus approved all other details of the monitoring methodology for that installation as contained within the installation's permit or, for aviation activities, the aircraft operator's monitoring plan. 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 or, for aviation activities, the content of the approved monitoring plan. Stating the combination of tiers in the emissions report shall constitute reporting uncertainty for the purposes of Directive 2003/87/EC. Hence there is no further requirement to report on uncertainty if the calculation based methodology is applied.

▼B

The uncertainty determined for the measurement system within the tier system shall comprise the specified uncertainty of the applied measurement instruments, uncertainty associated with the calibration and any additional uncertainty connected to how the measurement instruments are used in practice. The stated threshold values within the tier system refer to the uncertainty associated to the value for one reporting period.

As regards commercially traded fuels or materials, competent authorities may permit the determination of the annual fuel/material flow by the operator based solely on the invoiced amount of fuel or material without further individual proof of associated uncertainties, provided that national legislation or the demonstrated application of relevant national or international standards ensures that respective uncertainty requirements for activity data are met for commercial transactions.

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►M2 In all other cases, the operator shall provide written proof of the uncertainty level associated with the determination of activity data for each source stream in order to demonstrate compliance with the uncertainty thresholds defined in ►M3 Annexes II to XI and XIV to ►M4 XXIV ◄ ◄ of these Guidelines. ◄ The operator shall base the calculation on the specifications as provided by the supplier of the measurement instruments. If the specifications are not available, the operator shall provide for an uncertainty assessment of the measurement instrument. In both cases, he shall take into account necessary corrections of these specifications from effects resulting from the actual use conditions like ageing, conditions of the physical environment, calibration and maintenance. These corrections may involve conservative expert judgement.

If measurement systems are applied, the operator shall take into account the cumulative effect of all components of the measurement system on the uncertainty of the annual activity data using the error propagation law ([1]) which yields two convenient rules for combining uncorrelated uncertainties under addition and multiplication or respective conservative approximations if interdependent uncertainties occur:

(a) ***for uncertainty of a sum (e.g. of individual contributions to an annual value):***

for uncorrelated uncertainties:

$$U_{total} = \frac{\sqrt{(U_1 \cdot x_1)^2 + (U_2 \cdot x_2)^2 + ... + (U_n \cdot x_n)^2}}{|x_1 + x_2 + ... + x_n|}$$

for interdependent uncertainties:

$$U_{total} = \frac{(U_1 \cdot x_1) + (U_2 \cdot x_2) + ... + (U_n \cdot x_n)}{|x_1 + x_2 + ... + x_n|}$$

Where:

U_{total} is the uncertainty of the sum, expressed as a percentage;

x_i and U_i are the uncertain quantities and the percentage uncertainties associated with them, respectively;

(b) ***for uncertainty of a product (e.g. of different parameters used to convert a meter reading into mass flow data):***

for uncorrelated uncertainties:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + ... + U_n^2}$$

([1]) Annex 1 of the 2000 Good Practice Guidance and in Annex I of the Revised 1996 *IPCC Guidelines* (Reporting instructions): http://www.ipcc-nggip.iges.or.jp/public/public.htm.

▼B

for interdependent uncertainties:

$$U_{total} = U_1 + U_2 + ... + U_n$$

Where:

U_{total} is the uncertainty of the product, expressed as a percentage;

U_i are the percentage uncertainties associated with each of the quantities.

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.

7.2. MEASUREMENT

▼M1

As set out in Section 4.2, an operator can justify the use of measurement-based methodology if it reliably results in a lower uncertainty than the relevant calculation-based methodology (compare Section 4.2) or he is required to use a measurement based method in accordance with Annex XIII. 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 taking into account EN 14181:

▼B

— the specified uncertainty of continuous measurement equipment,

— uncertainties associated to the calibration,

— additional uncertainty connected to how the monitoring equipment 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 selected or all emission sources in an installation plus approve all other details of the monitoring methodology for those emission 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 emission sources and source streams, until such point that the competent authority reviews the choice of measurement over calculation and requests that the uncertainty figure be re-calculated. Stating this uncertainty figure in the emissions report shall constitute reporting uncertainty for the purposes of Directive 2003/87/EC.

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.

▼B

8. **REPORTING**

▼M2

Annex IV to Directive 2003/87/EC sets out the reporting requirements for installations and aircraft operators. The reporting format set out in Section 14 of this Annex and the information required therein shall be used as a basis for reporting of the quantitative data unless an equivalent electronic standard protocol for annual reporting has been published by the EU Commission. Where a reporting format is specified in an activity-specific Annex, this reporting format and the information required therein shall be used for reporting.

▼B

The emission report covers annual emissions of a calendar year in a reporting period.

The report shall be verified in accordance with the detailed requirements established by the Member State pursuant to Annex V to Directive 2003/87/EC. 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 ([1]). 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 Directive 2003/87/EC, and its unique permit number;

(2) for all emissions sources and/or source streams the emission totals, chosen approach (measurement or calculation), chosen tiers and method (if applicable), activity data ([2]), emission factors ([3]), and oxidation/conversion factors ([4]). 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 Nm^3]; CO_2 emissions [tCO_2] from biomass where measurement is used to determine emissions; CO_2 transferred from an installation [tCO_2]; inherent CO_2 leaving the installation as part of a fuel;

([1]) OJ L 41, 14.2.2003, p. 26.

([2]) 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.

([3]) Emission factors for combustion activities shall be reported as CO_2 emission per energy content.

([4]) Conversion and oxidation factors shall be reported as dimensionless fractions.

▼B

(3) if emission factors and activity data for fuels are related to mass instead of energy, the operator shall report supplementary proxy data for the annual average net calorific value and emission factor for each fuel 'proxy data' means annual values — substantiated empirically or by accepted sources — used to substitute data for variables (i.e. fuel/material flow, net calorific value or emission, oxidation or conversion factors) required in the default calculation approaches according to Annexes I-XI in order to ensure complete reporting when the monitoring methodology does not generate all required variables;

(4) if a mass-balance approach 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;

(5) if continuous emissions monitoring (Annex XII) is applied, the operator shall report the annual fossil CO_2 emissions as well the CO_2 emissions from biomass use. In addition, the operator shall report supplementary proxy data for the annual average net calorific value and emission factor for each fuel or respective other relevant parameters for materials and products as derived by means of the corroborating calculation;

(6) if a fall-back approach according to Section 5.3 is applied, the operator shall report supplementary proxy data for every parameter for which the approach does not produce the required data according to ►**M3** Annexes I to XI and XVI ►**M4** to XXIV ◄ ◄;

(7) where fuel use occurs, but emissions are calculated as process emissions, the operator shall report supplementary proxy data for the respective variables of the default emission calculation for combustion emissions for these fuels;

(8) temporal or permanent changes of tiers, reasons for these changes, starting date for changes, and starting and ending dates of temporal changes;

(9) any other changes in the installation during the reporting period that may be relevant for the emissions report;

▼M3

(10) where applicable, amounts of CO_2 transferred to or received from other installations, stating the installation's identification code as defined by the Regulation pursuant to Article 19 of Directive 2003/87/EC;

▼M4

(11) where applicable, the production level of primary aluminium, the frequency and average duration of anode effects during the reporting period, or the anode effect overvoltage data during the reporting period, as well as the results of the most recent determination of the installation specific emission factors for CF_4 and C_2F_6 as outlined in Annex XXIV, and of the most recent determination of the collection efficiency of the ducts.

▼M3

The competent authority may allow operators of CO_2 storage sites after closure to hand in simplified emission reports containing at least the elements listed under subparagraphs (1) and (9), if the greenhouse gas emissions permit contains no emission sources.

▼B

Information to be provided under (8) and (9) and supplementary information to be provided ►M4 under (2) and (11) ◄ 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.

Fuels and resulting emissions shall be reported using the IPCC fuel categories (see Section 11 of this Annex) which are based on the definitions of the International Energy Agency. 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 Community list of wastes specified in 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 ([1]). The respective six-digit codes shall be added to the names of the relevant waste types used in the installation.

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

▼M1

Emissions shall be reported as rounded tonnes of CO_2 or $CO_{2(e)}$ (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.

▼M2

In order to achieve consistency between data reported under Directive 2003/87/EC and data reported by Member States under the UN Framework Convention on Climate Change and other emission data reported for the European Pollutant Release and Transfer Register (EPRTR), each activity carried out by an installation or aircraft operator shall be labelled applying the codes, if applicable, from the following two reporting schemes:

▼B

(a) 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 15.1 of this Annex);

([1]) 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).

▼B

(b) the IPPC code of Annex I of Regulation 166/2006 on the European Pollutant Release and Transfer Register (EPRTR) (see Section 15.2 below).

9. **RETENTION OF INFORMATION**

▼M2

An operator shall document and archive monitoring data for the installation's or aircraft operator's emissions from all emission sources and/or source streams belonging to activities listed in Annex I to Directive 2003/87/EC 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 or aircraft operator's emissions submitted by the operator pursuant to Article 14(3) of Directive 2003/87/EC, in accordance with the criteria set out in Annex V to that Directive.

▼B

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, ►M2 an operator ◄ shall retain the following information for at least ten years after the submission of the report pursuant to Article 14(3) of Directive 2003/87/EC for each reporting year:

For calculation-based methodologies:

— the list of all source streams monitored,

— the activity data used for any calculation of the emissions for each source stream, categorised by process and fuel, or material 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,

▼M2

— documentation of the process of collection of activity data for the installation or aircraft operator and its source streams,

▼B

— 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

▼B

— any other information that is identified as required for the verification of the annual emissions report.

The following additional information shall be retained for measurement-based methodologies:

— the list of all emission sources monitored,

— documentation justifying the selection of a measurement-based methodology,

— the data used for the uncertainty analysis of emissions from each emission source, categorised by process,

— the data used for the corroborating calculations,

— 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 log-book on tests, down-times, calibrations, servicing and maintenance,

— documentation of any changes of the continuous measurement system.

▼M2

The following additional information shall be retained for aviation activities:

— the list of aircraft owned and leased-in, and necessary evidence for the completeness of that list,

— the list of flights covered in each reporting period, and necessary evidence for the completeness of that list,

— data used for determination of payload and distance relevant for the years for which tonne-kilometre data is reported,

— documentation on the approach for data gaps if applicable, and the data used for closing the data gaps where they have occurred.

▼M3

The following additional information shall be retained for CO_2 capture, transport and geological storage activities:

— where applicable, documentation of the amount of CO_2 injected into the storage complex by installations carrying out geological storage of CO_2,

— where applicable, representatively aggregated pressure and temperature data from a transport network,

— where applicable, a copy of the storage permit, including the approved monitoring plan, pursuant to Article 9 of Directive 2009/31/EC,

— where applicable, the reports submitted pursuant to Article 14 of Directive 2009/31/EC,

▼M3

— where applicable, reports on the results of the inspections carried out pursuant to Article 15 of Directive 2009/31/EC,

— where applicable, documentation on corrective measures taken pursuant to Article 16 of Directive 2009/31/EC.

▼M4

The following additional information shall be retained for primary aluminium production:

— documentation of results from measurement campaigns for the determination of the installation specific emission factors for CF_4 and C_2F_6,

— documentation of results of the determination of the collection efficiency for fugitive emissions,

— all relevant data on primary aluminium production, anode effect frequency and duration or overvoltage data.

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10. **CONTROL AND VERIFICATION**

The control and verification of emissions is subject to Section 16 of this Annex.

10.1. DATA ACQUISITION AND HANDLING

The operator shall establish, document, implement and maintain effective data acquisition and handling activities (hereinafter referred to as data flow activities) for the monitoring and reporting of greenhouse gas emissions in accordance with the approved monitoring plan, the permit and these guidelines. These data flow activities include measuring, monitoring, analyzing, recording, processing and calculating parameters in order to be able to report on the greenhouse gas emissions.

10.2. CONTROL SYSTEM

The operator shall establish, document, implement and maintain an effective control system to ensure that the annual emissions report, resulting from the data flow activities does not contain misstatements and is in conformance with the approved monitoring plan, the permit and these guidelines.

The operator's control system is made up of the processes aimed at effective monitoring and reporting as designed and implemented by those in charge of annual emissions reporting. The control system consists of the following components:

(a) the operator's own assessment process of inherent and control risks to errors, misrepresentations or omissions (misstatements) in the annual emissions report, and non-conformities against the approved monitoring plan, the permit and these guidelines;

▼B

(b) control activities that help to mitigate the identified risks.

The operator shall evaluate and improve his control system to ensure that the annual emissions report is not materially misstated or contains a material non-conformity. The evaluations shall include internal audits of the control system and the data reported. The control system may make reference to other procedures and documents, including those in management systems EU Eco-Management and Audit Scheme (EMAS), ISO 14001:2004 (Environmental management systems — Specification with guidance for use), ISO 9001:2000 and financial control systems. When such a reference has been made, the operator shall ensure that the requirements in the approved monitoring plan, the permit and these guidelines are arranged for in the respective applicable system.

10.3. CONTROL ACTIVITIES

For the purposes of controlling and mitigating the inherent and control risks pursuant to Chapter 10.2 the operator shall identify and implement control activities in accordance with the following Sections 10.3.1 to 10.3.6.

10.3.1. *PROCEDURES AND RESPONSIBILITIES*

The operator shall assign responsibilities to all data flow activities and to all control activities. Conflicting duties shall be segregated, including handling and control activities, where possible and otherwise alternative controls shall be put in place.

The operator shall document the data flow activities pursuant to Section 10.1 and the control activities pursuant to Sections 10.3.2 to 10.3.6 in written procedures, including:

— the sequence and interaction of data acquisition and handling activities according to 10.1, including the methods of calculations or measurement which are used,

— risk assessment of the definition and evaluations of the control system according to 10.2,

— management of the necessary competences for the responsibilities assigned according to 10.3.1,

— quality assurance of the measuring equipment and information technology used (if applicable) according to 10.3.2,

— internal reviews of reported data according to 10.3.3,

— outsourced processes according to 10.3.4,

— corrections and corrective action according to 10.3.5,

— records and documentation according to 10.3.6.

Each of these procedures shall address (where appropriate) the following elements:

— responsibilities,

— records (electronic and physical, whatever is applicable and suitable),

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— information systems used (if applicable),

— input and output, and clear linkage with previous and next activity,

— frequency (if applicable).

The procedures shall be suitable to mitigate the identified risks.

10.3.2. *QUALITY ASSURANCE*

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 where available, in accordance with the risks identified according to 10.2. The operator shall identify in the monitoring plan if components of the measurement instrument cannot be calibrated, and propose alternative control activities, which need approval of the competent authority. 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 for the period of 10 years.

If the operator uses information technology, including process-control computer technology, it shall be designed, documented, tested, implemented, controlled and maintained as a way to ensure reliable, accurate and timely processing of data in accordance with the risks identified according to 10.2. This includes the proper use of calculation formulae contained in the monitoring plan. The control of information technology shall include access control, back up, recovery, continuity planning and security.

10.3.3. *REVIEWS AND VALIDATION OF DATA*

For managing the data flow, the operator shall design and implement reviews and validation of data in accordance with the risks identified according to 10.2. These validations may be conducted either manually or electronically. They shall be designed in such a way that boundaries for rejecting the data are clear upfront, where possible.

Simple and effective data reviews may 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 ►**M2** installation or aircraft operator ◄ in different years. A monitoring error is likely 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).

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

— comparison of fuel or material purchasing data with data on stock changes (based on information on end stock and begin stock) and data on consumption for the applicable source streams,

— comparison of emission factors that have been analysed, 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.

10.3.4. *OUTSOURCED PROCESSES*

Where an operator chooses to outsource any process in the data flow, the operator shall control the quality of these processes in accordance with the risks identified according to 10.2. The operator shall define appropriate requirements for outputs and methods, and review the quality delivered.

10.3.5. *CORRECTIONS AND CORRECTIVE ACTION*

When any part of the data flow activities or control activities (device, equipment, staff member, supplier, procedure or other) is found not to function effectively or to function outside set boundaries, the operator shall promptly take appropriate corrections and the rejected data shall be corrected. The operator shall assess the validity of the outputs of the applicable steps, determine the root cause of the malfunctioning or error, and take appropriate corrective action.

The activities in this Section shall be performed in accordance with the risk-based approach according to 10.2.

10.3.6. *RECORDS AND DOCUMENTATION*

To be able to show and ensure compliance, and to be able to reconstruct emissions data reported, the operator shall keep records of all control activities (including quality assurance/quality control of equipment and information technology, review and validation of data and corrections) and all information listed under Section 9 of this Annex for at least 10 years.

The operator shall ensure that relevant documents are available when and where they are needed to perform the data flow activities as well as the control activities. The operator shall have a procedure to identify, produce, distribute and control the version of these documents.

The activities in this Section shall be performed in accordance with the risk-based approach according to 10.2.

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10.4. VERIFICATION

10.4.1. *GENERAL PRINCIPLES*

The objective of the verification is to ensure that emissions have been monitored in accordance with the guidelines and that reliable and correct emissions data will be reported pursuant to Article 14(3) of Directive 2003/87/EC. Member States shall consider respective guidance issued by the European Cooperation for Accreditation (EA).

Subject to Chapter 10.4.2(e), a verification shall come to a verification opinion that states with reasonable assurance whether the data in the emissions report is free from material misstatements and whether there are no material non-conformities.

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The operator shall submit the emissions report, a copy of its approved monitoring plan or plans, and any other relevant information to the verifier.

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The scope of the verification is defined by the tasks the verifier needs to perform to achieve the above objective. As a minimum the verifier shall perform the activities in accordance with the subsequent Section 10.4.2.

10.4.2. *VERIFICATION METHODOLOGY*

The verifier shall plan and perform verification with an attitude of professional scepticism recognizing that circumstances may exist that cause the information contained in the Annual Emissions Report to be materially misstated.

As part of the verification process, the verifier shall carry out the following steps:

(a) ***strategic analysis***

The verifier shall:

— verify whether the monitoring plan has been approved by the competent authority and whether it is the right version. If this is not the case, the verifier should not continue the verification except for elements that are obviously not affected by the non-approval,

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— understand each activity undertaken by the installation or aircraft operator, the emission sources, source streams within the installation or the aircraft operator's relevant aviation activities, the metering equipment used to monitor or measure activity data, the origin and application of emission factors and oxidation/conversion factors, any other data used to calculate or measure the emissions, and the environment in which the installation or the aircraft operator operates,

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— understand the operator's monitoring plan, data flow, as well as its control system, including the overall organisation with respect to monitoring and reporting,

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— apply the materiality level defined in Table 3 below.

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Table 3

	Materiality Level
Category A and B Installations, or aircraft operators with annual emissions of equal to or less than 500 kilotonnes CO_2	5 %
Category C Installations, or aircraft operators with annual emissions of more than 500 kilotonnes CO_2	2 %

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The verifier shall perform the strategic analysis in such a way that the verifier is able to conduct the risk analysis as set out below. When necessary this shall include a site visit.

(b) ***risk analysis***

The verifier shall:

— analyse the inherent risks and control risks related to the scope and complexity of the operator's activities and emission sources and source streams, and which could lead to a material misstatements and non-conformities,

— draw up a verification plan which is commensurate with this risk analysis. The verification plan describes the way in which the verification activities are to be carried out. It contains a verification programme and a data sampling plan. The verification programme describes the nature of the activities, at what times they must be carried out and their scope in order for the verification plan to be completed. The data sampling plan sets out what data is to be tested in order to reach a verification opinion.

(c) ***verification***

In carrying out the verification, the verifier shall conduct a site visit, when appropriate, to inspect the operation of meters and monitoring systems, conduct interviews, and collect sufficient information and evidence.

Moreover, the verifier shall:

— carry out the verification plan by gathering data in accordance with the defined sampling methods, walkthrough tests, document reviews, analytical procedures and data review procedures, including any relevant additional evidence, upon which the verifier's verification opinion will be based,

— confirm the validity of the information used to calculate the uncertainty level as set in the approved monitoring plan,

— verify that the approved monitoring plan is implemented and seek understanding whether the monitoring plan is up to date,

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— request the operator to provide any missing data or complete missing sections of audit trails, explain variations in the emissions data, or revise calculations, or adjust reported data, before reaching a final verification opinion. The verifier should, in any form, report all non-conformities and misstatements identified to the operator.

The operator shall correct any reported misstatements. The entire population from which a sample was taken shall be corrected.

Throughout the verification process, the verifier shall determine misstatements and non-conformities by assessing whether:

— the monitoring plan has been implemented to support the determination of non-conformities,

— there is clear and objective evidence obtained through the gathering of data to support the determination of misstatements.

(d) ***internal verification report***

At the end of the verification process, the verifier shall prepare an internal verification report. The verification report shall record evidence showing that the strategic analysis, the risk analysis and the verification plan has been performed in full, and provide sufficient information to support verification opinions. The internal verification report should as well facilitate a potential evaluation of the audit by the competent authority and accreditation body.

Based on the findings contained in the internal verification report, the verifier shall make a judgment with respect to whether the annual emissions report contains any material misstatement as compared to the materiality threshold, and whether there are material non-conformities or other issues relevant for the verification opinion.

(e) ***verification report***

The verifier shall present the verification methodology, his findings and verification opinion in a verification report, addressed to the operator, to be submitted by the operator with the annual emission report to the competent authority. An annual emissions report is verified as satisfactory if the total emissions are not materially misstated, and if, in the opinion of the verifier, there are no material non-conformities. In the case of non-material non-conformities or non-material misstatements, the verifier may include these in the verification report (verified as satisfactory with non-material non-conformities or non-material misstatements). The verifier may also report these in a separate management letter.

The verifier may conclude an annual emissions report is not verified as satisfactory, if the verifier finds material non-conformities or material misstatements (with or without material non-conformities). The verifier may conclude an annual emissions report is not verified when there was a limitation of scope (when circumstances prevent, or a restriction was imposed that prevents, the verifier from obtaining evidence required to reduce the verification risk to the reasonable level) and/or material uncertainties.

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Member States shall ensure that the operator addresses non-conformities and misstatements after consultation of the competent authority in a timeframe set by the competent authority. In addition, all divergences of opinion between operators, verifiers and competent authorities shall not affect proper reporting and shall be settled in accordance with Directive 2003/87/EC, these guidelines, and the requirements established by the Member States pursuant to Annex V to that Directive, and relevant national procedures.

11. **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

Fuel emission factors related to net calorific value (NCV) and net calorific values per mass of fuel

Fuel type description	Emission factor (tCO_2/TJ)	Net calorific value (TJ/Gg)
	2006 IPCC guidelines (except biomass)	2006 IPCC guidelines
Crude oil	73,3	42,3
Orimulsion	76,9	27,5
Natural gas liquids	64,1	44,2
Motor gasoline	69,2	44,3
Kerosene	71,8	43,8
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Aviation gasoline (AvGas)	70,0	44,3
Jet gasoline (Jet B)	70,0	44,3
Jet kerosene (jet A1 or jet A)	71,5	44,1
▼B		
Shale oil	73,3	38,1
Gas/diesel oil	74,0	43,0
Residual fuel oil	77,3	40,4
Liquefied petroleum gases	63,0	47,3
Ethane	61,6	46,4

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Fuel type description	Emission factor (tCO_2/TJ)	Net calorific value (TJ/Gg)
	2006 IPCC guidelines (except biomass)	2006 IPCC guidelines
Naphtha	73,3	44,5
Bitumen	80,6	40,2
Lubricants	73,3	40,2
Petroleum coke	97,5	32,5
Refinery feedstocks	73,3	43,0
Refinery gas	51,3	49,5
Paraffin waxes	73,3	40,2
White spirit and SBP	73,3	40,2
Other petroleum products	73,3	40,2
Anthracite	98,2	26,7
Coking coal	94,5	28,2
Other bituminous coal	94,5	25,8
Sub-bituminous coal	96,0	18,9
Lignite	101,1	11,9
Oil shale and tar sands	106,6	8,9
Patent fuel	97,5	20,7
Coke oven coke and lignite coke	107,0	28,2
Gas coke	107,0	28,2
Coal tar	80,6	28,0
Gas works gas	44,7	38,7
Coke oven gas	44,7	38,7
Blast furnace gas	259,4	2,5

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Fuel type description	Emission factor (tCO_2/TJ)	Net calorific value (TJ/Gg)
	2006 IPCC guidelines (except biomass)	2006 IPCC guidelines
Oxygen steel furnace gas	171,8	7,1
Natural gas	56,1	48,0
Industrial wastes	142,9	n.a.
Waste oils	73,3	40,2
Peat	105,9	9,8
Wood/wood waste	0	15,6
Other primary solid biomass	0	11,6
Charcoal	0	29,5
Biogasoline	0	27,0
Biodiesels	0	27,0
Other liquid biofuels	0	27,4
Landfill gas	0	50,4
Sludge gas	0	50,4
Other biogas	0	50,4
	Other sources	Other sources
Waste tyres	85,0	n.a.
Carbon monoxide	155,2	10,1
Methane	54,9	50,0

12. **LIST OF CO_2-NEUTRAL BIOMASS**

This list contains materials, which are considered biomass for the application of these guidelines and shall be weighted with an emission factor of 0 [tCO_2/TJ or t or Nm^3]. Peat and fossil fractions of the materials listed below shall not be considered biomass. Unless a contamination with other materials or fuels is apparent based on visual or olfactory evidence, no analytical procedures need to be applied to demonstrate the purity of members of Group 1 and 2 below:

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Group 1 — Plants and parts of plants:

— straw,

— hay and grass,

— leaves, wood, roots, stumps, bark,

— crops, e.g. maize and triticale.

Group 2 — Biomass wastes, products and by-products:

— 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 (with only biomass carbon),

— crude tall oil, tall oil and pitch oil from the production of pulp,

— forestry residues,

— lignin from the processing of plants containing ligno-celluose,

— animal, fish and food meal, fat, oil and tallow,

— primary residues from the food and beverage production,

— plant oils and fats,

— 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,

— charcoal.

Group 3 — Biomass fractions of mixed materials:

— 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 black liquor containing fossil carbon,

— the biomass fraction of processed municipal and industrial wastes,

— the biomass fraction of ethyl-tertiary-butyl-ether (ETBE),

— the biomass fraction of butanol.

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Group 4 — Fuels whose components and intermediate products have all been produced from biomass:

— bioethanol,

— biodiesel,

— etherised bioethanol,

— biomethanol,

— biodimethylether,

— bio-oil (a pyrolysis oil fuel) and bio-gas.

13. **DETERMINATION OF ACTIVITY-SPECIFIC DATA AND FACTORS**

This Section is mandatory only for those parts of these guidelines with explicit reference to Section 13 of Annex I. The provisions in this Section are subject to those set out in Section 16 of this Annex.

13.1. 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 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, where available, be according to a standardised method that limits sampling and measurement bias and has a known measurement uncertainty. CEN standards shall be used if available. If CEN standards are not available, suitable ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with suitable draft standards or industry best practice guidelines.

Relevant CEN standards are the following:

— EN ISO 6976:2005 Natural gas — Calculation of calorific values, density, relative density, and Wobbe index from composition,

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

Relevant ISO standards are the following:

— 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,

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— ISO 9951:1993/94 Measurement of gas flow in closed conduits — Turbine meters.

Supplemental national standards for the characterization 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 comply with requirements laid down in Section 13.5 of this Annex. 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 sampling procedure and frequency of analyses for the determination of the carbon content, net calorific values and emission factors shall comply with the requirements of Section 13.6.

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.

13.2. 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 respective reporting period in which it will be applied.

The procedures applied to determine a representative activity-specific oxidation factors (e.g. via the carbon content of soot, ashes, effluents and other wastes or by-products) for a specific activity shall, where available, be according to a standardised method that limits sampling and measurement bias and has a known measurement uncertainty. CEN standards shall be used if available. If CEN standards are not available, suitable ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with suitable draft standards or industry best practice guidelines.

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The laboratory used to determine the oxidation factor or the underlying data shall comply with requirements set out in Section 13.5 of this Annex. The sampling procedure and frequency of analyses for the determination of relevant variables (e.g. the carbon content of ash) used for the calculation of oxidation factors shall comply with the requirements of Section 13.6.

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

13.3. DETERMINATION OF PROCESS EMISSION FACTORS, CONVERSION FACTORS AND COMPOSITION DATA

The specific procedure to determine the activity-specific emission factor, conversion factor or composition data including the sampling procedure for a specific material shall be agreed with the competent authority before the start of 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, where available, be according to a standardised method that limits sampling and measurement bias and has a known measurement uncertainty. CEN standards shall be used if available. If CEN standards are not available suitable ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with suitable draft standards or industry best practice guidelines.

The laboratory used shall comply with requirements laid down in Section 13.5 of this Annex. The sampling procedure and frequency of analyses shall comply with the requirements of Section 13.6.

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

13.4. DETERMINATION OF A BIOMASS FRACTION

The term ‘biomass fraction’ for the purpose of these guidelines refers to the mass percentage of biomass carbon according to the biomass definition (see Sections 2 and 12 of this Annex) out of the total mass of carbon in a sample.

Fuel or material shall qualify as pure biomass with simplified provisions for the monitoring and reporting as set out in Section 5.2, if the non-biomass content accounts to no more than 3 % of the total quantity of the fuel or material concerned.

The specific procedure to determine the biomass fraction of a specific fuel or material 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 or material and to determine the biomass fraction shall, where available, be according to a standardised method that limits sampling and measurement bias and has a known measurement uncertainty. CEN standards shall be used if available. If CEN standards are not available suitable ISO standards or national standards shall apply. Where no applicable standards exist, procedures can be carried out where possible in accordance with suitable draft standards or industry best practice guidelines.

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Methods applicable to determine the biomass fraction in a fuel or material 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. For fuels or materials originating from a production process with defined and traceable input streams, the operator may alternatively base the determination of the biomass fraction on a mass-balance of fossil and biomass carbon entering and leaving the process. The respective methods are to be approved by the competent authority.

The laboratory used to determine the biomass fraction shall comply with requirements laid down in Section 13.5 of this Annex.

The sampling procedure and frequency of analyses for the determination of the biomass fraction of fuels and materials shall comply with the requirements of Section 13.6.

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.

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13.5. REQUIREMENTS FOR DETERMINATION OF FUEL AND MATERIAL PROPERTIES, AND CONTINUOUS EMISSIONS MEASUREMENT

13.5.1. *USE OF ACCREDITED LABORATORIES*

The laboratory (including other service providers) used to determine the emission factor, net calorific value, oxidation factor, carbon content, the biomass fraction, composition data or to carry out calibrations and relevant equipment assessments for CEMS should be accredited according to EN ISO 17025:2005 (General requirements for the competence of testing and calibration laboratories).

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13.5.2. *USE OF NON-ACCREDITED LABORATORIES*

Preference is for use of laboratories accredited according to EN ISO 17025:2005. The use of non-accredited laboratories shall be limited to situations in which the operator can demonstrate to the competent authority that the laboratory meets equivalent requirements to those laid out in EN ISO 17025:2005. ►M2 The respective laboratories and relevant analytical procedures shall be listed in the monitoring plan. ◄ Equivalence in respect to quality management could be demonstrated by an accredited certification of the laboratory against EN ISO 9001:2000. Additional evidence shall be provided that the laboratory is technically competent and able to generate technically valid results using the relevant analytical procedures.

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Under the responsibility of the operator, each non-accredited laboratory used by the operator to determine results used for the calculation of emissions shall take the following measures:

(a) ***validation***

A validation of each relevant analytical method to be carried out by the non-accredited laboratory against the reference method shall be carried out by a laboratory accredited according to EN ISO 17025:2005. The validation procedure is carried out before or at the beginning of the contract relationship between operator and laboratory. It includes a sufficient number of repetitions of the analysis of a set of at least five samples representative for the expected value range including a blank sample for each relevant parameter and fuel or material in order to characterise the repeatability of the method and to derive the calibration curve of the instrument;

(b) ***inter-comparison***

An inter-comparison of the results of analytical methods shall be executed once a year by a laboratory accredited according to EN ISO 17025:2005 involving at least a fivefold repetition of the analysis of a representative sample using the reference method for each relevant parameter and fuel or material;

The operator shall apply conservative adjustments (i.e. avoiding under-estimation of emissions) to all relevant data of the respective year in cases in which a difference is observed between the results derived by the non-accredited and the accredited laboratory which might lead to an under-estimation of emissions. Any statistically significant (2σ) differences between the end results (e.g. the composition data) derived by the non-accredited and the accredited laboratory shall be notified to the competent authority and be immediately resolved under supervision of a laboratory accredited according to EN ISO 17025:2005.

13.5.3. *ONLINE GAS ANALYSERS AND GAS CHROMATOGRAPHS*

The use of online gas chromatographs and extractive or non-extractive gas analysers for emission determination under these guidelines is subject to approval by the competent authority. The use of these systems is limited to the determination of composition data of gaseous fuels and materials. The operator operating the systems shall meet the requirements of EN ISO 9001:2000. Evidence that the system is meeting those requirements can be demonstrated by an accredited certification of the system. Calibration services and the suppliers of calibration gases shall be accredited against EN ISO 17025:2005.

Where applicable an initial and annually repeated validation of the instrument shall be carried out by a laboratory accredited against EN ISO 17025:2005 using EN ISO 10723:1995 Natural gas — Performance evaluation for online analytical systems. In all other cases, the operator shall commission an initial validation and annual inter-comparison:

(a) ***initial validation***

The validation shall be carried out before 31 January 2008 or as part of the commissioning of a new system. It includes an appropriate number of repetitions of the analysis of a set of at least five samples representative for the expected value range including a blank sample for each relevant parameter and fuel or material in order to characterise the repeatability of the method and to derive the calibration curve of the instrument;

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(b) ***annual inter-comparison***

The inter comparison of the results of analytical methods shall be executed once a year by a laboratory accredited according to EN ISO 17025:2005 involving an appropriate number of repetitions of the analysis of a representative sample using the reference method for each relevant parameter and fuel or material;

The operator shall apply conservative adjustments (i.e. avoiding under-estimation of emissions) to all relevant data of the respective year in cases in which a difference is observed between the results derived by the results of the gas analyser or gas chromatograph and the accredited laboratory which might lead to an under-estimation of emissions. Any statistically significant (2σ) differences between the end results (e.g. the composition data) of the gas analyser or gas chromatograph, and the accredited laboratory shall be notified to the competent authority and be immediately resolved under supervision of a laboratory accredited according to EN ISO 17025:2005.

13.6. SAMPLING METHODS AND FREQUENCY OF ANALYSES

The determination of the relevant emission factor, net calorific value, oxidation factor, conversion factor, carbon content, biomass fraction or composition data shall follow generally accepted practice for representative sampling. The operator shall provide evidence that the derived samples are representative and free of bias. The respective value shall be used only for the delivery period or batch of fuel or material for which it was intended to be representative.

Generally, the analysis will be carried out on a sample which is the mixture of a larger number (e.g. 10-100) of samples collected over a period of time (e.g. from a day to several months) provided that the sampled fuel or material can be stored without changes of its composition.

The sampling procedure and frequency of analyses shall be designed to ensure that the annual average of the relevant parameter is determined with a maximum uncertainty of less than 1/3 of the maximum uncertainty which is required by the approved tier level for the activity data for the same source stream.

If the operator is not able to meet the allowed maximum uncertainty for the annual value or unable to demonstrate compliance with the thresholds, he shall apply the frequency of analyses as laid down in Table 5 as a minimum, if applicable. In all other cases the competent authority shall define the frequency of analyses.

Table 5

Indicative minimum frequency of analyses

Fuel/material	Frequency of analyses
Natural gas	At least weekly
Process gas (refinery mixed gas, coke oven gas, blast-furnace gas and convertor gas)	At least daily — using appropriate procedures at different parts of the day
Fuel oil	Every 20 000 tonnes and at least six times a year

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Fuel/material	Frequency of analyses
Coal, coking coal, petroleum coke	Every 20 000 tonnes and at least six times a year
Solid waste (pure fossil or mixed biomass fossil)	Every 5 000 tonnes and at least four times a year
Liquid waste	Every 10 000 tonnes and at least four times a year
Carbonate minerals (e.g. limestone and dolomite)	Every 50 000 tonnes and at least four times a year
Clays and shales	Amounts of material corresponding to 50 000 tonnes of CO_2 and at least four times a year
Other input and output streams in the mass balance (not applicable for fuels or reducing agents)	Every 20 000 tonne and at least once every month
Other materials	Depending on the type of material and the variation, amounts of material corresponding to 50 000 tonnes of CO_2 and at least four times a year

14. **REPORTING FORMAT**

►**M2** Unless otherwise provided by an activity-specific Annex, 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. ◄ The grey-shaded cells mark fields into which information is to be filled in.

14.1. IDENTIFICATION OF INSTALLATION

Identification of installation	Response
1. Name of company	
2. Operator of installation	
3. Installation	
3.1. Name	
3.2. Permit number ([1])	
3.3. Reporting under EPRTR required?	Yes/No
3.4. EPRTR identification number ([2])	
3.5. Address/city of the installation	
3.6. Postcode/country	
3.7. Coordinates of the location	
4. Contact Person	
4.1. Name	
4.2. Address/city/postcode/country	

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Identification of installation	Response
4.3. Telephone	
4.4. Fax	
4.5. email	
5. Reporting year	
6. Type of Annex I activities carried out ([3])	
Activity 1	
Activity 2	
Activity N	

([1]) The identification number will be provided by the competent authority in the permitting process.
([2]) ►M4 Only to be filled in if installation is required to report under EPRTR. ◄
([3]) E.g. 'Mineral oil refineries'

14.2. OVERVIEW OF ACTIVITIES

Emissions of Annex I activities

Categories	IPCC CRF category ([1]) — Combustion emissions	IPCC CRF category ([2]) – Process emissions	IPPC code of EPRTR category	Tiers changed? Yes/No	Emissions tCO_2
Activities					
Activity 1					
Activity 2					
Activity N					
Total					

([1]) E.g. '1A2f Fuel Combustion in other industries'
([2]) E.g. '2A2 Industrial Processes — Lime Production'

Memo items

	Transferred or inherent CO_2			Biomass emissions ([1])
	Amount transferred or inherent	Transferred material or fuel	Type of transfer (inherent into/out of installation, transfer into/out of installation)	
Unit	$[tCO_2]$			$[tCO_2]$
Activity 1				
Activity 2				
Activity N				

([1]) Only to be filled in if emissions have been determined by measurement.

▼B

14.3. COMBUSTION EMISSIONS (CALCULATION)

Activity				
Type of fuel:				
IEA category				
Waste catalogue number (where applicable):				
Parameter	Units allowed	Unit used	Value	Tier applied
Amount of fuel consumed	t or Nm^3			
Net calorific value of fuel	TJ/t or TJ/Nm^3			
Emission factor	tCO_2/TJ or tCO_2/t or tCO_2/Nm^3			
Oxidation factor				
CO_2 fossil	tCO_2	tCO_2		
Biomass used	TJ or t or Nm^3			

14.4. PROCESS EMISSIONS (CALCULATION)

Activity				
Type of material:				
Waste catalogue number (where applicable):				
Parameter	Units allowed	Unit used	Value	Tier applied
Activity data	t or Nm^3			
Emission factor	tCO_2/t or tCO_2/Nm^3			
Conversion factor				
CO_2 fossil	tCO_2	tCO_2		
Biomass used	t or Nm^3			

14.5. MASS-BALANCE APPROACH

Parameter	
Name of fuel or material	
IEA category (where applicable)	

▼B

Waste catalogue number (where applicable)				
	Units allowed	Unit used	Value	Tier applied
Activity data (mass or volume): for output streams use negative values	t or Nm^3			
NCV (where applicable)	TJ/t or TJ/Nm^3			
Activity data (heat input) = mass or volume * NCV (where applicable)	TJ			
Carbon content	tC/t or t C/Nm^3			
CO_2 fossil	tCO_2	tCO_2		

14.6. MEASUREMENT APPROACH

Activity				
Type of emission source				
Parameter	Units allowed	Value	Tier applied	Uncertainty
CO_2 fossil	tCO_2			
CO_2 from biomass	tCO_2			

▼M1

14.7. N_2O EMISSIONS REPORTING FOR NITRIC ACID, ADIPIC ACID, CAPROLACTAM, GLYOXAL AND GLYOXYLIC ACID PLANTS

Emissions of Annex I activities — nitric acid, adipic acid etc.													
Categories	IPCC CRF-Category — Process emissions	IPPC code of EPRTR Category	Monitoring method and tier applied	Tiers changed? Yes/No	Production rate t/year and t/hour	Flue gas flow uncer-tainty (annual average hourly or total annual) %	N_2O concen-tration uncertainty (annual average hourly or total annual) %	Overall annual emissions uncertainty (if required) %	Annual average hourly emission uncertainty %	Emission t/yr	Annual average hourly emission (kg/hr)	GWP applied	Emissions $tCO_{2(e)}$ and CO_2/yr
Activities													
Activity 1													
Activity 2													
Activity N													
Total emissions in $tCO_{2(e)}$ and tCO_2 per year													

▼M4

14.8. PFC EMISSIONS REPORTING FOR PRODUCTION OF PRIMARY ALUMINIUM

	Activity			
	Cell type			
	Slope method (A) or overvoltage method (B)?			
	Parameter	Unit	Value	Tier applied
	Primary aluminium production	t		
Method A	Number of anode effects			
Method A	Average duration of anode effects	min		
Method A	Anode effect minutes/cell-day	min/cell-day		
Method A	SEF_{CF_4} … Slope emission factor	(kg CF_4/t Al)/(min/cell-day)		
Method B	AEO … Anode effect overvoltage per cell	mV		
Method B	CE … average current efficiency	%		
Method B	AEO/CE	mV		
Method B	OVC … Overvoltage coefficient	kg CF_4/ (t Al mV)		
	$F_{C_2F_6}$ … Weight fraction of C_2F_6	t C_2F_6/t CF_4		
	CF_4 emissions	t		
	C_2F_6 emissions	t		
	GWP_{CF_4} applied	t $CO_{2(e)}$/t		
	$GWP_{C_2F_6}$ applied	t $CO_{2(e)}$/t		
	Total emissions	**t $CO_{2(e)}$**		

▼B

15. **REPORTING CATEGORIES**

Emissions shall be reported according to the following categories of the Reporting Format and the IPPC code of Annex I of the EPRTR Regulation EC 166/2006 (see Section 15.2 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.

▼B

15.1. IPCC REPORTING FORMAT

The table below is an excerpt of the Common Reporting Format (CRF) part of the UNFCCC reporting guidelines on annual inventories ([1]). In the CRF emissions are attributed to seven major categories:

(1) energy;

(2) industrial processes;

(3) solvent and other products use;

(4) agriculture;

(5) land-use change and forestry;

(6) waste;

(7) other.

Categories 1 and 2 and 6 of the following table of the CRF, which are the categories relevant for Directive 2003/87/EC, are reproduced below together with their relevant subcategories.

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**
(a) iron and steel
(b) non-ferrous metals
(c) chemicals
(d) pulp, paper and print
(e) food processing, beverages and tobacco
(f) other

▼M2

3. **Transport**
(a) Civil Aviation

▼B

4. **Other sectors**
(a) commercial/institutional
(b) residential
(c) agriculture/forestry/fisheries
5. **Other** ([1])
(a) stationary
(b) mobile
B. **Fugitive emissions from fuels**
1. **Solid fuels**
(a) coal mining
(b) solid fuel transformation
(c) other

([1]) UNFCCC (1999): FCCC/CP/1999/7.

▼B

2. **Oil and natural gas**
(a) oil
(b) natural gas
(c) venting and flaring
venting
flaring
(d) other
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
B. **Chemical industry**
1. Ammonia production
2. Nitric acid production
3. Adipic acid production
4. Carbide production
5. Other
C. **Metal production**
1. Iron and steel production
2. Ferroalloys production
3. Aluminium production
4. SF_6 Used in aluminium and magnesium foundries
5. Other
6. SECTORAL REPORT FOR WASTE
C. **Waste incineration** ([1])
MEMO ITEMS
CO_2 emissions from biomass

▼M2

International Bunkers, Aviation

▼B

([1]) Not including waste-to-energy facilities. Emissions from waste burnt for energy are reported under the Energy Module, 1A. See Intergovernmental Panel on Climate Change; Greenhouse Gas Inventory Reporting Instructions. Revised 1996 IPCC Guidelines for national greenhouse gas inventories; 1997.

▼B

15.2. SOURCE CATEGORY CODE

The following source category codes should be used for the purpose of reporting data:

No	Activity
1.	**Energy sector**
(a)	Mineral oil and gas refineries
(b)	Installations for gasification and liquefaction
(c)	Thermal power stations and other combustion installations
(d)	Coke ovens
(e)	Coal rolling mills
(f)	Installations for the manufacture of coal products and solid smokeless fuel
2.	**Production and processing of metals**
(a)	Metal ore (including sulphide ore) roasting or sintering installations
(b)	Installations for the production of pig iron or steel (primary or secondary melting) including continuous casting
(c)	Installations for the processing of ferrous metals: (i) hot-rolling mills; (ii) smitheries with hammers; (iii) application of protective fused metal coats.
(d)	Ferrous metal foundries
(e)	Installations: (i) for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes; (ii) for the smelting, including the alloying, of non-ferrous metals, including recovered products (refining, foundry casting, etc.).
(f)	Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process
3.	**Mineral industry**
(a)	Underground mining and related operations
(b)	Opencast mining
(c)	Installations for the production of: — cement clinker in rotary kilns; — lime in rotary kilns; — cement clinker or lime in other furnaces.

▼B

No	Activity
(d)	Installations for the production of asbestos and the manufacture of asbestos-based products
(e)	Installations for the manufacture of glass, including glass fibre
(f)	Installations for melting mineral substances, including the production of mineral fibres
(g)	Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain
4.	**Chemical industry**
(a)	Chemical installations for the production on an industrial scale of basic organic chemicals, such as: (i) simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic); (ii) oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resins; (iii) sulphurous hydrocarbons; (iv) nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitrile s, cyanates, isocyanates; (v) phosphorus-containing hydrocarbons; (vi) halogenic hydrocarbons; (vii) organometallic compounds; (viii) basic plastic materials (polymers, synthetic fibres and cellulose-based fibres); (ix) synthetic rubbers; (x) dyes and pigments; (xi) surface-active agents and surfactants.
(b)	Chemical installations for the production on an industrial scale of basic inorganic chemicals, such as: (i) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride; (ii) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids; (iii) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide; (iv) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate; (v) non-metals, metal oxides or other inorganic compounds such as calc ium carbide, silicon, silicon carbide.

▼B

No	Activity
(c)	Chemical installations for the production on an industrial scale of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers)
(d)	Chemical installations for the production on an industrial scale of basic plant health products and of biocides
(e)	Installations using a chemical or biological process for the production on an industrial scale of basic pharmaceutical products
(f)	Installations for the production on an industrial scale of explosives and pyrotechnic products
5.	**Waste and waste-water management**
(a)	Installations for the incineration, pyrolysis, recovery, chemical treatment or landfilling of hazardous waste
(b)	Installations for the incineration of municipal waste
(c)	Installations for the disposal of non-hazardous waste
(d)	Landfills (excluding landfills of inert waste)
(e)	Installations for the disposal or recycling of animal carcasses and animal waste
(f)	Municipal waste-water treatment plants
(g)	Independently operated industrial waste-water treatment plants which serve one or more activities of this Annex
6.	**Paper and wood production and processing**
(a)	Industrial plants for the production of pulp from timber or similar fibrous materials
(b)	Industrial plants for the production of paper and board and other primary wood products (such as chipboard, fibreboard and plywood)
(c)	Industrial plants for the preservation of wood and wood products with chemicals
7.	**Intensive livestock production and aquaculture**
(a)	Installations for the intensive rearing of poultry or pigs
(b)	Intensive aquaculture
8.	**Animal and vegetable products from the food and beverage sector**
(a)	Slaughterhouses
(b)	Treatment and processing intended for the production of food and beverage products from: — Animal raw materials (other than milk) — Vegetable raw materials
(c)	Treatment and processing of milk

▼B

No	Activity
9.	**Other activities**
(a)	Plants for the pretreatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles
(b)	Plants for the tanning of hides and skins
(c)	Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating
(d)	Installations for the production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitization
(e)	Installations for the building of, and painting or removal of paint from ships

16. **REQUIREMENTS FOR INSTALLATIONS WITH LOW EMISSIONS**

To Sections 4.3, 5.2, 7.1, 10 and 13 the following exemptions from the requirements of this Annex shall apply for installations with average verified reported emissions of less than 25 000 tonnes of CO_2 per year during the previous trading period. If the reported emission data are no longer applicable because of changes to the operating conditions or the installation itself or if a history of verified emissions is missing, the exemptions apply if the competent authority has approved a conservative projection of emissions for the next five years with less than 25 000 tonnes of fossil CO_2 for each year. Member States may waive the mandatory need for annual site visits by the verifier in the verification process and let the verifier take the decision based on the results of his risk analysis:

— where necessary, the operator may use information as specified by the supplier of relevant measurement instruments irrespective of specific use conditions to estimate the uncertainty of activity data,

— Member States may waive the need of proof of compliance with the requirements regarding calibration in Section 10.3.2 of this Annex,

— Member States may permit the use of lower tier approaches (with Tier 1 as minimum level) for all source streams and relevant variables,

— Member States may permit the use of simplified monitoring plans which contain at least the elements listed under items (a), (b), (c), (e), (f), (k) and (l) as listed in Section 4.3 of this Annex,

— Member States may waive requirements regarding the accreditation against EN ISO 17025:2005 if the laboratory in question:

  — provides conclusive evidence that it is technically competent and is able to generate technically valid results using the relevant analytical procedures, and

▼B

— participates annually in inter-laboratory comparisons and subsequently undertakes corrective measures if necessary,

— the uses of fuels or materials can be determined based on purchasing records and estimated stock changes without further consideration of uncertainties.

▼B

ANNEX II

▼M4

Guidelines for combustion emissions from activities as listed in Annex I to Directive 2003/87/EC carried out in installations

▼B

1. **BOUNDARIES AND COMPLETENESS**

▼M4

The activity-specific guidelines contained in this Annex shall be used to monitor emissions from combustion activities as listed in Annex I to Directive 2003/87/EC carried out in installations and defined pursuant to Article 3(t) and to monitor combustion emissions from other activities as listed in that Annex I to Directive 2003/87/EC where referred to in Annexes III to XI and XVI to XXIV to these Guidelines. Furthermore this Annex shall be used to monitor emissions from combustion processes being part of any activity listed in Annex I to Directive 2003/87/EC for which no other activity-specific Annex to these Guidelines applies.

▼B

The monitoring of 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 SO_2 from flue gas. Emissions from internal combustion engines for transportation purposes shall not be monitored and reported. All 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.

Emissions of a combustion installation adjacent and drawing its main fuel from an integrated steel plant but operated under a separate greenhouse gas emission permit may be calculated as part of the mass balance consideration of this steel plant if the operator can prove to the competent authority that such an approach will reduce overall uncertainty of the emission determination.

2. **DETERMINATION OF CO_2 EMISSIONS**

Emission sources of CO_2 emissions from combustion ►M4 activities ◄ 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.

▼B

2.1. CALCULATION OF CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

2.1.1.1. GENERAL COMBUSTION ACTIVITIES

CO_2 emissions from combustion ►M4 activities ◄ 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:

CO_2 emissions = Activity data * Emission factor * Oxidation factor

With:

(a) ***activity data***

Activity data are generally expressed as the net energy content of the fuel consumed [TJ] during the reporting period. The energy content of the fuel consumption shall be calculated by means of the following formula:

Energy content of fuel consumption [TJ] = fuel consumed [t or Nm^3] * net calorific value of fuel [TJ/t or TJ/Nm^3] ([1])

In case a mass or volume related emission factor [tCO_2/t or tCO_2//Nm^3] is used, activity data is expressed as the amount of fuel consumed [t or Nm^3].

With:

(a1) **fuel consumed:**

Tier 1

The fuel consumption over the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ± 7,5 % taking into account the effect of stock changes where applicable.

Tier 2

The fuel consumption over the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ± 5 % taking into account the effect of stock changes where applicable.

Tier 3

The fuel consumption over the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ± 2,5 % taking into account the effect of stock changes where applicable.

Tier 4

The fuel consumption over the reporting period shall be determined by the operator or fuel supplier within a maximum uncertainty of less than ± 1,5 % taking into account the effect of stock changes where applicable.

(a2) **net calorific value**

Tier 1

Reference values for each fuel are used as specified in Section 11 of Annex I.

([1]) 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.

▼B

Tier 2a

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 2b

For commercially traded fuels the net calorific value as derived from the purchasing records for the respective fuel provided by the fuel supplier is used, provided it has been derived based on accepted national or international standards.

Tier 3

The net calorific value representative for the fuel in an installation is measured by the operator, a contracted laboratory or the fuel supplier in accordance with the provisions of Section 13 of Annex I.

(b) ***emission factor***

Tier 1

Reference factors for each fuel are used as specified in Section 11 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 the fuel based on one of the following established proxies:

— density measurement of specific oils or gases common, e.g. to the refinery or steel industry, and

— net calorific value for specific coals types.

In combination with an empirical correlation as determined at least once per year according to the provisions of Section 13 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 for the fuel are determined by the operator, an external laboratory or the fuel supplier according to the provisions of Section 13 of Annex I.

(c) ***oxidation factor***

The operator may choose the appropriate tier for his monitoring methodology.

▼B

Tier 1

An oxidation factor of 1,0 ([1]) is used.

Tier 2

The operator applies oxidation 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 3

For fuels activity-specific factors are derived by the operator based on relevant carbon contents of ashes, effluents and other wastes and by-products and other relevant non-fully oxidised gaseous forms of carbon emitted. Composition data shall be determined according to the provisions specified in Section 13 of Annex I.

2.1.1.2. MASS-BALANCE APPROACH — CARBON BLACK PRODUCTION AND GAS PROCESSING TERMINALS

The mass-balance approach may be applied for carbon black production and for gas processing terminals. It shall consider all carbon in inputs, stocks, products and other exports from the installation to account for the emissions of greenhouse gases, using the following equation:

$$CO_2 \text{ emissions } [tCO_2] = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

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 installation,

— *export [tC]*: carbon exported from the boundaries of the installation, 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:

$$CO_2 \text{ emissions } [tCO_2] = (\Sigma(\text{activity data}_{input} * \text{carbon content}_{input}) - \Sigma(\text{activity data}_{products} * \text{carbon content}_{products}) - \Sigma(\text{activity data}_{export} * \text{carbon content}_{export}) - \Sigma(\text{activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [tC/TJ] of the respective mass flow for the calculation of the mass balance.

([1]) See IPCC 2006 Guidelines for National Greenhouse Gas Inventories.

▼B

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

The carbon content of input or output streams shall be derived from standard emission factors for fuels or materials listed in Section 11 of Annex I or the ►**M4** other activity-specific Annexes ◄. The carbon content is derived as follows:

$$\text{C} - \text{Cont [t / t or TJ]} = \frac{\text{Emission factor [t CO}_2\text{ / t or TJ]}}{3,664\ \text{[t CO}_2\text{ / t C]}}$$

Tier 2

The carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

2.1.1.3. FLARES

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

CO_2 emissions shall be calculated from the amount of gas flared [Nm^3] and the carbon content of the flared gas [tCO_2/Nm^3] (including inherent CO_2).

CO_2 emissions = activity data * emission factor * oxidation factor

With:

(a) ***activity data***

Tier 1

Amount of flare gas used over the reporting period is derived with a maximum uncertainty of ± 17,5 %.

Tier 2

Amount of flare gas used over the reporting period is derived with a maximum uncertainty of ± 12,5 %.

Tier 3

Amount of flare gas used during reporting period is derived with a maximum uncertainty of ± 7,5 %.

▼B

(b) ***emission factor***

Tier 1

Using a reference emission factor of 0,00393 tCO_2/m^3 (at standard conditions) derived from the combustion of pure ethane used as a conservative proxy for flare gases.

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

Installation-specific emission factors are derived from an estimate of the molecular weight of the flare stream, using process modelling based on industry-standard models. By considering the relative proportions and the molecular weights of each of the contributing streams, a weighted annual average figure is derived for the molecular weight of the flare gas.

Tier 3

Emission factor [$tCO_2/Nm^3_{flare\ gas}$] calculated from the carbon content of the flared gas applying the provisions of Section 13 of Annex I.

(c) ***oxidation factor***

Lower tiers can be applied.

Tier 1

A value of 1,0 shall be used.

Tier 2

The operator applies an oxidation factor 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.

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:

$$CO_2 \text{ emissions [t]} = \text{activity data} * \text{emission factor}$$

With:

Calculation method A — carbonate based

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

(a) ***activity data***

Tier 1

Tons of dry carbonate as process input consumed over the reporting period determined by the operator or supplier with a maximum uncertainty of less than ± 7,5 %.

▼B

(b) ***emission factor***

Tier 1

The emission factors shall be calculated and reported in units of mass of CO_2 released per tonne of carbonate. Stoichiometric ratios as shown in Table 1 below shall be used to convert composition data into emission factors.

The determination of the amount of $CaCO_3$ and $MgCO_3$ in each relevant kiln input material is carried out using industry best practice guidelines.

Table 1

Stoichiometric ratios

Carbonate	Ratio[tCO_2/t Ca-, Mg- or other carbonate]	Remarks
$CaCO_3$	0,440	
$MgCO_3$	0,522	
General: $X_Y (CO_3)_Z$	Emission factor = $[M_{CO_2}]/\{Y * [M_x] + Z * [M_{CO_3}^{2-}]\}$	X = alkali earth or alkali metal M_x = molecular weight of X in [g/mol] M_{CO_2} = molecular weight of CO_2 = 44 [g/mol] $M_{CO_{3-}}$ = 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

Calculation method B — gypsum based

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

(a) ***activity data***

Tier 1

Tons of dry gypsum ($CaSO_4 \cdot 2H_2O$) as process output per year determined by the operator or processor of gypsum with a maximum uncertainty of less than ± 7,5 %.

(b) ***emission factor***

Tier 1

Stoichiometric ratio of dry gypsum ($CaSO_4 \cdot 2H_2O$) and CO_2 in the process: 0,2558 tCO_2/t gypsum.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex XII shall be applied.

▼B

ANNEX III

Activity-specific guidelines for mineral oil refineries as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES**

The monitoring of 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 Directive 2003/87/EC which are not part of the refining production chain shall not be accounted for.

2. **DETERMINATION OF CO_2 EMISSIONS**

Potential emission sources for CO_2 include:

(a) Energy related combustion:

— boilers,

— process heaters/treaters,

— internal combustion engines/turbines,

— catalytic and thermal oxidizers,

— 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 CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

Combustion emissions shall be monitored in accordance with Annex II.

2.1.2. *PROCESS EMISSIONS*

Specific processes leading to CO_2 emissions include:

1. ***Catalytic cracker regeneration, other catalyst regeneration and flexi-cokers***

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 emissions shall be calculated by a material balance, taking into account the state of the input air and the flue gas. All CO in the flue gas shall be accounted for as CO_2 ([1]).

([1]) Applying the mass relation: $tCO_2 = tCO * 1{,}571$.

▼B

The analysis of input air and flue gases and the choice of tiers shall be according to the provisions of Section 13 of Annex I. The specific calculation approach shall be approved by the competent authority as part of evaluation of the monitoring plan and the monitoring methodology therein.

Tier 1

For each emission source a total uncertainty of the overall emissions over the reporting period of less than ± 10 % shall be achieved.

Tier 2

For each emission source a total uncertainty of the overall emissions over the reporting period of less than ± 7,5 % shall be achieved.

Tier 3

For each emission source a total uncertainty of the overall emissions over the reporting period of less than ± 5 % shall be achieved.

Tier 4

For each emission source a total uncertainty of the overall emissions over the reporting period of less than ± 2,5 % shall be achieved.

2. ***Refinery hydrogen production***

The CO_2 emitted stems from the carbon content of the feed gas. An input-based calculation of CO_2 emissions shall be carried out.

$$CO_2 \text{ emissions} = \text{activity data}_{input} * \text{emission factor}$$

With:

(a) ***activity data***

Tier 1

Amount of hydrocarbon feed [t feed] processed during the reporting period, derived with a maximum uncertainty of ± 7,5 %.

Tier 2

Amount of hydrocarbon feed [t feed] processed during the reporting period, derived with a maximum uncertainty of ± 2,5 %.

(b) ***emission factor***

Tier 1

Use a reference value of 2,9 tCO_2 per t feed processed conservatively based on ethane.

Tier 2

Use of an activity-specific emission factor [CO_2/t feed] calculated from the carbon content of the feed gas, determined according to Section 13 of Annex I.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I and Annex XII shall be applied.

▼B

ANNEX IV

▼M4

Activity-specific guidelines for the production of coke as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

▼M4

Coke ovens can be part of steel works with a direct technical connection to sintering activities and activities 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 or coke) to take place in regular operation. If an installation's permit according to Articles 4, 5 and 6 of Directive 2003/87/EC encompasses the entire steel works and not solely the coke oven, the CO_2-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.

▼B

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 CO_2 EMISSIONS**

In coke ovens, CO_2 emissions result from the following emission sources and source streams:

— 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 CO_2 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 consider all carbon in inputs, stocks, products and other exports from the installation to determine the level of emissions of greenhouse gases over the reporting period, using the following equation:

$$CO_2 \text{ emissions } [tCO_2] = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

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 installation,

▼B

— *export [tC]:* carbon exported from the boundaries of the installation, 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:

$$CO_2 \text{ emissions } [tCO_2] = (\Sigma(\text{activity data}_{input} * \text{carbon content}_{input}) - \Sigma(\text{activity data}_{products} * \text{carbon content}_{products}) - \Sigma(\text{activity data}_{export} * \text{carbon content}_{export}) - \Sigma(\text{activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes}) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [tC/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

▼M4

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or the Annexes IV-X. The carbon content is derived as follows:

▼B

$$C - Cont\ [t\ /\ t\ or\ TJ] = \frac{\text{Emission factor } [t\ CO_2\ /\ t\ or\ TJ]}{3,664\ [t\ CO_2\ /\ t\ C]}$$

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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.

▼B

Tier 3

The carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

2.1.2. *COMBUSTION EMISSIONS*

Combustion processes taking place at coke ovens where fuels (e.g. coke, coal, and natural gas) are not included in the mass-balance approach 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 other carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), hydrocarbons (C_xH_y).

Total CO_2 emission from coke ovens shall be calculated as follows:

$$CO_2 \text{ emission } [tCO_2] = \sum (\text{activity data}_{INPUT} * \text{emission factor}_{INPUT}) - \sum (\text{activity data}_{OUTPUT} * \text{emission factor}_{OUTPUT})$$

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 over a reporting period is determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

The mass flow of fuels into and from the installation over a reporting period is determined with a maximum uncertainty of less than ± 5,0 %.

Tier 3

The mass flow of the fuel into and from the installation over a reporting period is determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

The mass flow of the fuel into and from the installation over a reporting period is determined with a maximum uncertainty of less than ± 1,5 %.

▼B

(a2) **net calorific value**

Tier 1

Reference values for each fuel are used as specified in Section 11 of Annex I.

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 13 of Annex I.

(b) ***emission factor***

Tier 1

Use of reference factors from Section 11 of Annex I.

Tier 2

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 3

Specific emission factors are determined in accordance with the provisions of Section 13 of Annex I.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I and Annex XII shall be applied.

▼B

ANNEX V

▼M4

Activity-Specific Guidelines for metal ore roasting and sintering as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

▼M4

Metal ore roasting, sintering or pelletisation activities can form an integral part of steel works with a direct technical connection to coke ovens and activities 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 or limestone) takes place in regular operation. If an installation's permit according to Articles 4, 5 and 6 of Directive 2003/87/EC encompasses the entire steel works and not solely the roasting or sintering activity, the CO_2-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.

▼B

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 CO_2 EMISSIONS**

In metal ore roasting, sintering or pelletisation installations, CO_2 emissions result from the following emission sources and source streams:

— raw materials (calcination of limestone, dolomite and carbonatic iron ores, e.g. $FeCO_3$),

— 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 CO_2 EMISSIONS

In case an ore roasting, sintering or pelletisation installation 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 ore roasting, sintering or pelletisation installation as individual activity of the integrated steelworks.

2.1.1. *MASS-BALANCE APPROACH*

The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the installation to determine the level of emissions of greenhouse gases over the reporting period, using the following equation:

$$CO_2 \text{ emissions } [tCO_2] = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

▼B

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 installation,

— *export [tC]*: carbon exported from the boundaries of the installation, 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:

$$CO_2 \text{ emissions } [tCO_2] = (\Sigma(\text{activity data}_{input} * \text{carbon content}_{input}) - \Sigma(\text{activity data}_{products} * \text{carbon content}_{products}) - \Sigma(\text{activity data}_{export} * \text{carbon content}_{export}) - \Sigma(\text{activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [tC/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

▼M4

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or the Annexes IV-X. The carbon content is derived as follows:

▼B

$$C - Cont\ [t / t \text{ or } TJ] = \frac{\text{Emission factor}[t\ CO_2 / t \text{ or } TJ]}{3{,}664\ [t\ CO_2 / t\ C]}$$

▼B

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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 carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

2.1.2. *COMBUSTION EMISSIONS*

Combustion processes that take place at metal ore roasting, sintering or pelletization installations where fuels 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 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:

$$CO_2 \text{ emissions} = \sum\{\text{activity data}_{\text{process input}} * \text{emission factor} * \text{conversion factor}\}$$

(a) ***activity data***

Tier 1

Amounts [t] of carbonate input material [t_{CaCO3}, t_{MgCO3} or $t_{CaCO3\text{-}MgCO3}$] and process residues used as input material in the process over a reporting period by the operator or his suppliers with a maximum uncertainty of less than ± 5,0 %.

Tier 2

Amounts [t] of carbonate input material [t_{CaCO3}, t_{MgCO3} or $t_{CaCO3\text{-}MgCO3}$] and process residues used as input material employed in the process over a reporting period by the operator or his suppliers with a maximum uncertainty of less than ± 2,5 %.

(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 $tCO_2/t\ CaCO_3$
$MgCO_3$	0,522 $tCO_2/t\ MgCO_3$

▼B

Emission factor	
$FeCO_3$	0,380 $tCO_2/t\ FeCO_3$

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 13 of Annex I.

(c) ***conversion factor***

Tier 1

Conversion factor: 1,0.

Tier 2

Activity-specific factors determined according to the provisions of Section 13 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 CO_2 EMISSIONS

The measurement guidelines contained in Annex I and Annex XII shall be applied.

▼B

ANNEX VI

▼M4

Activity-specific guidelines for the production of pig iron and steel including continuous casting as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

▼M4

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

Activities for the production of pig iron and steel including continuous casting are generally integral parts of steel works with a technical connection to coke oven and sinter activities. Thus an intensive energy and material exchange (e.g. blast furnace gas, coke oven gas, coke or limestone) takes place in regular operation. If an installation's permit according to Articles 4, 5 and 6 of Directive 2003/87/EC encompasses the entire steel works and not solely the blast furnace, the CO_2-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.

▼B

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 CO_2 EMISSIONS**

In installations for the production of pig iron and steel including continuous casting, CO_2 emissions result from the following emission sources and source streams:

— raw materials (calcination of limestone, dolomite and carbonatic iron ores, e.g. $FeCO_3$),

— 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 CO_2 EMISSIONS

In case the installation for the production of pig iron and steel 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) the installation for the production of pig iron and steel as individual activity of the integrated steelworks.

▼B

2.1.1. *MASS-BALANCE APPROACH*

The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the installation to determine the level of emissions of greenhouse gases over the reporting period, using the following equation:

$$CO_2 \text{ emissions } [tCO_2] = (\text{input - products - export - stock changes}) * \text{conversion factor } CO_2/C$$

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 installation,

— *export [tC]:* carbon exported from the boundaries of the installation, 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 mass balance.

The calculation shall then be as follows:

$$CO_2 \text{ emissions } [tCO_2] = (\Sigma(\text{activity data}_{input} * \text{carbon content}_{input}) - \Sigma(\text{activity data}_{products} * \text{carbon content}_{products}) - \Sigma(\text{activity data}_{export} * \text{carbon content}_{export}) - \Sigma(\text{activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [t C/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

▼B

(b) ***carbon content***

Tier 1

▼M4

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or the Annexes IV-X. The carbon content is derived as follows:

▼B

$$\text{C} - \text{Cont [t / t or TJ} = \frac{\text{Emission factor [t CO}_2\text{ / t or TJ]}}{3,664\ \text{[t CO}_2\text{ / t C]}}$$

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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 carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

The carbon content of products or semi-finished products may be determined based on annual analyses following the provisions of Section 13 of Annex I or be derived from mid-range composition values as specified by relevant international or national standards.

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 characterized by a sequence of facilities (e.g. blast furnace, basic oxygen furnace) 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 CO_2 emissions from pig iron and steel installations including continuous casting shall be calculated as follows:

$$CO_2 \text{ emission } [tCO_2] = \sum (\text{activity data}_{INPUT} * \text{emission factor}_{INPUT}) - \sum (\text{activity data}_{OUTPUT} * \text{emission factor}_{OUTPUT})$$

▼B

With:

(a) ***activity data***

(a1) **mass flows**

Tier 1

The mass flow into and from the installation over the reporting period is determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

The mass flow into and from the installation over the reporting period is determined with a maximum uncertainty of less than ± 5,0 %.

Tier 3

The mass flow into and from the installation over the reporting period is determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

The mass flow into and from the installation over the reporting period is determined with a maximum uncertainty of less than ± 1,5 %.

(a2) **net calorific value (if applicable)**

Tier 1

Reference values for each fuel are used as specified in Section 11 of Annex I.

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 13 of Annex I.

(b) ***emission factor***

The emission factor for the activity $data_{OUTPUT}$ refers to the amount of non-CO_2-carbon in process output, which is expressed as tCO_2/t output to enhance comparability.

Tier 1

Reference factors are used for input and output material (see Table 1 below and Section 11 of Annex I).

▼B

Table 1

Reference emission factors [1]

Emission factor	Value	Unit	Source of emission factor
$CaCO_3$	0,440	$tCO_2/t\ CaCO_3$	Stoichiometric ratio
$CaCO_3$-$MgCO_3$	0,477	$tCO_2/t\ CaCO_3$-$MgCO_3$	Stoichiometric ratio
$FeCO_3$	0,380	$tCO_2/t\ FeCO_3$	Stoichiometric ratio
Direct reduced iron (DRI)	0,07	tCO_2/t	IPCC GL 2006
EAF carbon Electrodes	3,00	tCO_2/t	IPCC GL 2006
EAF charge carbon	3,04	tCO_2/t	IPCC GL 2006
Hot briquetted iron	0,07	tCO_2/t	IPCC GL 2006
Oxygen steel furnace gas	1,28	tCO_2/t	IPCC GL 2006
Petroleum coke	3,19	tCO_2/t	IPCC GL 2006
Purchased pig iron	0,15	tCO_2/t	IPCC GL 2006
Scrap iron	0,15	tCO_2/t	IPCC GL 2006
Steel	0,04	tCO_2/t	IPCC GL 2006

Tier 2

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 3

Specific emission factors (tCO_2/t_{INPUT} or t_{OUTPUT}) for input and output materials are used, developed in accordance with the provisions of Section 13 of Annex I.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I and Annex XII shall be applied.

[1] See IPCC; 2006 IPCC Guidelines for National Greenhouse Gas Inventories; 2006. IPCC based values stem from factors expressed in tC/t, multiplied with a CO/C conversion factor of 3,664.

▼B

ANNEX VII

▼M4

Activity-specific guidelines for the production of cement clinker as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

No specific boundary issues.

2. **DETERMINATION OF CO_2 EMISSIONS**

▼M4

In cement producing activities, CO_2 emissions result from the following emission sources and source streams:

▼B

— 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,

— organic carbon content of limestone and shales,

— raw materials used for waste gas scrubbing.

2.1. CALCULATION OF CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

Combustion processes involving different types of fuels (e.g. coal, petroleum coke, 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.

2.1.2. *PROCESS EMISSIONS*

Process related CO_2 emissions occur from the calcination of carbonates in the raw materials used to produce the clinker (2.1.2.1), from the partial or full calcination of cement kiln dust or bypass dust removed from the process (2.1.2.2) and in some instances from the non-carbonate carbon content of raw materials (2.1.2.3).

2.1.2.1. **CO_2 from clinker production**

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 and can be mutually used by the operator to validate the results of the respective other method.

Calculation method A — kiln input based

Calculation shall be based on the carbonate content of process inputs (including fly-ash or blast furnace slag) with cement kiln dust (CKD) and bypass dust deducted from raw material consumption and respective emissions calculated according to Section 2.1.2.2, in the case CKD and bypass dust leave the kiln system. Non-carbonate carbon is captured by this method thus 2.1.2.3 does not apply.

CO_2 shall be calculated with the following formula:

$$CO_2\ \text{emissions}_{\text{clinker}} = \sum\{\text{Activity data} * \text{Emission factor} * \text{Conversion factor}\}$$

▼B

With:

(a) ***activity data***

Unless raw meal as such is characterised, these requirements apply separately to each of the relevant carbon-bearing kiln inputs (other than fuels), e.g. limestone or shale, avoiding double counting or omissions from returned or by-passed materials. The net amount of raw meal may be determined by means of a site specific empirical raw meal/clinker ratio which is to be updated at least once per year applying industry best practice guidelines.

Tier 1

The net amount of relevant kiln input [t] consumed during the reporting period, is determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

The net amount of relevant kiln input [t] consumed during the reporting period, is determined with a maximum uncertainty of less than ± 5,0 %.

Tier 3

The net amount of relevant kiln input [t] consumed during the reporting period, is determined with a maximum uncertainty of less than ± 2,5 %.

(b) ***emission factor***

The emission factors shall be calculated and reported in units of mass of CO_2 released per tonne of each relevant kiln input. Stoichiometric ratios, as shown in Table 1 below, shall be used to convert composition data into emission factors.

Tier 1

The determination of the amount of relevant carbonates including $CaCO_3$ and $MgCO_3$ in each relevant kiln input material is carried out according to Section 13 of Annex I. This may be done by means of thermo-gravimetric methods.

Table 1

Stoichiometric ratios

Substance	Stoichiometric ratios
$CaCO_3$	0,440 [tCO_2/t $CaCO_3$]
$MgCO_3$	0,522 [tCO_2/t $MgCO_3$]
$FeCO_3$	0,380 [tCO_2/t $FeCO_3$]
C	3,664 [tCO_2/t C]

(c) ***conversion factor***

Tier 1

Carbonates leaving the kiln are conservatively assumed to be zero, i.e. assuming full calcination and a conversion factor of 1.

▼B

Tier 2

Carbonates and other carbon leaving the kiln in the clinker are considered by means of a conversion factor with a value between 0 and 1. The operator may assume complete conversion for one or several kiln inputs and attribute unconverted carbonates or other carbon to the remaining kiln input(s). The additional determination of relevant chemical parameters of the products is carried out according to Section 13 of Annex I.

Calculation method B — clinker output based

This calculation method is based on the amount of clinker produced. CO_2 shall be calculated with the following formula:

$$CO_2\ \text{emissions}_{\text{clinker}} = \text{Activity data} * \text{Emission factor} * \text{Conversion factor}$$

CO_2 released from the calcination of cement kiln dust and bypass dust need to be considered for installations where such dust leaves the kiln system (see 2.1.2.2) along with potential emissions from non-carbonate carbon in the raw meal (see 2.1.2.3). Emissions from clinker production and from cement kiln dust and bypass dust and non-carbonate carbon in input materials shall be calculated separately and added up to the emission total:

$$CO_2\text{-emissions}_{\text{process\_total}}\ [t] = CO_2\text{-emissions}_{\text{clinker}}\ [t] + CO_2\text{-emissions}_{\text{dust}}\ [t] + CO_2\text{-emissions}_{\text{non-carbonate carbon}}$$

EMISSIONS RELATED TO CLINKER OUTPUT

(a) ***activity data***

The clinker production [t] over the reporting period is determined either

— by direct weighing of clinker or,

— based on cement deliveries using the following formula (material balance taking into account dispatch of clinker, clinker supplies as well as clinker stock variation):

clinker produced [t] = ((cement deliveries [t] - cement stock variation [t])* clinker/cement ratio [t clinker/t cement]) - (clinker supplied [t]) + (clinker dispatched [t]) - (clinker stock variation [t])

The cement/clinker ratio shall either be derived for each of the different cement products based on the provisions of Section 13 of Annex I or be calculated from the difference of cement deliveries and stock changes and all materials used as additives to the cement including by-pass dust and cement kiln dust.

Tier 1

The amount of clinker produced [t] over a reporting period is derived with a maximum uncertainty of less than ± 5,0 %.

Tier 2

The amount of clinker produced [t] over a reporting period is derived with a maximum uncertainty of less than ± 2,5 %.

▼B

(b) ***emission factor***

Tier 1

Emission factor: 0,525 tCO_2/t clinker

Tier 2

The operator applies a country-specific emission factor 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 determination of the amount of CaO and MgO in the product is carried out according to Section 13 of Annex I.

Stoichiometric ratios as shown in Table 2 shall be used to convert composition data into emission factors assuming that all CaO and MgO have been derived from respective carbonates.

Table 2

Stoichiometric ratios

Oxide	Stoichiometric ratios [tCO_2]/[t *earth alkali oxide*]
CaO	0,785
MgO	1,092

(c) ***conversion factor***

Tier 1

The amount of (non-carbonate) CaO and MgO in the raw materials is conservatively assumed to be zero, i.e. all Ca and Mg in the product is assumed to have originated from carbonate raw materials, reflected by conversion factors of value 1.

Tier 2

The amount of (non-carbonate) CaO and MgO in the raw materials is reflected by means of conversion factors with a value between 0 and 1 with a value of 1 corresponding to a full conversion of raw material carbonates into oxides. The additional determination of relevant chemical parameters of the raw materials is carried out according to Section 13 of Annex I. This may be done by means of thermo-gravimetric methods.

2.1.2.2. EMISSIONS RELATED TO DISCARDED DUST

CO_2 from bypass dust or cement kiln dust (CKD) leaving the kiln system shall be calculated based on amounts of dust leaving the kiln system and the emission factor calculated as for clinker (but with potentially different CaO and MgO contents), corrected for partial calcination of CKD. Emissions shall be calculated as follows:

$$CO_2\ emissions_{dust} = Activity\ data * Emission\ factor$$

▼B

With:

(a) ***activity data***

Tier 1

Amount [t] of CKD or bypass dust (if relevant) leaving the kiln system over a reporting period estimated using industry best practice guidelines.

Tier 2

Amount [t] of CKD or bypass dust (if relevant) leaving the kiln system during over a period derived with a maximum uncertainty of less than ± 7,5 %.

(b) ***emission factor***

Tier 1

Use of the reference value of 0,525 tCO_2 per tonne clinker also for CKD or by-pass dust leaving the kiln system.

Tier 2

The emission factor [tCO_2/t] for CKD or by-pass dust leaving the kiln system shall be calculated based on the degree of calcination and composition. The degree of calcination and composition shall be determined at least once per year following the provisions of Section 13 of Annex I.

The relation between the degree of CKD calcination and the CO_2 emissions per tonne of CKD is non-linear. It shall be approximated using the following formula:

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

where

EF_{CKD} = emission factor of partially calcined cement kiln dust [tCO_2/t CKD]

EF_{Cli} = installation specific emission factor of clinker [CO_2/t clinker]

d = degree of CKD calcination (released CO_2 as % of total carbonate CO_2 in the raw mix)

2.1.2.3. EMISSIONS FROM NON-CARBONATE CARBON IN RAW MEAL

Emissions from non-carbonate carbon in limestone, shale or alternative raw materials (e.g. fly ash) used in the raw meal in the kiln shall be determined using the following expression:

$$CO_2\text{-emissions}_{\text{non-carbonate raw}} = \text{Activity data} * \text{Emission factor} * \text{Conversion Factor}$$

With:

(a) ***activity data***

Tier 1

Amount of relevant raw material [t] consumed over a reporting period derived with a maximum uncertainty of less than ± 15 %.

▼B

Tier 2

Amount of relevant raw material [t] consumed over a reporting period derived with a maximum uncertainty of less than ± 7,5 %.

(b) ***emission factor***

Tier 1

The content of non-carbonate carbon in the relevant raw material shall be estimated using industry best practice guidelines.

Tier 2

The content of non-carbonate carbon in the relevant raw material shall be determined at least annually following the provisions of Section 13 of Annex I.

(c) ***conversion factor***

Tier 1

Conversion Factor: 1,0.

Tier 2

The conversion factor is calculated applying industry best practice.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I shall be applied.

▼B

ANNEX VIII

▼M4

Activity-specific guidelines for the production of lime or calcination of dolomite or magnesite as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

No specific boundary issues.

2. **DETERMINATION OF CO_2 EMISSIONS**

▼M4

In the production of lime or calcination of dolomite or magnesite, CO_2 emissions result from the following emission sources and source streams:

— calcination of limestone, dolomite or magnesite in the raw materials,

▼B

— conventional fossil kiln fuels,

— alternative fossil-based kiln fuels and raw materials,

— biomass kiln fuels (biomass wastes),

— other fuels.

2.1. CALCULATION OF CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

▼M4

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 or calcination of dolomite or magnesite shall be monitored and reported in accordance with Annex II.

▼B

2.1.2. *PROCESS EMISSIONS*

▼M4

Relevant emissions occur during calcination and from the oxidation of organic carbon in the raw materials. During calcination in the kiln, CO_2 from carbonates is released from the raw materials. Calcination CO_2 is directly linked with the lime, dolime or magnesia production. On an installation level, calcination CO_2 can be calculated in two ways: based on the amount of calcium and magnesium carbonate from the raw material (mainly limestone, dolomite and magnesite) converted in the process (calculation method A), or based on the amount of calcium and magnesium oxides in the products (calculation method B). The two approaches are considered to be equivalent and can be mutually used by the operator to validate the results of the respective other method.

▼B

Calculation method A — carbonates

▼M4

Calculation shall be based on the amount of calcium carbonate and magnesium carbonate – and where relevant, of other carbonates – in the raw materials consumed. The following formula shall be used:

▼B

$$\text{CO}_2 \text{ emission [t CO}_2\text{]} = \sum \left\{ \text{activity data}_{\text{INPUT}} * \text{emission factor} * \text{conversion factor} \right\}$$

(a) ***activity data***

These requirements apply separately to each of the relevant carbon-bearing kiln inputs (other than fuels), e.g. chalk or limestone, avoiding double counting or omissions from returned or by-passed materials.

▼B

Tier 1

The amount of relevant kiln input [t] consumed during the reporting period is determined by the operator with a maximum uncertainty of less than ± 7,5 %.

Tier 2

The amount of relevant kiln input [t] consumed during the reporting period is determined by the operator with a maximum uncertainty of less than ± 5,0 %.

Tier 3

The amount of relevant kiln input [t] consumed during the reporting period is determined by the operator with a maximum uncertainty of less than ± 2,5 %.

(b) ***emission factor***

Tier 1

The emission factors shall be calculated and reported in units of mass of CO_2 released per tonne of each relevant kiln input assuming full conversion. Stoichiometric ratios as shown in Table 1 below shall be used to convert composition data into emission factors. ►M4 Where relevant, carbonate content values shall be adjusted for the respective moisture and gangue content of the applied carbonate material, and take into account other magnesium bearing minerals than carbonates. ◄

The determination of the amount of $CaCO_3$, $MgCO_3$ and organic carbon (where relevant) in each relevant kiln input material is carried out according to Section 13 of Annex I.

Table 1

Stoichiometric ratios

▼M4

Carbonate	Ratio[t CO_2/t Ca-, Mg- or other Carbonate]	Remarks
$CaCO_3$	0,440	
$MgCO_3$	0,522	
general: $X_Y(CO_3)_Z$	Emission factor = $[M_{CO_2}]/\{Y * [M_x] + Z * [M_{CO_3^{2-}}]\}$	X = alkali earth or alkali metal M_x = molecular weight of X in [g/mol] M_{CO_2} = molecular weight of CO_2 = 44 [g/mol] $M_{CO_{3-}}$ = 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

▼B

(c) ***conversion factor***

Tier 1

Carbonates leaving the kiln are conservatively assumed to be zero, i.e. assuming full calcination and a conversion factor is of 1.

Tier 2

Carbonates leaving the kiln in the lime are considered by means of a conversion factor with a value between 0 and 1. The operator may assume complete conversion for one or several kiln inputs and attribute unconverted carbonates to the remaining kiln input(s). The additional determination of relevant chemical parameters of the products is carried out according to Section 13 of Annex I.

Calculation method B — alkali earth oxides

▼M4

CO_2 emissions arise from the calcination of carbonates and shall be calculated based on the amounts of CaO and MgO contents in the lime, dolime or magnesia produced. Already calcined Ca and Mg entering the kiln, for instance through fly ash or fuels and raw materials with a relevant CaO or MgO content, as well as other magnesium bearing minerals than carbonates shall be considered appropriately by means of the conversion factor. Kiln dust leaving the kiln system shall be considered appropriately.

▼B

Emissions from carbonates

The following calculation formula shall be used:

$$\text{CO}_2\ \text{emission}\ [\text{t CO}_2] = \sum \left\{ \text{activity data}_{\text{OUTPUT}} * \text{emission factor} * \text{conversion factor} \right\}$$

(a) ***activity data***

Tier 1

Amount of lime [t] produced during the reporting period is determined by the operator with a maximum uncertainty of less than ± 5,0 %.

Tier 2

Amount of lime [t] produced during the reporting period is determined by the operator with a maximum uncertainty of less than ± 2,5 %.

(b) ***emission factors***

Tier 1

The determination of the amount of CaO and MgO in the product is carried out according to Section 13 of Annex I.

Stoichiometric ratios as shown in Table 2 shall be used to convert composition data into emission factors assuming that all CaO and MgO have been derived from respective carbonates.

▼B

Table 2

Stoichiometric ratios

▼M4

Oxide	Stoichiometric ratios	Remarks
CaO	0,785 [tonne CO_2 per tonne of oxide]	
MgO	1,092 [tonne CO_2 per tonne of oxide]	
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_{CO_2} = 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

▼B

(c) ***conversion factor***

Tier 1

CaO and MgO in the raw materials are conservatively assumed to be zero, i.e. all Ca and Mg in the product is assumed to have originated from carbonate raw materials, reflected by conversion factors of value 1.

Tier 2

The amount of CaO and MgO already in the raw materials is reflected by means of conversion factors with a value between 0 and 1 with a value of 1 corresponding to a full conversion of raw material carbonates into oxides. The additional determination of relevant chemical parameters of the raw materials is carried out according to Section 13 of Annex I.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I shall be applied.

▼B

ANNEX IX

▼M4

Activity-specific guidelines for the manufacture of glass or mineral wool insulation material as listed in Annex I to Directive 2003/87/EC

▼B

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.

This Annex also applies to installations for the production of water glass and stone/rock wool.

2. **DETERMINATION OF CO_2 EMISSIONS**

▼M4

In the production of glass or mineral wool, CO_2 emissions result from the following emission sources and source streams:

▼B

— decomposition of alkali- and earth alkali carbonates during melting of the raw material,

— conventional fossil fuels,

— alternative fossil-based fuels and raw materials,

— biomass fuels (biomass wastes),

— other fuels,

— carbon containing additives including coke and coal dust,

— waste gas scrubbing.

2.1. CALCULATION OF CO_2 EMISSIONS

▼M4

2.1.1. *COMBUSTION EMISSIONS*

Combustion processes that take place in installations for the manufacture of glass or mineral wool shall be monitored and reported in accordance with Annex II. This includes emissions from carbon containing additives (coke and coal dust, organic coatings of glass fibres and mineral wool) and flue gas cleaning (post-combustion).

▼B

2.1.2. *PROCESS EMISSIONS*

CO_2 is released during melting in the furnace, from carbonates contained in the raw materials, and from the neutralization of HF, HCl and SO_2 in the flue 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 to the emission total but be reported separately if possible.

▼M4

CO_2 from carbonates in the raw materials released during melting in the furnace is directly linked with the glass or mineral wool production and shall be calculated based on the converted quantity of carbonates from raw material – mainly soda, lime/limestone, dolomite and other alkali and alkali earth carbonates supplemented by carbonate free recycled glass (cullet).

▼B

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

$$CO_2 \text{ emissions } [t\ CO_2] = \sum \{\text{activity data} * \text{emission factor} + \sum \text{additive} * \text{emission factor}\}$$

With:

(a) ***activity data***

Activity data is the amount [t] of carbonate raw materials or additives associated with CO_2 emissions, as delivered (such as dolomite, limestone, soda, and other carbonates) and processed for the production of glass in the installation during the reporting period.

Tier 1

The total mass [t] of the carbonate raw materials or carbon containing additives consumed in the reporting period is determined per type of raw material by the operator or his supplier with a maximum uncertainty of ± 2,5 %.

Tier 2

The total mass [t] of the carbonate raw materials or carbon containing additives consumed in the reporting period is determined per type of raw material by the operator or his supplier with a maximum uncertainty of ± 1,5 %.

(b) ***emission factor***

Carbonates

The emission factors shall be calculated and reported in units of mass of CO_2 released per tonne of each carbonate raw material. Stoichiometric ratios as shown in Table 1 below shall be used to convert composition data into emission factors.

Tier 1

The purity of relevant input materials is determined by means of best industry practice. The derived values shall be adjusted according to moisture and gangue content of the applied carbonate materials.

Tier 2

The determination of the amount of relevant carbonates in each relevant input material is carried out according to Section 13 of Annex I.

Table 1

Stoichiometric emission factors

Carbonate	Emission factor [tCO_2/t carbonate]	Remarks
$CaCO_3$	0,440	
$MgCO_3$	0,522	
Na_2CO_3	0,415	
$BaCO_3$	0,223	

▼B

Carbonate	Emission factor [tCO_2/t carbonate]	Remarks
Li_2CO_3	0,596	
K_2CO_3	0,318	
$SrC0_3$	0,298	
$NaHCO_3$	0,524	
General: $X_Y (CO_3)_Z$	Emission factor = $[M_{CO_2}]/\{Y * [M_x] + Z * [M_{CO_3}^{2-}]\}$	X = alkali earth or alkali metal M_x = molecular weight of X in [g/mol] M_{CO_2} = molecular weight of CO_2 = 44 [g/mol] $M_{CO_{3-}}$ = 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

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I shall be applied.

▼B

ANNEX X

▼M4

Activity-specific guidelines for the manufacture of ceramic products as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

No specific boundary issues.

2. **DETERMINATION OF CO_2 EMISSIONS**

In ►M4 ——————— ◄ the manufacture of ceramic products, CO_2 emissions result from the following emission sources and source streams:

— conventional fossil kiln fuels,

— alternative fossil-based kiln fuels,

— biomass kiln fuels,

— calcination of limestone/dolomite and other carbonates in the raw material,

— limestone and other carbonates for reducing air pollutants and other flue gas cleaning,

— fossil/biomass additives used to induce porosity, e.g. polystyrol, residues from paper production or sawdust,

— fossil organic material in the clay and other raw materials.

2.1. CALCULATION OF CO_2 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*

CO_2 is released during calcination of the raw materials in the kiln and the oxidation of organic material of the clay and additives, and from the neutralization of HF, HCl and SO_2 in the flue gases with limestone or other carbonates and from other flue gas cleaning processes. Emissions from the decomposition of carbonates and the oxidation of organic material in the kiln and from flue gas cleaning shall all be included in the installation's emissions. They shall be added up to the emission total but reported separately, if possible. Calculation shall be as follows:

$$CO_2\ \text{emissions}_{\text{total}}\ [t] = CO_2\ \text{emissions}_{\text{input material}}\ [t] + CO_2\ \text{emissions}_{\text{flue gas cleaning}}\ [t]$$

2.1.2.1. CO_2 FROM INPUT MATERIAL

CO_2 from carbonates and from carbon contained in other input materials shall be calculated using either a calculation method based on the amount of inorganic and organic carbon in raw materials (e.g. various carbonates, organic content of the clay and of additives) converted in the process (*calculation method A*), or a methodology based on the alkali earth oxides in ceramics produced (*calculation method B*). The two approaches are considered equivalent for ceramics based on purified or synthetic clays. Calculation method A shall be applied for ceramic products based on unprocessed clays and whenever clays or additives with significant organic content are used.

▼B

Calculation method A — carbon inputs

Calculation is based on the carbon input (organic and inorganic) in each of the relevant raw materials, e.g. different types of clays, clay mixings or additives. Quartz/silica, feldspar, kaolin and mineral talc commonly do not constitute significant sources of carbon.

Activity data, emission factor and conversion factor shall refer to a common state of the material, preferably the dry state.

The following calculation formula shall be used:

$$CO_2 \text{ emission } [tCO_2] = \sum \{\text{activity data} * \text{emission factor} * \text{conversion factor}\}$$

With:

(a) ***activity data***

These requirements apply separately to each of the relevant carbon-bearing raw materials (other than fuels), e.g. clay or additives, avoiding double counting or omissions from returned or by-passed materials.

Tier 1

The amount of each relevant raw material or additive [t] consumed during the reporting period (excluding losses) is determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

The amount of each relevant raw material or additive [t] consumed during the reporting period (excluding losses) is determined with a maximum uncertainty of less than ± 5,0 %.

Tier 3

The amount of each relevant raw material or additive [t] consumed during the reporting period (excluding losses) is determined with a maximum uncertainty of less than ± 2,5 %.

(b) ***emission factor***

One aggregate emission factor including organic and inorganic carbon (total carbon (TC)) may be applied for each source stream (i.e. relevant raw material mix or additive). Alternatively, two different emission factors for total inorganic carbon (TIC) and total organic carbon (TOC) for each source stream may be applied. Where applicable, stoichiometric ratios shall be applied to convert composition data for individual carbonates, as shown in Table 1 below. The determination of biomass fraction of additives which do not qualify as pure biomass shall follow the provisions of Section 13.4 of Annex I.

Table 1

Stoichiometric ratios

Carbonates	Stoichiometric ratios	
$CaCO_3$	0,440 [tCO_2/t $CaCO_3$]	
$MgCO_3$	0,522 [tCO_2/t $MgCO_3$]	
$BaCO_3$	0,223 [tCO_2/t $BaCO_3$]	

▼B

Carbonates	Stoichiometric ratios	
General: $X_Y (CO_3)_Z$	Emission factor = $[M_{CO_2}]/\{Y * [M_x] + Z * [M_{CO_3}^{2-}]\}$	X = alkali earth or alkali metal M_x = molecular weight of X in [g/mol] M_{CO_2} = molecular weight of CO_2 = 44 [g/mol] $M_{CO_{3-}}$ = 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

Tier 1

A conservative value of 0,2 tonnes $CaCO_3$ (corresponding to 0,08794 tonnes of CO_2) per tonne of dry clay is applied for the calculation of the emission factor instead of results of analyses.

Tier 2

An emission factor for each source stream is derived and updated at least once per year using industry best practice reflecting site specific conditions and the product mix of the installation.

Tier 3

The determination of composition of the relevant raw materials is carried out according to Section 13 of Annex I.

(c) ***conversion factor***

Tier 1

Carbonates and other carbon leaving the kiln in the products are conservatively assumed to be zero, assuming full calcination and oxidation reflected by a conversion factor of 1.

Tier 2

Carbonates and carbon leaving the kiln are captured by means of conversion factors with a value between 0 and 1 with a value of 1 corresponding to a full conversion of carbonates or other carbon. The additional determination of relevant chemical parameters of the products is carried out according to Section 13 of Annex I.

Calculation method B — alkali earth oxides

Calcination CO_2 is calculated based on the amounts of ceramics produced and the CaO, MgO and other (earth) alkali oxide contents of the ceramics (activity $data_{OUTPUT}$). The emission factor is corrected for already calcined Ca, Mg and for other alkali earth/alkali contents entering the kiln (activity $data_{INPUT}$), for instance alternative fuels and raw materials with a relevant CaO or MgO content. The following calculation formula shall be used:

$$CO_2 \text{ emission } [tCO_2] = \sum \{\text{activity data} * \text{emission factor} * \text{conversion factor}\}$$

▼B

With:

(a) ***activity data***

The activity data of the products relate to gross production including rejected products and cullet from the kilns and shipment.

Tier 1

The mass of the products during the reporting period is derived with a maximum uncertainty of less than ± 7,5 %.

Tier 2

The mass of the products during the reporting period is derived with a maximum uncertainty of less than ± 5,0 %.

Tier 3

The mass of the products during the reporting period is derived with a maximum uncertainty of less than ± 2,5 %.

(b) ***emission factor***

One aggregate emission factor shall be calculated based on the content of the relevant metal oxides, e.g. CaO, MgO and BaO in the product using the stoichiometric ratios in Table 2.

Table 2

Stoichiometric ratios

Oxide	Stoichiometric ratios	Remarks
CaO	0,785 [tonne CO_2 per tonne of oxide]	
MgO	1,092 [tonne CO_2 per tonne of oxide]	
BaO	0,287 [tonne CO_2 per tonne of oxide]	
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_{CO_2} = 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

Tier 1

A conservative value of 0,123 tonnes CaO (corresponding to 0,09642 tonnes of CO_2) per tonne of product is applied for the calculation of the emission factor instead of results of analyses.

Tier 2

An emission factor is derived and updated at least once per year using industry best practice reflecting site specific conditions and the product mix of the installation.

▼B

Tier 3

The determination of composition of the products is carried out according to Section 13 of Annex I.

(c) ***conversion factor***

Tier 1

Relevant oxides in the raw materials are conservatively assumed to be zero, i.e. all Ca, Mg, Ba and other relevant alkali oxides in the product is assumed to have originated from carbonate raw materials, reflected by conversion factors of value 1.

Tier 2

Relevant oxides in the raw materials are reflected by means of conversion factors with a value between 0 and 1 with a value of 0 corresponding to a full content of relevant oxide already in the raw material. The additional determination of relevant chemical parameters of the raw materials is carried out according to Section 13 of Annex I.

2.1.2.2. CO_2 FROM LIMESTONE FOR REDUCING AIR POLLUTANTS AND OTHER FLUE GAS CLEANING

CO_2 from limestone for reducing air pollutants and other flue gas clean shall be calculated based on the amount of $CaCO_3$ input. Double counting from used limestone recycled as raw material in the same installation shall be avoided.

The following calculation formula shall be used:

$$CO_2 \text{ emission } [t\ CO_2] = \text{activity data} * \text{emission factor}$$

With:

(a) ***activity data***

Tier 1

The amount [t] of dry $CaCO_3$ consumed during the reporting period determined by weighing by operator or his suppliers with a maximum uncertainty of less than ± 7,5 %.

(b) ***emission factor***

Tier 1

Stoichiometric ratios of $CaCO_3$ as shown in Table 1.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I shall be applied.

▼B

ANNEX XI

▼M4

Activity-specific guidelines for pulp and paper production as listed in Annex I to Directive 2003/87/EC

▼B

1. **BOUNDARIES AND COMPLETENESS**

Subject to the approval of the competent authority, if the installation exports fossil fuel-derived CO_2, 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 CO_2 EMISSIONS**

Pulp and paper mill processes with the potential to emit CO_2 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,

— 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 Directive 2003/87/EC. Consequently their emissions fall outside the scope of Directive 2003/87/EC.

2.1. CALCULATION OF CO_2 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 ($CaCO_3$) and sodium carbonate (Na_2CO_3), which do result in CO_2 emissions, are sometimes used. The carbon contained in these chemicals is usually of fossil origin, although in some cases (e.g. Na_2CO_3 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 CO_2 from the lime kiln or recovery furnace. These emissions are determined by assuming that all of the carbon in $CaCO_3$ and Na_2CO_3 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.

▼B

CO_2 emissions shall be calculated as follows:

CO_2 emissions = $\sum$ {(Activity data $_{Carbonate}$ * Emission factor)}

With:

(a) ***activity data***

Activity $data_{Carbonate}$ are the amounts of $CaCO_3$ and Na_2CO_3 consumed in the process.

Tier 1

Amounts [t] of $CaCO_3$ and Na_2CO_3 consumed in the process as determined by the operator or his suppliers with a maximum uncertainty of less than ± 2,5 %.

Tier 2

Amounts [t] of $CaCO_3$ and Na_2CO_3 consumed in the process as determined by the operator or his suppliers with a maximum uncertainty of less than ± 1,5 %.

(b) ***emission factor***

Tier 1

Stoichiometric ratios [t_{CO2}/t_{CaCO3}] and [t_{CO2}/t_{Na2CO3}] for non-biomass carbonates as indicated in Table 1. Biomass carbonates are weighted with an emission factor of 0 [tCO_2/t carbonate].

Table 1

Stoichiometric emission factors

Carbonate type and origin	Emission factor [tCO_2/t carbonate]
Pulp mill make-up $CaCO_3$	0,440
Pulp mill make-up Na_2CO_3	0,415

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

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annex I shall be applied.

▼M3

ANNEX XII

▼M4

Guidelines for determination of emissions or amount of transfer of greenhouse gases by continuous measurement systems

▼M3

1. **BOUNDARIES AND COMPLETENESS**

The provisions of this Annex apply to emissions of greenhouse gases from all activities covered by Directive 2003/87/EC. Emissions may occur at several emission sources in an installation.

The provisions of this Annex apply furthermore to continuous measurement systems used for determination of CO_2 flows in pipelines, in particular when used for the transfer of CO_2 between installations such as for the capture, transport and geological storage of CO_2. For this purpose, the references to emissions in Sections 6 and 7.2 of Annex I shall be interpreted as references to the amount of CO_2 transferred in accordance with Section 5.7 of Annex I.

2. **DETERMINATION OF GREENHOUSE GAS EMISSIONS**

Tier 1

For each measurement point a total uncertainty of the overall emissions or CO_2 flow over the reporting period of less than ± 10 % shall be achieved.

Tier 2

For each measurement point a total uncertainty of the overall emissions or CO_2 flow over the reporting period of less than ± 7,5 % shall be achieved.

Tier 3

For each measurement point a total uncertainty of the overall emissions or CO_2 flow over the reporting period of less than ± 5 % shall be achieved.

Tier 4

For each measurement point a total uncertainty of the overall emissions or CO_2 flow over the reporting period of less than ± 2,5 % shall be achieved.

Overall approach

Total emissions of a greenhouse gas (GHG) from an emission source or the amount of CO_2 conducted through the measurement point over the reporting period shall be determined by using the formula below. In case several emission sources exist in one installation and cannot be measured as one, emissions from these emission sources shall be measured separately and summed up to the total emissions of the specific gas over the reporting period in the whole installation.

$$\mathrm{GHG}_{-\mathrm{tot\ ann}}\ [\mathrm{t}] = \sum_{i=1}^{operating\_hours\_p.a.} \mathrm{GHG-concentration_i} * \mathrm{flue\ gas\ flow_i}$$

Determination of the parameters GHG-concentration and flue gas flow shall be carried out according to the provisions of Section 6 of Annex I. For measurement of transferred CO_2 in pipelines, Section 6 of Annex I shall apply as if the measurement point were an emission source, as appropriate. For such measurement points no corroborating calculation pursuant to section 6.3 subsection (c) shall be required.

▼M3

GHG-concentration

The GHG-concentration in the flue gas is determined by continuous measurement at a representative point. The GHG-concentration can be measured by two approaches:

METHOD A

The concentration of GHG is measured directly.

METHOD B

For very high GHG concentrations such as in transport networks, the GHG concentration may be calculated using a mass balance, taking into account measured concentration values of all other components of the gas stream as laid down in the installation's monitoring-plan:

$$GHG\ concentration\ [\%] = 100\ \% - \sum_{i} Conc.\ of\ component_i\ [\%]$$

Flue gas flow

The dry flue gas flow can be determined using one of the following methods.

METHOD A

The flue gas flow Q_e is calculated by means of a mass balance approach, taking into account all significant parameters such as input material loads, input airflow, process efficiency, and on the output side the product output, the O_2 concentration, SO_2 and NO_x concentrations.

The specific calculation approach shall be approved by the competent authority as part of the evaluation of the monitoring plan and the monitoring methodology therein.

METHOD B

The flue gas flow Q_e is determined by continuous flow measurement at a representative point.

▼M1

ANNEX XIII

Activity-specific guidelines for determination of nitrous oxide (N_2O) emissions from nitric acid, adipic acid, caprolactam, glyoxal and glyoxylic acid production

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines contained in this Annex shall apply to monitoring N_2O emissions occurring from the production of nitric acid, adipic acid, caprolactam, glyoxal and glyoxylic acid within relevant installations included pursuant to Article 24 of Directive 2003/87/EC.

For each activity from which N_2O emissions result, all sources emitting N_2O from production processes shall be covered, including where N_2O emissions from production are channelled through any abatement equipment. This includes:

— nitric acid production — N_2O emissions from the catalytic oxidation of ammonia and/or from the NO_x/N_2O abatement units,

— adipic acid production — N_2O emissions, including from the oxidation reaction, any direct process venting and/or any emissions control equipment,

— glyoxal and glyoxylic acid production — N_2O emissions, including from the process reactions, any direct process venting and/or any emissions control equipment,

— caprolactam production — N_2O emissions, including from the process reactions, any direct process venting and/or any emissions control equipment.

These provisions are not applicable to any N_2O emissions from combustion of fuels.

Any relevant CO_2 emissions directly associated with the production process (and not already covered under the EU ETS) that are included in the installation's greenhouse gas emission permit shall be monitored and reported in accordance with these guidelines.

Annex I, Section 16 does not apply to the monitoring of N_2O emissions.

2. **DETERMINATION OF $CO_{2(e)}$ AND N_2O EMISSIONS**

2.1. ANNUAL N_2O EMISSIONS

Emissions of N_2O from nitric acid production shall be measured using continuous emissions measurement (excluding for *de minimis* sources — Section 6.3).

Emissions of N_2O from adipic acid, caprolactam, glyoxal and glyoxylic acid production shall be monitored using continuous emissions measurement for abated emissions and the calculation method (based on a mass balance approach (Section 2.6)) for temporary occurrences of unabated emissions.

Total annual N_2O emissions from the installation are the sum of annual N_2O emissions from all its emission sources.

▼M1

For each emission source where continuous emissions measurement is applied, the total annual emissions are the sum of all hourly emissions using the following formula:

$$N_2O\ \text{emissions}_{\text{annual}}[t] = \sum[N_2O\ \text{conc}_{\text{hourly}}[mg/Nm^3] \times \text{flue gas flow}_{\text{hourly}}[Nm^3/h]] \times 10^{-9}$$

Where:

N_2O emissions$_{annual}$ = total annual emissions of N_2O from the emission source in tonnes N_2O

N_2O conc $_{hourly}$ = hourly concentrations of N_2O in mg/Nm^3 in the flue gas flow measured during operation

Flue gas flow = flue gas flow as calculated below in Nm^3/h for each hourly concentration

2.2. HOURLY N_2O EMISSIONS

Annual average hourly N_2O emissions for each source where continuous emission measurement is applied shall be calculated using the following equation:

$$N_2O\ \text{emissions}_{\text{avhourly}}[kg/h] = \frac{\sum(N_2O\ \text{conc}_{\text{hourly}}[mg/Nm^3] \times \text{flue gas low}\ [Nm^3/h]) \times 10^{-6}}{\text{Hours of operation}\ [h]}$$

Where:

N_2O emissions$_{av\ hourly}$ = annual average hourly N_2O emissions in kg/h from the source

N_2O conc $_{hourly}$ = hourly concentrations of N_2O in mg/Nm^3 in the flue gas flow measured during operation

Flue gas flow = flue gas flow as calculated below in Nm^3/h for each hourly concentration

The total uncertainty of the annual hourly average emissions for each emission source must not exceed the tier values as set out below. The highest tier approach shall be used by all operators. Only if it is shown to the satisfaction of the competent authority that the highest tier is not technically feasible or will lead to unreasonably high costs, may a next lower tier be used. For the reporting period 2008–12 as a minimum Tier 2 shall be applied unless technically not feasible.

In cases for which it is technically not feasible or would lead to unreasonable costs to apply at least Tier 1 requirements for each emission source (except *de minimis* sources), the operator shall apply and demonstrate compliance with the appropriate tier for the total annual emission for the emission source as in Section 2, Annex XII. For the reporting period 2008–12 the minimum requirement is Tier 2, unless technically not feasible. Respective installations applying this approach are to be notified by Member States to the Commission pursuant to Article 21 of Directive 2003/87/EC.

▼**M1**

Tier 1:

For each emission source a total uncertainty of annual average hourly emissions of less than ± 10 % shall be achieved.

Tier 2:

For each emission source a total uncertainty of annual average hourly emissions of less than ± 7,5 % shall be achieved.

Tier 3:

For each emission source a total uncertainty of annual average hourly emissions of less than ± 5 % shall be achieved.

2.3. HOURLY N_2O CONCENTRATIONS

Hourly N_2O concentrations [mg/Nm^3] in the flue gas from each emission source shall be determined by continuous measurement at a representative point, after the NO_x/N_2O abatement equipment (if abatement is used).

Suitable measuring techniques include IR Spectroscopy, but others can be used in accordance with paragraph 2 of Section 6.1 of Annex I, provided they achieve the required uncertainty level for the N_2O emissions. The used techniques must be capable of measuring N_2O concentrations of all emission sources during both abated and unabated conditions (for example during periods when abatement equipment fails and concentrations increase). If uncertainties increase during such periods, these must be taken into account in the uncertainty assessment.

All measurements shall be adjusted to a dry gas basis and be reported consistently.

2.4. DETERMINATION OF FLUE GAS FLOW

The methods for monitoring flue gas flow set out in Annex XII shall be used for measuring flue gas flow for N_2O emissions monitoring.

For nitric acid production, Method A shall be applied unless it is not technically feasible, in which case an alternative method, such as a mass balance approach based on significant parameters (such as ammonia input load) or determination of flow by continuous emissions flow measurement, can be used provided it is approved by the competent authority as part of the evaluation of the monitoring plan and the monitoring methodology therein.

For other activities, other methods for monitoring flue gas flow described in Annex XII can be used, provided they are approved by the competent authority as part of the evaluation of the monitoring plan and the monitoring methodology therein.

Method A — nitric acid production

The flue gas flow shall be calculated in accordance with the following formula:

$$V_{\text{flue gas flow}}[Nm^3/h] = V_{\text{air}} \times (1 - O_{2,\text{ air}})/(1 - O_{2,\text{ flue gas}})$$

Where:

V_{air} = total input air flow in Nm^3/h at standard conditions;

$O_{2\ \text{air}}$ = volume fraction of O_2 in dry air [= 0,2095];

$O_{2\ \text{flue gas}}$ = volume fraction of O_2 in flue gas.

▼**M1**

The V_{air} shall be calculated as the sum of all air flows entering the nitric acid production unit.

The installation shall apply the following formula, unless stated otherwise in its monitoring plan:

$$V_{air} = V_{prim} + V_{sec} + V_{seal}$$

Where:

V_{prim} = Primary input air flow in Nm^3/h at standard conditions;

V_{sec} = Secondary input air flow in Nm^3/h at standard conditions;

V_{seal} = Seal input air flow in Nm^3/h at standard conditions.

The V_{prim} is determined by continuous flow measurement before the mixing with ammonia takes place. The V_{sec} is determined by continuous flow measurement e.g. before the heat recovery unit. The V_{seal} is the purged airflow within the nitric acid production process (if relevant).

For input air streams accounting for cumulatively less than 2,5 % of the total air flow, the competent authority may accept estimation methods for determination of this air flow rate proposed by the operator based on industry best practices.

The operator shall provide evidence through measurements under normal operation conditions that the flue gas flow measured is sufficiently homogeneous to allow for the proposed measurement method. If non-homogeneous flow is confirmed through these measurements, this must be taken into account when determining appropriate monitoring methods and when calculating the uncertainty in the N_2O emissions.

All measurements shall be adjusted to a dry gas basis and be reported consistently.

2.5. OXYGEN (O_2)

Oxygen concentrations in the flue gas shall be measured if needed for calculating the flue gas flow according to Section 2.4. Requirements described for concentration measurements within Section 6 of Annex I shall apply. Suitable measurement techniques include: paramagnetic alternating pressure, magnetic torsion balance or zirconium dioxide probe. Uncertainty of O_2 concentration measurements shall be taken into account in determining the uncertainty in the N_2O emissions.

All measurements shall be adjusted to a dry gas basis and be reported consistently.

2.6. CALCULATION OF N_2O EMISSIONS

For specific periodic, unabated emissions of N_2O from adipic acid, caprolactam, glyoxal and glyoxylic acid production (such as unabated emissions from venting for safety reasons and/or when abatement plant fails) where continuous emissions monitoring of N_2O is not technically feasible, calculation of N_2O emissions using a mass balance approach can be applied. The calculation method shall be based on the maximum potential emission rate of N_2O from the chemical reaction taking place at the time and the period of the emission. The specific calculation approach shall be approved by the competent authority as part of the evaluation of the monitoring plan and the monitoring methodology therein.

▼M1

The uncertainty in any calculated emissions for a specific emission source shall be taken into account in determining the annual average hourly uncertainty for the emission source. The same tiers as for emissions measured entirely with continuous emissions measurement shall be applied to calculated emissions, or where a combination of calculation and continuous measurement are used to determine N_2O emissions.

3. **CALCULATION OF ANNUAL CO_2 EQUIVALENTS ($CO_{2(e)}$)**

The total annual N_2O emissions from all emissions sources (measured in tonnes to three decimal places) shall be converted to annual $CO_{2(e)}$ emissions (rounded tonnes) using the following formula:

$$CO_{2(e)}[t] = N_2O_{annual}[t] \times GWP_{N2O}$$

For emissions during the period 2008–12, the Global Warming Potential GWP_{N2O} = 310 t $CO_{2(e)}$/t N_2O shall be used, which is the value provided in the Intergovernmental Panel on Climate Change's Second Assessment Report (1995 IPCC GWP value).

The total annual $CO_{2(e)}$ generated by all emission sources and any direct CO_2 emissions from other emission sources (if included in the greenhouse gas permit) shall be added to the total annual CO_2 emissions generated by the installation and shall be used for reporting and surrendering allowances.

4. **DETERMINATION OF ACTIVITY PRODUCTION RATES**

Production rates shall be calculated using daily production reports and hours of operation.

5. **MONITORING PLAN**

In addition to requirements set out in Annex I, Section 4.3(a), (b), (c), (d), (j), (k), (m) and (n), monitoring plans for installations covered by this Annex shall contain the following information:

(a) all relevant emissions points during typical operation, and during restrictive and transition phases (e.g. breakdown periods or commissioning phases) shown in a process diagram;

(b) the method and parameters used to determine the quantity of materials (e.g. ammonia) used in the production process and the maximum quantity of material used at full capacity;

(c) the method and parameters used to determine the quantity of product produced as an hourly load, expressed as nitric acid (100 %), adipic acid (100 %), glyoxal and glyoxylic acid and caprolactam per hour respectively;

(d) the method and parameters used to determine the N_2O concentration in the flue gas from each emission source, its operating range, and its uncertainty, and details of any alternative methods to be applied if concentrations fall outside the operating range and the situations when this may occur;

▼M1

(e) the method used to determine the total flue gas flow rate (expressed in Nm^3 per hour) from each emission source, its operating range and its uncertainty. If derived by calculation, details for each monitored flue gas stream shall be given;

(f) the calculation method used to determine N_2O emissions from periodic, unabated sources in adipic acid, caprolactam, glyoxal and glyoxylic acid production;

(g) the way in which or the extent to which the installation operates with variable loads, and the manner in which the operational management is carried out;

(h) the method and any calculation formulae used to determine the annual N_2O emissions of each emission source;

(i) the process conditions that deviate from normal operations, an indication of the potential frequency and the duration of such conditions, as well as an indication of the volume of the N_2O emissions during the deviating process conditions (such as abatement equipment malfunction);

(j) the assessment used to show that the tier uncertainty requirements referred in Section 2 of this Annex are complied with and the tier achieved;

(k) the value expressed in kg/N_2O per hour which has been determined in accordance with Annex I, Sections 6.3(a) and (b) in order to be used in case the measuring instrument fails or does not function properly;

(l) Details of any deviations from the requirements of general standards such as EN 14181 and ISO 14956:2002.

In addition to the requirements in Annex I, Section 4.3, a substantial change to the monitoring methodology as part of the monitoring plan shall be subject to the approval of the competent authority if it concerns:

— significant changes in the functioning of the installation that affect the total level of N_2O emissions, the N_2O concentration, the flow rate or other parameters of the flue gas, especially if N_2O abatement measures are installed or replaced,

— changes in the methods used to determine N_2O emissions, including changes in the continuous measurement of concentrations, oxygen concentrations and flue gas flow, or calculation method which significantly affect the total uncertainty of the emissions,

— changes in the parameters used to determine annual emissions and/or production of nitric acid, adipic acid, caprolactam, glyoxal and glyoxylic acid,

— changes in uncertainty assessment.

6. **GENERAL**

6.1. SAMPLING RATES

Valid hourly averages shall be calculated in accordance with Section 6.3(a) of Annex I for:

— concentration of N_2O in the flue gas,

— total flue gas flow where this is measured directly and where required,

▼M1

— all gas flows and oxygen concentrations necessary to determine the total flue gas flow indirectly.

6.2. MISSING DATA

Missing data shall be dealt with in accordance with Annex I, Section 6.3(a) and (b). If missing data occur during failure of abatement equipment, it shall be assumed that emissions for that whole hour were unabated and substitute values calculated accordingly.

The operator shall take all practical steps to ensure that continuous emissions monitoring equipment is not out of operation for more than one week in any calendar year. If this occurs, the operator shall inform the competent authority immediately.

6.3. *DE MINIMIS* SOURCES OF N_2O

'*De minimis* source streams' for N_2O emission sources means one or more minor, unabated source streams selected by the operator and jointly emitting 1 000 tonnes of $CO_{2(e)}$ or less per year, or that emit less that 20 000 tonnes of $CO_{2(e)}$ per year and contribute less than 2 % of the total annual emissions of $CO_{2(e)}$ of that installation.

Subject to approval by the competent authority, the operator may apply approaches for monitoring and reporting using his own no-tier estimation method for *de minimis* source streams of N_2O.

6.4. CORROBORATING CALCULATION OF EMISSIONS

Annex I, Section 6.3(c) shall apply to corroborating reported emissions of N_2O (from continuous emissions measurement and calculation) and performed using production data, the 2006 IPCC Guidelines and the approach specified in Annex I, Section 10.3.3 'Horizontal approach'.

7. **UNCERTAINTY ASSESSMENTS**

Uncertainty assessments required to demonstrate compliance with relevant tiers in Section 2 shall be determined by means of an error propagation calculation taking into account the uncertainty of all relevant elements of the emission calculation. For the continuous measurement the following sources of uncertainty should be assessed in accordance with EN 14181 and ISO 14956:2002:

— the specified uncertainty of continuous measurement equipment, including sampling,

— uncertainties associated to the calibration, and

— additional uncertainty connected to how the monitoring equipment is used in practice.

For the calculation of the total uncertainty to be used in Section 2.2, hourly N_2O concentrations as determined pursuant to Section 2.3 shall be used. For the purpose of uncertainty calculation only, hourly N_2O concentrations below 20 mg/Nm^3 shall be substituted by a default value of 20 mg/Nm^3.

▼M1

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.

8. **CONTROL AND VERIFICATION**

8.1. CONTROL

In addition to the requirements in Annex I, Sections 10.1, 10.2 and 10.3, the following quality assurance procedures shall apply:

— quality assurance of the continuous measurements of the concentration of N_2O and oxygen shall take place in accordance with EN 14181,

— the installed measurement equipment shall be calibrated by means of parallel measurements once every three years,

— where emission limit values (ELVs) are typically used as the basis for calibration of continuous emissions monitors, and where no ELV exists for N_2O or O_2, then the annual average hourly concentration shall be used as a proxy for such ELVs,

— the QAL 2 should be done with suitable reference gases in addition to the sample gas, to ensure that a wide enough calibration range is assessed,

— the measurement equipment that measures the flue gas flow volume shall be calibrated annually or when the plant is maintained, whichever is sooner. Quality assurance of flue gas flow volume does not need to be performed in accordance with EN 14181,

— if internal audits find non-compliance with EN 14181 or that recalibration has to be performed, this shall be reported to the competent authority without undue delay.

8.2. VERIFICATION

In addition to the verification requirements set out in Section 10.4, the following will be checked:

— correctness of application of requirements of the standards named under Sections 7 and 8.1 of this Annex,

— calculation approaches and results where missing data has been substituted by calculated values,

— plausibility of calculated substitute values and measured values,

— any comparative assessments corroborating emissions results and calculation based methods and the reporting of activity data, emission factors and alike.

9. **REPORTING**

Total annual emissions of N_2O shall be reported in tonnes to three decimal places and as $CO_{2(e)}$ to rounded tonnes.

▼**M1**

In addition to the reporting requirements set out in Section 8 of Annex I, operators of installations covered by this Annex shall report the following information for installations:

(a) annual process unit operating time and total plant operating time;

(b) production data for each unit and the method used to determine the quantity of product;

(c) measurement criteria used in the quantification of each parameter;

(d) the uncertainty for each measured and calculated parameter (including gas concentrations, flue gas flow, calculated emissions) and the resulting total uncertainty of the hourly load and/or annual emission figure;

(e) details of any equipment malfunctions that affected emissions and emissions/flue gas flow measurements and calculations, including number of occasions, hours affected, duration and dates of malfunctions;

(f) details of when Section 6.2 of this Annex needed to be applied, including number of occasions, hours affected, calculations and substitute values used;

(g) the input data used in any corroborating assessments in accordance with Annex I, Sections 6.3(c) and 4.3 to check the annual N_2O emissions.

▼M2

ANNEX XIV

Activity-specific guidelines for determination of emissions from aviation activities as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines in this Annex shall be used to monitor and report emissions occurring from aviation activities as listed in Annex I to Directive 2003/87/EC. Annex II for the combustion of fuels is not applicable to mobile sources such as aircraft.

All flights included in Annex I to Directive 2003/87/EC and performed by an aircraft operator during the reporting period shall be included. For the purpose of identifying the unique aircraft operator as defined by Article 3(o) of Directive 2003/87/EC responsible for a flight, the call sign used for Air Traffic Control (ATC) purposes shall be used. The call sign is the ICAO designator in box 7 of the flight plan or, if not available, the registration marking of the aircraft. If the identity of the aircraft operator is not known, the owner of the aircraft shall be regarded as the aircraft operator unless it proves to the satisfaction of the competent authority who was the aircraft operator.

2. **DETERMINATION OF CO_2 EMISSIONS**

CO_2 emissions from aviation activities shall be calculated using the formula:

$$CO_2 \text{ emissions} = \text{Fuel consumption} * \text{emission factor}$$

2.1. CHOICE OF METHODOLOGY

The aircraft operator shall define in the monitoring plan which monitoring methodology is used for each aircraft type. In case the aircraft operator intends to use leased-in or other aircraft types which are not yet included in the monitoring plan at the time of submission to the competent authority, the aircraft operator shall include in the monitoring plan a description of the procedure to be used for defining the monitoring methodology for these additional aircraft types. The aircraft operator shall ensure that the monitoring methodology, once it has been chosen, is consistently applied.

The aircraft operator shall define in the monitoring plan for each aircraft type:

(a) which calculation formula will be used (method A or method B);

(b) the data source which is used for determining the data on fuel uplift and fuel contained in the tank, and the methods for transmitting, storing and retrieving that data;

(c) which method is used to determine density, where applicable. When density-temperature correlation tables are used the operator shall specify the source of this data.

▼M2

For points (b) and (c), where necessary due to special circumstances such as fuel suppliers who cannot provide all the required data for a certain methodology, this list of applied methodologies may contain a list of deviations from the general methodology for specific aerodromes.

2.2. FUEL CONSUMPTION

Fuel consumption is expressed as fuel consumed in mass units (tonnes) during the reporting period.

Fuel consumed shall be monitored for each flight and for each fuel and shall include fuel consumed by the auxiliary power unit as provided for by the calculation formulae below. Fuel uplift may be determined based on the measurement by the fuel supplier, as documented in the fuel delivery notes or invoices for each flight. Alternatively, fuel uplift may also be determined using aircraft onboard measurement systems. The data shall be taken from the fuel supplier, or recorded in the mass and balance documentation, in the aircraft technical log or be transmitted electronically from the aircraft to the aircraft operator. Fuel contained in the tank may be determined using aircraft onboard measurement systems and recorded in the mass and balance documentation, in the aircraft technical log or transmitted electronically from the aircraft to the aircraft operator.

The operator shall choose the method which provides for the most complete and timely data combined with the lowest uncertainty without incurring unreasonable costs.

2.2.1. *CALCULATION FORMULAE*

Actual fuel consumed shall be calculated using one of the following two methods:

METHOD A:

The following formula is used:

Actual fuel consumption for each flight (tonnes) = Amount of fuel contained in aircraft tanks once fuel uplift for the flight is complete (tonnes) – Amount of fuel contained in aircraft tanks once fuel uplift for subsequent flight is complete (tonnes) + Fuel uplift for that subsequent flight (tonnes)

In case there is no fuel uplift for the flight or subsequent flight, the amount of fuel contained in aircraft tanks shall be determined at block-off for the flight or subsequent flight. In the exceptional case that an aircraft performs activities other than a flight, such as undergoing major maintenance involving the emptying of the tanks, after the flight whose fuel consumption is being monitored, an aircraft operator may substitute the figures ‘Amount of fuel contained in aircraft tanks once fuel uplift for subsequent flight is complete + fuel uplift for that subsequent flight’ by the ‘amount of fuel remaining in tanks at the start of the subsequent activity of the aircraft’, as recorded by technical logs.

▼**M2**

METHOD B:

The following formula is used:

Actual fuel consumption for each flight (tonnes) = Amount of fuel remaining in aircraft tanks at block-on at the end of the previous flight (tonnes) + Fuel uplift for the flight (tonnes) – Amount of fuel contained in tanks at block-on at the end of the flight (tonnes)

The moment of block-on may be considered equivalent to the moment of engine shut down. When an aircraft did not perform a flight previous to the flight whose fuel consumption is being measured, aircraft operators may provide the amount of fuel remaining in aircraft tanks at the end of the previous activity of the aircraft, as recorded by technical logs, instead of the 'Amount of fuel remaining in aircraft tanks at block-on at the end of the previous flight'.

2.2.2. *QUANTIFICATION REQUIREMENTS*

Tier 1

Fuel consumption over the reporting period is determined with a maximum uncertainty of less than ± 5,0 %.

Tier 2

Fuel consumption over the reporting period is determined with a maximum uncertainty of less than ± 2,5 %.

Aircraft operators with average reported annual emissions over the previous trading period (or a conservative estimate or projection if reported emissions are not available or no longer applicable) equal to or less than 50 kilotonnes of fossil CO_2 shall apply as a minimum tier 1 for major source streams. All other aircraft operators shall apply tier 2 for major source streams.

2.2.3. *FUEL DENSITY*

If the amount of fuel uplift or the amount of fuel remaining in the tanks is determined in units of volume (litres or m^3), the aircraft operator shall convert this amount from volume to mass by using actual density values. Actual density means density expressed as kg/litre and determined for the applicable temperature for a specific measurement. Unless on-board measurement systems can be used, the actual density shall be the one measured by the fuel supplier at fuel uplift and recorded on the fuel invoice or delivery note. If such information is not available, the actual density shall be determined from the temperature of the fuel during the uplift provided by the fuel supplier or specified for the aerodrome where the fuel uplift takes place, using standard density-temperature correlation tables. Only in cases for which it is shown to the satisfaction of the competent authority that actual values are not available, a standard density factor of 0,8 kg/litre shall be applied.

▼M2

2.3. EMISSION FACTOR

The following reference factors, expressed as t CO_2/t fuel, based on the reference net calorific values and emission factors specified in Section 11 of Annex I, shall be used for each aviation fuel:

Table 1

Emission factors for aviation fuels

Fuel	Emission factor (tCO_2/tfuel)
Aviation gasoline (AvGas)	3,10
Jet gasoline (Jet B)	3,10
Jet kerosene (Jet A1 or Jet A)	3,15

For reporting purposes, this approach is considered as tier 1.

For alternative fuels for which no reference values have been defined, activity specific emission factors shall be determined as specified in Section 5.5 and 13 of Annex I. In such cases the net calorific value shall be determined and reported as a memo-item. If the alternative fuel contains biomass, the requirements for monitoring and reporting of biomass content as set out in Annex I shall apply.

For commercially traded fuels the emission factor or the carbon content, on which it is based, the biomass content and net calorific value may be derived from the purchasing records for the respective fuel provided by the fuel supplier, provided it has been derived based on accepted international standards.

3. **UNCERTAINTY ASSESSMENT**

The aircraft operator shall have an understanding of the main sources of uncertainty when calculating emissions. Aircraft operators shall not be required to carry out a detailed uncertainty assessment as set out in Section 7.1 of Annex I, provided the aircraft operator identifies sources of uncertainties and their associated levels of uncertainty. This information shall be used when selecting the monitoring methodology under section 2.2.

Where fuel uplifts are determined solely on the invoiced quantity of fuel or other appropriate information provided by the fuel supplier such as delivery notes for fuel uplift per flight, no further proof of the associated uncertainty level is required.

Where on-board systems are used for measuring fuel uplift, the level of uncertainty associated with fuel measurements shall be supported by calibration certificates. If such certificates are not available, aircraft operators shall.

— provide the aircraft manufacturer's specifications determining uncertainty levels of on-board fuel measurement systems, and,

— provide evidence of carrying out routine checks of the satisfactory operation of the fuel measurement systems,

▼M2

Uncertainties for all other components of the monitoring methodology may be based on conservative expert judgement taking into account the estimated number of flights within the reporting period. There is no requirement to take into account the cumulative effect of all components of the measurement system on the uncertainty of the annual activity data.

The aircraft operator shall regularly carry out cross-checks between uplift quantity as provided by invoices and uplift quantity indicated by on-board measurement, and take corrective action in accordance with section 10.3.5 if deviations are observed.

4. **SIMPLIFIED PROCEDURES FOR SMALL EMITTERS**

Aircraft operators operating fewer than 243 flights per period for three consecutive four-month periods and aircraft operators operating flights with total annual emissions lower than 10 000 tonnes CO_2 per year shall be considered small emitters.

Aircraft operators that are small emitters may estimate the fuel consumption using tools implemented by Eurocontrol or another relevant organisation, which can process all relevant air traffic information such as that available to Eurocontrol. The applicable tools shall be used only if they are approved by the Commission including the application of correction factors to compensate for any inaccuracies in the modelling methods.

An aircraft operator making use of the simplified procedure and exceeding the threshold for small emitters during a reporting year shall notify this fact to the competent authority. Unless the aircraft operator demonstrates to the satisfaction of the competent authority, that the threshold will not be exceeded again from the following reporting period onwards, the aircraft operator shall update the monitoring plan to meet the monitoring requirements laid down in sections 2 and 3. The revised monitoring plan shall be submitted without undue delay to the competent authority for approval.

5. **APPROACHES FOR DATA GAPS**

The aircraft operator shall take all necessary action to prevent missing data from occurring by implementing suitable control activities as referred to in section 10.2 to 10.3 of Annex I of these guidelines.

If a competent authority, an aircraft operator or the verifier detects that for a flight covered by Annex I to Directive 2003/87/EC part of the data necessary for determining the emissions are missing as a result of circumstances beyond the control of the aircraft operator and cannot be determined by an alternative method defined in the monitoring plan, the emissions for that flight may be estimated by the operator using the tools mentioned in section 4. The quantity of emissions for which such approach is used shall be specified in the annual emission report.

6. **MONITORING PLAN**

Aircraft operators shall submit their monitoring plan to the competent authority for approval at least four months prior to the start of the first reporting period.

The competent authority shall ensure that the aircraft operator reviews the monitoring plan before the start of each trading period and submits a revised monitoring plan as appropriate. Subsequent to the submission of a monitoring plan for the reporting of emissions from 1 January 2010, a review of the monitoring plan shall take place before the start of the trading period commencing in 2013.

▼M2

In performing such review, the aircraft operator shall assess to the satisfaction of the competent authority if the monitoring methodology can be changed in order to improve the quality of the reported data without leading to unreasonably high costs. Proposed changes to the monitoring methodology, if any, shall be notified to the competent authority. Substantial changes to the monitoring methodology which require an update of the monitoring plan shall be subject to the approval of the competent authority. Substantial changes include:

— a change of the average reported annual emissions which require the aircraft operator to apply a different tier as laid down in section 2.2.2,

— a change in the number of flights or in the total annual emissions which cause the aircraft operator to exceed the threshold for small emitters as laid down in section 4,

— substantial changes to the type of fuels used.

By way of derogation from Section 4.3 of Annex I, the monitoring plan shall contain the following information:

For all aircraft operators:

(1) identification of the aircraft operator, call sign or other unique designator used for air traffic control purposes, contact details of the aircraft operator and of a responsible person at the aircraft operator, contact address;

(2) identification of the version of the Monitoring Plan;

(3) an initial list of aircraft types in its fleet operated at the time of submission of the monitoring plan and the number of aircraft per type, and an indicative list of additional aircraft types expected to be used including, where available, an estimated number of aircraft per type as well as the fuel streams (fuel types) associated with each aircraft type;

(4) a description of procedures, systems and responsibilities used to track the completeness of the list of emission sources over the monitoring year, i.e. for ensuring the completeness of monitoring and reporting of the emissions of owned aircraft as well as leased-in aircraft;

(5) a description of the procedures used to monitor the completeness of the list of flights operated under the unique designator by aerodrome pair, and the procedures used for determining whether flights are covered by Annex I of Directive 2003/87/EC, ensuring completeness and avoiding double-counting;

(6) a description of data acquisition and handling activities and control activities, the quality control and assurance activities, including maintenance and calibration of measurement equipment (see section 10.3 of Annex I);

(7) where applicable, information on relevant links with activities undertaken under the Community eco-management and audit scheme (EMAS) and other environmental management systems (e.g. ISO14001:2004), in particular on procedures and controls with relevance to greenhouse gas emissions monitoring and reporting.

▼M2

In addition to points 1 to 7, for all aircraft operators, except small emitters who want to make use of the simplified procedure defined in section 4, the monitoring plan shall contain:

(8) a description of the methods for monitoring fuel consumption in both owned and leased-in aircraft, including:

(a) the chosen methodology (method A or method B) for calculation of fuel consumption; if the same method is not applied for all aircraft types, a justification for this approach is to be provided, as well as a list specifying which method is used under which conditions;

(b) procedures for measurement of fuel uplifts and fuel in tanks, including the selected tiers, a description of the measurement instruments involved and the procedures for recording, retrieving, transmitting and storing information regarding measurements, as applicable;

(c) a procedure to ensure that the total uncertainty of fuel measurements will comply with the requirements of the selected tier, referring to calibration certificates of measurement systems, national laws, clauses in customer contracts or fuel suppliers accuracy standards.

(9) the procedures for measurement of the density used for fuel uplifts and fuel in tanks, including a description of the measurement instruments involved, or if measurement is not feasible, the standard value used and a justification for this approach;

(10) emission factors used for each fuel type, or in case of alternative fuels, the methodologies for determining the emission factors, including the approach for sampling, methods of analysis, a description of the laboratories used and of their accreditation and/or of their quality assurance procedures.

In addition to points 1 to 7, for small emitters who want to make use of the simplified procedure defined in section 4, the monitoring plan shall contain:

(11) Evidence that the thresholds defined for small emitters in section 4 are met;

(12) A confirmation of which tool as described in section 4 will be used, including a description of the tool.

The competent authority may require the aircraft operator to use an electronic template for submission of the monitoring plan. The Commission may publish a standardised electronic template or file format specification. In this case the competent authority shall accept the use by the aircraft operator of this template or specification, unless the competent authority's template requires at least the same data input.

7. **REPORTING FORMAT**

Aircraft operators shall use the format set out in section 8 for reporting their annual emissions. The competent authority may require the aircraft operator to use an electronic template for submission of the annual emission report. The Commission may publish a standardised electronic template or file format specification. In this case the competent authority shall accept the use by the aircraft operator of this template or specification, unless the competent authority's template requires at least the same data input.

▼M2

Emissions shall be reported as rounded tonnes of CO_2. Emission factors shall be rounded to include only significant digits both for emission calculations and reporting purposes. Fuel consumption per flight shall be used with all significant digits for calculation.

8. **CONTENT OF THE ANNUAL EMISSION REPORT**

Each aircraft operator shall include the following information in its annual emission report:

(1) data identifying the aircraft operator as set out by Annex IV of Directive 2003/87/EC, and the call sign or other unique designators used for air traffic control purposes, as well as relevant contact details;

(2) name and address of the verifier of the report;

(3) the reporting year;

(4) reference to and version number of the relevant approved monitoring plan;

(5) relevant changes in the operations and deviations from the approved monitoring plan during the reporting period;

(6) the aircraft registration numbers and types of aircraft used in the period covered by the report to perform the aviation activities covered by Annex I of Directive 2003/87/EC carried out by the aircraft operator;

(7) the total number of flights covered by the report;

(8) the data according to Table 2;

(9) Memo-Items: amount of biomass used as fuel during the reporting year (in tonnes or m^3) listed per fuel type.

Table 2

Reporting format for annual emissions from aviation activities

Parameter	Units	Source stream			Total
		Fuel type 1	Fuel type 2	Fuel type n	
Name of fuel					
Emission sources using each type of source stream (Generic aircraft types):					
Total fuel consumption	t				
Net Calorific Value of the Fuel ([1])	TJ/t				
Emission Factor of this fuel	t CO_2/t or t CO_2/TJ				
Total aggregated CO_2 emissions from all eligible flights using this fuel	t CO_2				
of which departure MS is the same as arrival MS (domestic flights)	t CO_2				

▼M2

Parameter	Units	Source stream			Total
		Fuel type 1	Fuel type 2	Fuel type n	
of which all other flights (international flights both intra and extra EU)	t CO_2				

Aggregated CO_2 emissions from all flights of which departure Member State is the same as arrival Member State (domestic flights):

Member State 1	t CO_2				
Member State 2	t CO_2				
Member State n	t CO_2				

Aggregated CO_2 emissions from all flights departing from each Member State to another Member State or a third country ([2])**:**

Member State 1	t CO_2				
Member State 2	t CO_2				
Member State n	t CO_2				

Aggregated CO_2 emissions from all flights arriving at each Member State from a third country ([2])**:**

Member State 1	t CO_2				
Member State 2	t CO_2				
Member State n	t CO_2				

([1]) Not applicable to those commercial standard fuels listed in Table 1 of this Annex used for aviation activities.
([2]) Aggregated emissions per third country reported on a country by country basis.

Each aircraft operator shall include the following information as an annex to its annual emission report:

— Annual emissions and annual numbers of flights per aerodrome pair.

The operator may request that this annex is treated as confidential information.

9. **VERIFICATION**

In addition to the verification requirements set out in Section 10.4 of Annex I, the following shall be taken into account by the verifier:

— completeness of flight and emissions data compared to air traffic data such as collected by Eurocontrol,

— consistency between reported data and mass and balance documentation,

— consistency between aggregated fuel consumption data and data on fuel purchased or otherwise supplied to the aircraft performing the aviation activity.

▼M2

ANNEX XV

Activity specific guidelines for determination of tonne-kilometre data from aviation activities for the purpose of an application under Articles 3e or 3f of Directive 2003/87/EC

1. **INTRODUCTION**

This Annex contains the general guidelines for the monitoring, reporting and verification of tonne-kilometre data for the aviation activities listed in Annex I to Directive 2003/87/EC.

Annex I shall apply to the monitoring, reporting and verification of tonne-kilometre data as appropriate. For this purpose, the references to emissions shall be interpreted as references to tonne-kilometre data. Sections 4.1, 4.2, 5.1, 5.3 to 5.7, 6 to 7 and 11 to 16 of Annex I are not applicable to tonne-kilometre data.

2. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines of this Annex shall be used to monitor and report tonne-kilometre data from aviation activities as included in Annex I to Directive 2003/87/EC. All flights covered by Annex I of that Directive performed by an aircraft operator during the reporting period shall be included.

For the purpose of identifying the unique aircraft operator as defined by Article 3(o) of Directive 2003/87/EC responsible for a flight, the call sign used for Air Traffic Control (ATC) purposes shall be used. The call sign is the ICAO designator in box 7 of the flight plan or, if not available, the registration marking of the aircraft. If the identity of the aircraft operator is not known, the owner of the aircraft shall be regarded as the aircraft operator unless it proves which other person was the aircraft operator.

3. **THE MONITORING PLAN**

Pursuant to Article 3g of Directive 2003/87/EC aircraft operators shall submit a monitoring plan setting out measures to monitor and report tonne-kilometre data.

Aircraft operators shall submit their monitoring plan to the competent authority at least four months prior to the start of the first reporting period for approval.

The aircraft operator shall define in the monitoring plan which monitoring methodology is used for each aircraft type. In case the aircraft operator intends to use leased-in or other aircraft types which are not yet included in the monitoring plan at the time of submission to the competent authority, the aircraft operator shall include in the monitoring plan a description of the procedure to be used for defining the monitoring methodology for these additional aircraft types. The aircraft operator shall ensure that the monitoring methodology, once it has been chosen, is consistently applied.

By way of derogation from Section 4.3 of Annex I, the monitoring plan shall contain the following information:

(1) identification of the aircraft operator, call sign or other unique designators used for air traffic control purposes, contact details of the aircraft operator and of a responsible person at the aircraft operator, contact address;

(2) identification of the version of the monitoring plan;

▼M2

(3) an initial list of aircraft types in its fleet operated at the time of submission of the monitoring plan and the number of aircraft per type, and an indicative list of additional aircraft types expected to be used including, where available, an estimated number of aircraft per type;

(4) a description of procedures, systems and responsibilities used to track the completeness of the list of aircraft employed over the monitoring year, i.e. ensuring the completeness of monitoring and reporting of the tonne-kilometre data of owned aircraft as well as leased-in aircraft;

(5) a description of the procedures used to monitor the completeness of the list of flights operated under the unique designator by aerodrome pair, and the procedures used for determining whether flights are covered by Annex I of Directive 2003/87/EC, ensuring completeness and avoiding double-counting;

(6) a description of data acquisition and handling activities and control activities in accordance with section 10.3 of Annex I;

(7) information on relevant links with activities undertaken under a quality management system, in particular on procedures and controls with relevance to tonne-kilometre data monitoring and reporting, if applicable;

(8) a description of the methods for determining tonne-kilometre data per flight, including

(a) the procedures, responsibilities, data sources and calculation formulae for determination and recording of the distance per aerodrome pair;

(b) whether a standard mass of 100 kg per passenger (tier 1) is used or the passenger mass from the mass and balance documentation (tier 2). In the case of tier 2, a description of the procedure for obtaining passenger mass is to be provided;

(c) a description of the procedures used to determine the mass of freight and mail;

(d) a description of the measurement devices used for measuring mass of passengers, freight and mail as applicable.

The competent authority may require the aircraft operator to use an electronic template for submission of the monitoring plan. The Commission may publish a standardised electronic template or file format specification. In this case the competent authority shall accept the use by the aircraft operator of this template or specification, unless the competent authority's template requires at least the same data input.

4. METHODOLOGIES FOR CALCULATING TONNE-KILOMETRE DATA

4.1. CALCULATION FORMULA

Aircraft operators shall monitor and report tonne-kilometre data using a calculation-based methodology. Calculation of tonne-kilometre data shall be based on the following formula:

tonne kilometres (t km) = distance (km) * payload (t)

▼M2

4.2. DISTANCE

Distance shall be calculated using the formula:

Distance [km] = Great Circle Distance [km] + 95 km

The Great Circle Distance is defined as the shortest distance between any two points on the surface of the Earth, which shall be approximated using the system referred to in Article 3.7.1.1 of Annex 15 to the Chicago Convention (WGS 84).

The latitude and longitude of aerodromes shall be taken either from aerodrome location data published in Aeronautical Information Publications (hereinafter AIP) in compliance to Annex 15 of the Chicago Convention or from a source using such AIP data.

Distances calculated by software or by a third party may also be used, provided that the calculation methodology is based on the above formula and AIP data.

4.3. PAYLOAD

Payload shall be calculated using the following formula:

Payload (t) = mass of freight and mail (t) + mass of passengers and checked baggage (t)

4.3.1. *MASS OF FREIGHT AND MAIL*

Actual or standard mass contained in the mass and balance documentation for the relevant flights shall be used for calculating payload. Aircraft operators which are not required to have a mass and balance documentation shall propose a suitable methodology for determining mass of freight and mail in the monitoring plan for approval by the competent authority.

The actual freight and mail mass shall exclude the tare weight of all pallets and containers that are not payload, and the service weight.

4.3.2. *MASS OF PASSENGERS AND CHECKED BAGGAGE*

Aircraft operators may apply one of two different tiers to determine the mass of passengers. The aircraft operator may select as a minimum the Tier 1 level to determine the mass of passengers and checked baggage. Within the same trading period the chosen tier shall be applied to all flights.

Tier 1

A default value of 100 kg for each passenger and their checked baggage is used.

Tier 2

The mass for passengers and checked baggage contained in the mass and balance documentation for each flight is used.

5. **UNCERTAINTY ASSESSMENT**

The aircraft operator shall have an understanding of the main sources of uncertainty when calculating tonne-kilometre data. A detailed uncertainty analysis as set out in Section 7 of Annex I is not required for the methodology of tonne-kilometre data determination.

▼M2

The aircraft operator shall carry out regularly suitable control activities as set out by section 10.2 and 10.3 of Annex I, and take immediately corrective action in accordance with section 10.3.5 if irregularities are observed.

6. **REPORTING**

Reporting of tonne-kilometre data is required for the purpose of applications pursuant to Articles 3e and 3f of Directive 2003/87/EC in respect of the monitoring years specified therein only.

Aircraft operators shall use the format set out in section 7 below for reporting their tonne-kilometre data. The competent authority may require the aircraft operator to use an electronic template for submission of the tonne-kilometre data report. The Commission may publish a standardised electronic template or file format specification. In this case the competent authority shall accept the use by the aircraft operator of this template or specification, unless the competent authority's template requires at least the same data input.

Tonne-kilometres shall be reported as rounded values of [t km]. All data per flight shall be used with all significant digits for calculation.

7. **CONTENT OF THE REPORT ON TONNE-KILOMETRE DATA**

Each aircraft operator shall include the following information in its report on tonne-kilometre data:

(1) data identifying the aircraft operator as set out by Annex IV of Directive 2003/87/EC, and the call sign or other unique designator used for air traffic control purposes, as well as relevant contact details;

(2) name and address of the verifier of the report;

(3) the reporting year;

(4) reference to and version number of the relevant approved monitoring plan;

(5) relevant changes in the operations and deviations from the approved monitoring plan during the reporting period;

(6) the aircraft registration numbers and types of aircraft used in the period covered by the report to perform the aviation activities covered by Annex I of Directive 2003/87/EC carried out by the aircraft operator;

(7) chosen method for calculation of mass for passengers and checked baggage, as well as for freight and mail;

(8) total number of passenger kilometres and tonne-kilometres for all flights performed during the year to which the report relates falling within the aviation activities listed in Annex I;

(9) for each aerodrome pair: ICAO designator of the two aerodromes, distance (= great circle distance + 95 km) in km, total number of flights per aerodrome pair in the reporting period, total mass of passengers and checked baggage (tonnes) during the reporting period per aerodrome pair, total number of passengers during the reporting period, total number of passenger * kilometres per aerodrome pair, total mass of freight and mail (tonnes) during the reporting period per aerodrome pair, total tonne-kilometres per aerodrome pair (t km).

▼M2

8. **VERIFICATION**

In addition to the verification requirements set out in Section 10.4 of Annex I, the following shall be taken into account by the verifier:

— completeness of flight and tonne-kilometre data compared to air traffic data such as collected by Eurocontrol to ascertain that only eligible flights have been taken into account in the operators report,

— consistency between reported data and mass and balance documentation,

For tonne-kilometre data, the materiality level shall be 5 %.

▼M3

ANNEX XVI

Activity-specific guidelines for determination of greenhouse gas emissions from CO_2 capture activities for the purposes of transport and geological storage in a storage site permitted under Directive 2009/31/EC of the European Parliament and of the Council

1. BOUNDARIES AND COMPLETENESS

The activity-specific guidelines contained in this Annex apply to the monitoring of emissions from CO_2 capture activities.

CO_2 capture can be performed either by dedicated installations receiving CO_2 by transfer from other installations, or by installations carrying out the activities emitting the CO_2 to be captured under the same greenhouse gas emissions permit. All parts of the installation related to the purpose of CO_2 capture, intermediate storage, transfer to a CO_2 transport network or to a site for geological storage of CO_2 greenhouse gas emissions shall be included in the greenhouse gas emissions permit. In case the installation carries out other activities covered by Directive 2003/87/EC, the emissions of these activities shall be monitored in accordance with the respective Annexes of these Guidelines.

2. EMISSIONS FROM CO_2 CAPTURE ACTIVITIES

In CO_2 capture operations potential emission sources for CO_2 include:

— CO_2 transferred to the capture installation,

— combustion and other associated activities at the installation (capture-related), i.e., fuel and input material use.

3. QUANTIFICATION OF TRANSFERRED AND EMITTED CO_2 AMOUNTS

3.1. INSTALLATION LEVEL QUANTIFICATION

Emissions are calculated using a complete mass-balance, taking into account the potential CO_2 emissions from all emission relevant processes at the installation as well as the amount of CO_2 captured and transferred to the transport network.

The emissions of the installation shall be calculated using the following formula:

$$E_{capture\ installation} = T_{input} + E_{without\ capture} - T_{for\ storage}$$

With:

$E_{capture\ installation}$ = Total greenhouse gas emissions of the capture installation

▼**M3**

T_{input} = Amount of CO_2 transferred to the capture installation, determined in accordance with Annex XII and Section 5.7 of Annex I; If the operator can demonstrate to the satisfaction of the competent authority that the total CO_2 emissions of the emitting installation are transferred to the capture installation, the competent authority may allow the operator to use the emissions of the emitting installation determined pursuant to Annexes I to XII ►**M4** and XIX to XXIV ◄ instead of using CEMS.

$E_{without\ capture}$ = Emissions of the installation if the CO_2 were not captured, i.e. the sum of the emissions from all other activities at the installation, monitored in accordance with the respective Annexes;

$T_{for\ storage}$ = Amount of CO_2 transferred to a transport network or a storage site, determined in accordance with Annex XII and section 5.7 of Annex I.

In cases, in which CO_2 capture is carried out by the same installation as the one from which the captured CO_2 originates, T_{input} is zero.

In cases of stand-alone capture installations, $E_{without\ capture}$ represents the amount of emissions that occur from other sources than the CO_2 transferred to the installation for capture, such as combustion emissions from turbines, compressors, heaters. These emissions can be determined by calculation or measurement in accordance with the appropriate activity specific Annex.

In the case of stand-alone capture installations, the installation transferring CO_2 to the capture installation shall deduct the amount T_{input} from its own emissions.

3.2. DETERMINATION OF TRANSFERRED CO_2

The amount of CO_2 transferred from and to the capture installation shall be determined in accordance with Section 5.7 of Annex I by means of CEMS carried out in accordance with Annex XII. As a minimum, Tier 4 as defined in Annex XII shall be applied. Only if it is shown to the satisfaction of the competent authority that this tier approach is technically not feasible, may a next lower tier be used for the relevant emission source.

▼M3

ANNEX XVII

Activity-specific guidelines for determination of greenhouse gas emissions from the transport of CO_2 by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC

1. **BOUNDARIES AND COMPLETENESS**

The boundaries for monitoring and reporting of emissions from CO_2 transport by pipeline are laid down in the transport network's greenhouse gas emissions permit, including all installations functionally connected to the transport network, including booster stations and heaters. Each transport network has as a minimum one starting point and one ending point, each connected to other installations carrying out one or more of the activities capture, transport or geological storage of CO_2. Starting and ending points can include bifurcations of the transport network and national borders. Starting and ending points as well as the installations they are connecting to, shall be laid down in the greenhouse gas emissions permit.

2. **QUANTIFICATION OF CO_2 EMISSIONS**

During the transport of CO_2 by pipeline, potential emission sources for CO_2 emissions include:

— combustion and other processes at installations functionally connected to the transport network, e.g. booster stations,

— fugitive emissions from the transport network,

— vented emissions from the transport network,

— emissions from leakage incidents in the transport network.

A transport network using Method B below shall not add to its calculated level of emissions CO_2 received from another ETS installation, and shall not subtract from its calculated level of emissions any CO_2 which is transferred to another ETS installation.

2.1. QUANTIFICATION APPROACHES

Operators of transport networks may choose one of the following approaches:

METHOD A

The emissions of the transport network are determined using a mass balance according to the following formula:

$$Emissions\ [tCO_2] = E_{own\ activity} + \sum_i T_{IN,i} - \sum_j T_{OUT,j}$$

With:

Emissions = Total CO_2 emissions of the transport network [t CO_2];

$E_{own\ activity}$ = Emissions from the transport network's own activity (i.e. not stemming from CO_2 transported), like from fuel use in booster stations, monitored in accordance with the respective Annexes of these Guidelines;

▼**M3**

$T_{IN,i}$ = Amount of CO_2 transferred to the transport network at entry point *i*, determined in accordance with Annex XII and Section 5.7 of Annex I;

$T_{OUT,j}$ = Amount of CO_2 transferred out of the transport network at exit point *j*, determined in accordance with Annex XII and Section 5.7 of Annex I.

METHOD B

Emissions shall be calculated taking into account the potential CO_2-emissions from all emission relevant processes at the installation as well as the amount of CO_2 captured and transferred to the transport facility, using the following formula:

$$Emissions\ [tCO_2] = CO_{2\ fugitive} + CO_{2\ vented} + CO_{2\ leakage\ events} + CO_{2\ installations}$$

With:

Emissions = Total CO_2 emissions of the transport network [tCO_2];

$CO_{2\ fugitive}$ = Amount of fugitive emissions [tCO_2] from CO_2 transported in the transport network, including from seals, valves, intermediate compressor stations and intermediate storage facilities;

$CO_{2\ vented}$ = Amount of vented emissions [tCO_2] from CO_2 transported in the transport network;

$CO_{2\ leakage\ events}$ = Amount of CO_2 [tCO_2] transported in the transport network, which is emitted as the result of failure of one or more components of the transport network;

$CO_{2\ installations}$ = Amount of CO_2 [tCO_2] being emitted from combustion or other processes functionally connected to the pipeline transport in the transport network, monitored in accordance with the respective Annexes of these Guidelines.

2.2. QUANTIFICATION REQUIREMENTS

In choosing either Method A or Method B, the operator has to demonstrate to the competent authority that the chosen methodology will lead to more reliable results with lower uncertainty of the overall emissions, using best available technology and knowledge at the time of application for the greenhouse gas emissions permit, without leading to unreasonable costs. If Method B is chosen the operator shall demonstrate to the satisfaction of the competent authority that the overall uncertainty for the annual level of greenhouse gas emissions for the operator's transport network does not exceed 7,5 %.

2.2.1. SPECIAL REQUIREMENTS FOR METHOD A

The amount of CO_2 transferred from and to the transport network shall be determined in accordance with Section 5.7 of Annex I by means of CEMS carried out in accordance with Annex XII. As a minimum, Tier 4 as defined in Annex XII shall be applied. Only if it is shown to the satisfaction of the competent authority that this tier approach is technically not feasible, may a next lower tier be used for the relevant emission source.

▼M3

2.2.2. SPECIAL REQUIREMENTS FOR METHOD B

2.2.2.1. *Combustion emissions*

Potential combustion emissions from fuel use shall be monitored in accordance with Annex II.

2.2.2.2. *Fugitive emissions from the transport network*

Fugitive emissions include the emissions from the following types of equipment:

— seals,

— measurement devices,

— valves,

— intermediate compressor stations,

— intermediate storage facilities.

Average emission factors *EF* (expressed in g CO_2/unit time) per piece of equipment/occurrence where fugitive emissions can be expected shall be determined by the operator at the beginning of operation, and at the latest by the end of the first reporting year in which the transport network is in operation. These factors shall be reviewed by the operator at least every 5 years in the light of the best available techniques in this field.

Overall emissions shall be calculated by multiplying the number of pieces of equipment in each category by the emission factor and adding up the results for the single categories as shown in the equation below:

$$Fugitive\ Emissions\ [t\mathrm{CO}_2] = \left(\sum_{Category} EF[gCO_2/occurrence] \times number\ of\ occurences\right)/1\ 000\ 000$$

The number of occurrences is the number of pieces of the given equipment per category, multiplied by the number of time units per year.

2.2.2.3. *Emissions from leakage events*

The operator of the transport network shall provide proof of the network integrity by using representative (spatial and time-related) temperature and pressure data. If the data indicates that a leakage has occurred, the operator shall calculate the amount of CO_2 leaked with a suitable methodology documented in the monitoring plan, based on industry best practice guidelines, e.g. by using the differences in temperature and pressure data compared to integrity related average pressure and temperature values.

2.2.2.4. *Vented emissions*

The operator shall provide in the monitoring plan an analysis regarding potential situations of venting emissions, including for maintenance or emergency reasons, and provide a suitable documented methodology to calculate the amount of CO_2 vented, based on industry best practice guidelines.

2.2.2.5. *Validation of calculation result for fugitive and leaked emissions*

Given that monitoring of CO_2 transferred to and from the transport network will in any case be carried out for commercial reasons, the operator of a transport network shall use Method A for validation of the results of Method B at least once annually. In this regard, for measurement of transferred CO_2 lower tiers defined in Annex XII may be used.

▼M3

ANNEX XVIII

Activity-specific guidelines for the geological storage of CO_2 in a storage site permitted under Directive 2009/31/EC

1. **BOUNDARIES**

Boundaries for monitoring and reporting of emissions from geological storage of CO_2 shall be site-specific and shall be based on the delimitation of the storage site and storage complex as specified in the permit pursuant Directive 2009/31/EC. All emission sources from the CO_2 injection facility shall be included in the greenhouse gas emissions permit. Where leakages from the storage complex are identified and lead to emissions or release of CO_2 to the water column, they shall be included as emission sources for the respective installation until corrective measures pursuant to Article 16 of Directive 2009/31/EC have been taken and emissions or release into the water column from that leakage can no longer be detected.

2. **DETERMINATION OF CO_2 EMISSIONS**

Potential emissions sources for CO_2 emissions from the geological storage of CO_2 include:

— fuel use at booster stations and other combustion activities such as on-site power plants,

— venting at injection or at enhanced hydrocarbon recovery operations,

— fugitive emissions at injection,

— breakthrough CO_2 from enhanced hydrocarbon recovery operations,

— leakage.

A storage site shall not add to its calculated level of emissions CO_2 received from another installation, and shall not subtract from its calculated level of emissions any CO_2 which is transferred to another installation or geologically stored in the storage site.

2.1. EMISSIONS FROM FUEL USE

Combustion emissions from above ground activities shall be determined in accordance with Annex II.

2.2. VENTED AND FUGITIVE EMISSIONS FROM INJECTION

Emissions from venting and fugitive emissions shall be determined as follows:

$$CO_2 \text{ emitted } [tCO_2] = V\ CO_2\ [tCO_2] + F\ CO_2\ [tCO_2]$$

With

$V\ CO_2$ = amount of CO_2 vented

$F\ CO_2$ = amount of CO_2 from fugitive emissions

V CO_2 shall be determined by using CEMS according to Annex XII of these Guidelines. If the application of CEMS would lead to unreasonable costs, the operator may include in the monitoring plan an appropriate methodology based on industry best practice, subject to approval by the competent authority.

▼M3

F CO_2 shall be considered as one source, meaning that the uncertainty requirements of Annex XII and Section 6.2 of Annex I apply to the total value and not to the individual emission points. The operator shall provide in the monitoring plan an analysis regarding potential sources of fugitive emissions, and provide a suitable documented methodology to calculate or measure the amount of F CO_2, based on industry best practice guidelines. For the determination of F CO_2 data collected pursuant to Article 13 and Annex II 1.1 (e) – (h) of Directive 2009/31/EC for the injection facility can be used, where they comply with the requirements of these Guidelines.

2.3. VENTED AND FUGITIVE EMISSIONS FROM ENHANCED HYDROCARBON RECOVERY OPERATIONS

The combination of enhanced hydrocarbon recovery (EHR) with geological storage of CO_2 is likely to provide an additional source stream of emissions, namely the breakthrough of CO_2 with the produced hydrocarbons. Additional emission sources from EHR operations include:

— the oil-gas separation units and gas recycling plant, where fugitive emissions of CO_2 could occur,

— the flare stack, where emissions might occur due to the application of continuous positive purge systems and during depressurisation of the hydrocarbon production installation,

— the CO_2 purge system, to avoid that high concentrations of CO_2 extinguish the flare.

Any fugitive emissions occurring will usually be rerouted in a gas containment system, to the flare or CO_2 purge system. Any such fugitive emissions or CO_2 vented e.g. from the CO_2 purge system shall be determined in accordance to Section 2.2 of this Annex.

Emissions from the flare stack shall be determined in accordance with Annex II, taking into account potential inherent CO_2 in the flare gas.

3. **LEAKAGE FROM THE STORAGE COMPLEX**

Monitoring shall start in the case that any leakage results in emissions or release to the water column. Emissions resulting from a release of CO_2 into the water column shall be deemed to be equal to the amount released to the water column.

Monitoring of emissions or of release into the water column from a leakage shall continue until corrective measures pursuant to Article 16 of Directive 2009/31/EC have been taken and emissions or release into the water column can no longer be detected.

Emissions and release to the water column shall be quantified as follows:

$$CO_2 \text{ emitted } [tCO_2] = \sum_{T_{Start}}^{T_{End}} L\ CO_2\ [tCO_2/d]$$

▼**M3**

With

$L\ CO_2$ = mass of CO_2 emitted or released per calendar day due to the leakage. For each calendar day for which leakage is monitored it shall be calculated as the average of the mass leaked per hour [tCO2/h] multiplied by 24. The mass leaked per hour shall be determined according to the provisions in the approved monitoring plan for the storage site and the leakage. For each calendar day prior to commencement of monitoring, the mass leaked per day shall be taken to equal the mass leaked per day for the first day of monitoring.

T_{start} = the latest of:

(a) the last date when no emissions or release to the water column from the source under consideration were reported;

(b) the date the CO_2 injection started;

(c) another date such that there is evidence demonstrating to the satisfaction of the competent authority that the emission or release to the water column cannot have started before that date.

T_{end} = the date by which corrective measures pursuant to Article 16 of Directive 2009/31/EC have been taken and emissions or release to the water column can no longer be detected.

Other methods for quantification of emissions or release into the water column from leakages can be applied if approved by the competent authority on the basis of providing a higher accuracy than the above approach.

The amount of emissions leaked from the storage complex shall be quantified for each of the leakage events with a maximum overall uncertainty over the reporting period of ± 7,5 %. In case the overall uncertainty of the applied quantification approach exceeds ± 7,5 %, an adjustment shall be applied, as follows:

$$CO_{2,\ Reported}\ [tCO_2] = CO_{2,\ Quantified}\ [tCO_2] \times (1 + (Uncertainty_{System}\ [\%]/100) - 0{,}075)$$

With

$CO_{2,\ Reported}$: Amount of CO_2 to be included into the annual emission report with regards to the leakage event in question;

$CO_{2,\ Quantified}$: Amount of CO_2 determined through the used quantification approach for the leakage event in question;

$Uncertainty_{System}$: The level of uncertainty which is associated to the quantification approach used for the leakage event in question, determined according to section 7 of Annex I to these guidelines.

▼M4

ANNEX XIX

Activity-specific guidelines for the production of soda ash and sodium bicarbonate as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines in this Annex shall be applied for emissions from installations for the production of soda ash and sodium bicarbonate as listed in Annex I to Directive 2003/87/EC.

2. **DETERMINATION OF CO_2 EMISSIONS**

In installations for the production of soda ash and sodium bicarbonate emission sources and source streams for CO_2 emissions include:

— fuels used for combustion processes, e.g. with the purpose of producing hot water or steam,

— raw materials (e.g. vent gas from calcination of limestone, to the extent it is not used for carbonation),

— waste gases from washing or filtration steps after carbonation, to the extent they are not used for carbonation.

2.1. CALCULATION OF CO_2 EMISSIONS

As soda ash and sodium bicarbonate contain carbon stemming from the process inputs, the calculation of process emissions shall be based on a mass balance approach pursuant to Section 2.1.1. Emissions from the combustion of fuels can either be monitored separately pursuant to Section 2.1.2 or be taken into account in the mass balance approach.

2.1.1. *MASS-BALANCE APPROACH*

The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the installation to determine the level of emissions of greenhouse gases over the reporting period, except for emission sources monitored in accordance with Section 2.1.2 of this Annex. The amount of CO_2 used for producing sodium bicarbonate from soda ash shall be considered as emitted. The following equation shall be used:

$$CO_2 \text{ emissions } [t\ CO_2] = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

With:

— *input [t C]:* all carbon entering the boundaries of the installation,

— *products [t C]:* all carbon in products ([1]) and materials, including by-products, leaving the boundaries of the installation,

— *export [t C]:* carbon exported from the boundaries of the installation in liquid and/or solid phases, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases or carbon monoxide into the atmosphere,

([1]) For the purpose of this mass balance all sodium bicarbonate produced from soda ash shall be treated as soda ash.

▼M4

— *stock changes [t C]:* stock increases of carbon within the boundaries of the mass balance.

The calculation shall then be as follows:

$$CO_2 \text{ emissions [t } CO_2\text{]} = (\Sigma \text{ (activity data}_{input} * \text{carbon content}_{input}) - \Sigma \text{ (activity data}_{products} * \text{carbon content}_{products}) - \Sigma \text{ (activity data}_{export} * \text{carbon content}_{export}) - \Sigma \text{ (activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [t C/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or in other activity-specific Annexes to these Guidelines. The carbon content is derived as follows:

$$\text{C content [t/t or TJ]} = \text{Emission factor [t } CO_2\text{/t or TJ]}/3{,}664 \text{ [t } CO_2\text{/t C]}$$

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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 carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

▼**M4**

2.1.2. *COMBUSTION EMISSIONS*

Emissions from combustion of fuels shall be monitored and reported in accordance with Annex II, unless they are taken into account in the mass balance under Section 2.1.1.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annexes I and XII shall be applied.

▼M4

ANNEX XX

Activity-specific guidelines for the production of ammonia as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines contained in this Annex shall be used to monitor emissions from installations producing ammonia as listed in Annex I to Directive 2003/87/EC.

Ammonia production installations can be part of integrated installations in the chemical or refinery industry causing an intensive energy and material exchange. CO_2 emissions may occur from combustion of fuels as well as from fuels used as process input for the production of ammonia. In a number of ammonia producing installations CO_2 resulting from the production process is captured and used for other production processes, e.g. for the production of urea. Such captured CO_2 shall be accounted for as emitted.

2. **DETERMINATION OF CO_2 EMISSIONS**

In installations for the production of ammonia, CO_2 emissions result from the following emission sources and source streams:

— combustion of fuels supplying the heat for reforming or partial oxidation,

— fuels used as process input in the ammonia production process (reforming or partial oxidation),

— fuels used for other combustion processes, e.g. with the purpose of producing hot water or steam.

2.1. CALCULATION OF CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

Emissions from combustion of fuels not used as process input shall be monitored and reported in accordance with Annex II.

2.1.2. *EMISSIONS FROM FUEL USED AS PROCESS INPUT FOR AMMONIA PRODUCTION*

Emissions from fuel used as process input shall be monitored and reported in accordance with Annex II.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annexes I and XII shall be applied.

▼M4

ANNEX XXI

Activity-specific guidelines for the production of hydrogen and synthesis gas as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines contained in this Annex shall be used to monitor emissions from installations producing hydrogen or synthesis gas as listed in Annex I to Directive 2003/87/EC. Where hydrogen production is technically integrated in a mineral oil refinery, the operator of such installation shall use the relevant provisions of Annex III instead.

Installations for the production of hydrogen or synthesis gas can be part of integrated installations in the chemical or refinery industry causing an intensive energy and material exchange. CO_2 emissions may occur from combustion of fuels as well as from fuels used as process input.

2. **DETERMINATION OF CO_2 EMISSIONS**

In installations for the production of hydrogen or synthesis gas, CO_2 emissions result from the following emission sources and source streams:

— fuels used in the hydrogen or synthesis gas production process (reforming or partial oxidation),

— fuels used for other combustion processes, e.g. with the purpose of producing hot water or steam.

2.1. CALCULATION OF CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

Emissions from combustion of fuels not used as process input for the production of hydrogen or synthesis gas production, but for other combustion processes shall be monitored and reported in accordance with Annex II.

2.1.2. *EMISSIONS FROM FUEL USED AS PROCESS INPUT*

Emissions from fuels used as process input in hydrogen production shall be calculated using the input-related methodology laid down under Section 2.1.2.1. For synthesis gas production a mass balance as under Section 2.1.2.2 shall be used. Where hydrogen and synthesis gas are produced at the same installation, the operator may choose to calculate the respective emissions from both production processes using one mass balance according to Section 2.1.2.2.

2.1.2.1. HYDROGEN PRODUCTION

Emissions from fuel used as process input shall be calculated using the formula

$$CO_2 \text{ emissions} = \text{activity data} * \text{emission factor}$$

where

— activity data is expressed as the net energy content of the fuel used as process input [TJ] or, when a mass or volume related emission factor is used, as the amount of fuel used as process input [t or Nm^3],

▼M4

— emission factor is expressed as tonnes CO_2/TJ or as tonnes CO_2/t or as tonnes CO_2/Nm^3 of fuel used as process input.

The following tier requirements shall be applied:

(a) ***Activity data***

Activity data are generally expressed as the net energy content of the fuel used [TJ] during the reporting period. The energy content of the fuel used shall be calculated by means of the following formula:

Energy content of fuel used [TJ] = fuel used [t or Nm^3] * net calorific value of fuel [TJ/t or TJ/Nm^3]

In case a mass or volume related emission factor [t CO_2/t or t CO_2/Nm^3] is used, activity data are expressed as the amount of fuel used [t or Nm^3].

With:

(a1) **Fuel used**

Tier 1

Amount of fuel used as process input [t or Nm^3] processed during the reporting period, derived with a maximum uncertainty of ± 7,5 %.

Tier 2

Amount of fuel used as process input [t or Nm^3] processed during the reporting period, derived with a maximum uncertainty of ± 5,0 %.

Tier 3

Amount of fuel used as process input [t or Nm^3] processed during the reporting period, derived with a maximum uncertainty of ± 2,5 %.

Tier 4

Amount of fuel used as process input [t or Nm^3] processed during the reporting period, derived with a maximum uncertainty of ± 1,5 %.

(a2) **Net calorific value**

Tier 1

Reference values for each fuel are used as specified in Section 11 of Annex I.

Tier 2a

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 2b

For commercially traded fuels the net calorific value as derived from the purchasing records for the respective fuel provided by the fuel supplier is used, provided it has been derived based on accepted national or international standards.

▼M4

Tier 3

The net calorific value representative for the fuel in an installation is measured by the operator, a contracted laboratory or the fuel supplier in accordance with the provisions of Section 13 of Annex I.

(b) ***Emission factor***

Tier 1

The reference values listed in Section 11 of Annex I to these guidelines are used.

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 the fuel based on one of the following established proxies:

— density measurement of specific oils or gases common e.g. to the refinery or steel industry, and

— net calorific value for specific coal types,

in combination with an empirical correlation as determined at least once per year according to the provisions of Section 13 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

Use of an activity-specific emission factor [CO_2/TJ or CO_2/t or CO_2/Nm^3 feed] calculated from the carbon content of the fuel used, determined according to Section 13 of Annex I.

2.1.2.2. PRODUCTION OF SYNTHESIS GAS

As part of the carbon in the fuels used as process input is contained in the produced synthesis gas, a mass balance approach is to be used for the calculation of greenhouse gas emissions.

The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the installation to determine the level of emissions of greenhouse gases over the reporting period, except for emission sources monitored in accordance with Section 2.1.1 and 2.1.2.1 of this Annex. The following equation shall be used:}-\curr\hscale105%{\vskip-0.5pc\hskip3pc

$$CO_2 \text{ emissions [t } CO_2\text{]} = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

With:

— input [t C]: all carbon entering the boundaries of the installation,

— products [t C]: all carbon in products and materials, including by-products, leaving the boundaries of the installation,

▼M4

— export [t C]: carbon exported from the boundaries of the installation, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases or carbon monoxide into the atmosphere,

— stock changes [t C]: stock increases of carbon within the boundaries of the mass balance.

The calculation shall then be as follows:

$$CO_2 \text{ emissions [t } CO_2\text{]} = (\Sigma (\text{activity data}_{input} * \text{carbon content}_{input}) - \Sigma (\text{activity data}_{products} * \text{carbon content}_{products}) - \Sigma (\text{activity data}_{export} * \text{carbon content}_{export}) - \Sigma (\text{activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [t C/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or in other activity-specific Annexes to these Guidelines. The carbon content is derived as follows:

$$\text{C content [t/t or TJ]} = \text{Emission factor [t } CO_2\text{/t or TJ]}/3{,}664 \text{ [t } CO_2\text{/t C]}$$

Tier 2

The operator applies country-specific carbon contents for the respective fuel or material 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.

▼**M4**

Tier 3

The carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annexes I and XII shall be applied.

▼M4

ANNEX XXII

Activity-specific guidelines for the production of bulk organic chemicals as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines contained in this Annex shall be used to monitor emissions from the production of bulk organic chemicals as listed in Annex I to Directive 2003/87/EC. Where such production is technically integrated in a mineral oil refinery, the operator of such installation shall use the relevant provisions of Annex III instead, especially for emissions from catalytic crackers.

Installations for the production of bulk organic chemicals can be part of integrated installations in the chemical or refinery industry causing an intensive energy and material exchange. CO_2 emissions may occur from combustion of fuels as well as from fuels or materials used as process input.

2. **DETERMINATION OF CO_2 EMISSIONS**

Potential emission sources for CO_2 include fuels and input materials of the following processes:

— cracking (catalytic and non-catalytic),

— reforming,

— partial or full oxidation,

— similar processes which lead to CO_2 emissions from carbon contained in hydrocarbon-based feedstock,

— combustion of waste gases and flaring,

— other combustion of fuel for supply of heat to the abovementioned processes.

2.1. CALCULATION OF CO_2 EMISSIONS

In case of combustion processes where the fuels used do not take part in or stem from chemical reactions for the production of bulk organic chemicals, e.g. for generating process heat or electricity, the emissions shall be monitored and reported pursuant to Section 2.1.1. In all other cases the emissions from bulk organic chemicals production shall be calculated using a mass-balance approach laid down in Section 2.1.2. All CO in the flue gas shall be accounted for as CO_2. Based on the approval of the competent authority, an input-based approach such as presented in Annex II, taking into account industry best practice can be used instead of a mass-balance approach if the operator can show that this is more cost-efficient and leads to a comparable accuracy level.

2.1.1. *COMBUSTION EMISSIONS*

Emissions from combustion processes shall be monitored and reported in accordance with Annex II. If waste gas scrubbing is carried out at the installation and the resulting emissions are not calculated using the mass balance pursuant to Section 2.1.2, they shall be calculated in accordance with Annex II.

▼**M4**

2.1.2. *MASS-BALANCE APPROACH*

The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the installation to account for the emissions of greenhouse gases, except for emission sources monitored in accordance with Section 2.1.1 of this Annex. The following equation shall be used:

$$\text{Emissions [t } CO_2\text{]} = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

With:

— *input [t C]:* all carbon entering the boundaries of the installation,

— *products [t C]:* all carbon in products and materials, including by-products, leaving the boundaries of the installation,

— *export [t C]:* carbon exported from the boundaries of the installation, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases or carbon monoxide into the atmosphere,

— *stock changes [t C]:* stock increases of carbon within the boundaries of the installation.

The calculation shall then be as follows:

$$CO_2 \text{ emissions [t } CO_2\text{]} = (\Sigma\,(\text{activity data}_{\text{input}} * \text{carbon content}_{\text{input}}) - \Sigma\,(\text{activity data}_{\text{products}} * \text{carbon content}_{\text{products}}) - \Sigma\,(\text{activity data}_{\text{export}} * \text{carbon content}_{\text{export}}) - \Sigma\,(\text{activity data}_{\text{stock changes}} * \text{carbon content}_{\text{stock changes}})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [t C/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5,0 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

▼M4

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

The carbon content of input or output streams shall be derived from reference emission factors for fuels or materials listed in Section 11 of Annex I, in the Table below or in other activity-specific Annexes to these Guidelines. The carbon content is derived as follows:

$$\text{C content [t/t or TJ]} = \text{Emission factor [t } CO_2\text{/t or TJ]}/3{,}664 \text{ [t } CO_2\text{/t C]}$$

For substances not listed in Section 11 of Annex I or in other activity-specific Annexes to these Guidelines, operators may calculate the carbon content from the stoichiometric carbon content in the pure substance and the concentration of the substance in the input or output stream.

Table

Reference Emission Factors ([1])

Substance	Carbon content (t C/t feedstock or t C/t product)
Acetonitril	0,5852 t C/t
Acrylonitrile	0,6664 t C/t
Butadiene	0,888 t C/t
Carbon Black	0,97 t C/t
Ethylene	0,856 t C/t
Ethylene dichloride	0,245 t C/t
Ethylene glycol	0,387 t C/t
Ethylene oxide	0,545 t C/t
Hydrogen cyanide	0,4444 t C/t
Methanol	0,375 t C/t
Methane	0,749 t C/t
Propane	0,817 t C/t
Propylene	0,8563 t C/t
Vinyl chloride monomer	0,384 t C/t

([1]) See IPCC 2006 Guidelines for National Greenhouse Gas Inventories.

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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.

▼**M4**

Tier 3

The carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annexes I and XII shall be applied.

▼M4

ANNEX XXIII

Activity-specific guidelines for the production or processing of ferrous and non-ferrous metals as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines in this Annex shall be applied for emissions from the production or processing of ferrous and non-ferrous metals as listed in Annex I to Directive 2003/87/EC except for production of pig iron and steel and primary aluminium.

2. **DETERMINATION OF CO_2 EMISSIONS**

In installations for the production or processing of ferrous and non-ferrous metals emission sources and source streams for CO_2 emissions include:

— conventional fuels (e.g. natural gas, coal and coke, or fuel oil),

— other fuels (plastics, e.g. from recycling of batteries, or granulated (organic) material from post shredder plants),

— reducing agents (e.g. coke or graphite electrodes),

— raw materials (e.g. calcination of limestone, dolomite, and carbon containing metal ores and concentrates),

— secondary feed materials (e.g. organic materials contained in scrap).

2.1. CALCULATION OF CO_2 EMISSIONS

In installations where carbon stemming from fuels or input materials used at this installation remains in the products or other outputs of the production, e.g. for the reduction of metal ores, a mass balance approach shall be applied (see Section 2.1.1). In installations where this is not the case combustion emissions and process emissions shall be calculated separately (see Sections 2.1.2 and 2.1.3).

2.1.1. *MASS-BALANCE APPROACH*

The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the installation to determine the level of emissions of greenhouse gases over the reporting period, using the following equation:

$$\text{Emissions [t } CO_2\text{]} = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

With:

— *input [t C]:* all carbon entering the boundaries of the installation,

— *products [t C]:* all carbon in products and materials, including by-products, leaving the boundaries of the installation,

— *export [t C]:* carbon exported from the boundaries of the installation, e.g. discharged to sewer, deposited into landfill or through losses. Export does not include the release of greenhouse gases or carbon monoxide into the atmosphere,

▼M4

— *stock changes [t C]:* stock increases of carbon within the boundaries of the mass balance.

The calculation shall then be as follows:

$$CO_2 \text{ emissions [t } CO_2\text{]} = (\Sigma \text{ (activity data}_{input} * \text{carbon content}_{input}) - \Sigma \text{ (activity data}_{products} * \text{carbon content}_{products}) - \Sigma \text{ (activity data}_{export} * \text{carbon content}_{export}) - \Sigma \text{ (activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [t C/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

(b) ***carbon content***

Tier 1

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or in other activity-specific Annexes to these Guidelines. The carbon content is derived as follows:

$$\text{C content [t/t or TJ]} = \text{Emission factor [t } CO_2\text{/t or TJ]}/3{,}664 \text{ [t } CO_2\text{/t C]}$$

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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 carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

▼M4

2.1.2. *COMBUSTION EMISSIONS*

Emissions from combustion processes taking place at installations for the production or processing of ferrous and non-ferrous metals that are not monitored using a mass balance approach, shall be monitored and reported in accordance with Annex II.

2.1.3. *PROCESS EMISSIONS*

For each type of input material used the amount of CO_2 shall be calculated as follows:

$$CO_2 \text{ emissions} = \Sigma \text{ activity data}_{\text{process input}} * \text{emission factor} * \text{conversion factor}$$

With:

(a) ***activity data***

Tier 1

Amounts [t] of input material and process residues used as input material in the process not reported under Section 2.1.2 of this Annex over the reporting period are determined with a maximum uncertainty of less than ± 5,0 %.

Tier 2

Amounts [t] of input material and process residues used as input material in the process not reported under Section 2.1.2 of this Annex over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

(b) ***emission factor***

Tier 1

For carbonates, use of stoichiometric ratios given in the following Table:

Table

Stoichiometric emission factors

Carbonate	Ratio [t CO_2/t Ca-, Mg- or other Carbonate]	Remarks
$CaCO_3$	0,440	
$MgCO_3$	0,522	
general: $X_Y (CO_3)_Z$	Emission factor = $[M_{CO_2}]/\{Y * [M_x] + Z * [M_{CO_3}^{2-}]\}$	X = metal M_x = molecular weight of X in [g/mol] M_{CO_2} = molecular weight of CO_2 in [g/mol] $M_{CO_{3-}}$ = molecular weight of CO_3^{2-} in [g/mol] Y = stoichiometric number of X Z = stoichiometric number of CO_3^{2-}

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

▼**M4**

For process residues and other input materials than carbonates not reported under Section 2.1.2 of this Annex, activity-specific factors shall be determined according to the provisions of Section 13 of Annex I.

(c) ***conversion factor***

Tier 1

Conversion factor: 1,0.

Tier 2

Activity-specific factors determined according to the provisions of Section 13 of Annex I, determining the amount of carbon in the sinter, slag or other relevant output as well as in filtered dust. In case filtered dust is re-employed in the process, the amount of carbon [t] contained shall not be accounted for in order to avoid double counting.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annexes I and XII shall be applied.

▼M4

ANNEX XXIV

Activity-specific guidelines for the production or processing of primary aluminium as listed in Annex I to Directive 2003/87/EC

1. **BOUNDARIES AND COMPLETENESS**

The activity-specific guidelines in this Annex shall be applied for emissions from installations for the production or processing of primary aluminium as listed in Annex I to Directive 2003/87/EC.

This Annex includes guidelines for monitoring emissions from the production of electrodes for primary aluminium smelting, which is also applicable for stand-alone plants for the production of such electrodes.

2. **DETERMINATION OF GREENHOUSE GAS EMISSIONS**

In installations for the production or processing of primary aluminium emission sources and source streams for greenhouse gas emissions include:

— fuels for the production of heat or steam,

— anode production (CO_2),

— reduction of Al_2O_3 during electrolysis (CO_2) which is related to electrode consumption,

— use of soda ash or other carbonates for waste gas scrubbing (CO_2),

— anode effects (PFCs) including fugitive emissions of PFCs.

2.1. CALCULATION OF CO_2 EMISSIONS

2.1.1. *COMBUSTION EMISSIONS*

Emissions from combustion of fuels, including flue gas scrubbing, shall be monitored and reported in accordance with Annex II, unless they are included in a mass balance pursuant to Section 2.1.2.

2.1.2. *MASS BALANCE*

Process emissions from anode production and consumption shall be calculated by using a mass-balance approach. The mass-balance approach shall consider all carbon in inputs, stocks, products and other exports from the mixing, forming, baking and recycling of anodes as well as from the electrode consumption in electrolysis. Where pre-baked anodes are used, either separate mass balances for production and consumption may be applied, or one common mass balance taking into account both production and consumption of electrodes. In the case of Søderberg cells, the operator shall use one common mass balance. The mass balance shall determine the level of emissions of greenhouse gases over the reporting period, using the following equation independently of whether a common mass balance or separate mass balances are used:

▼**M4**

$$CO_2 \text{ emissions } [t\ CO_2] = (\text{input} - \text{products} - \text{export} - \text{stock changes}) * \text{conversion factor } CO_2/C$$

With:

— *input [t C]:* all carbon entering the boundaries of the mass balance, e.g. pitch, coke, packing coke or purchased anodes,

— *products [t C]:* all carbon in products and materials, including by-products and waste, leaving the boundaries of the mass balance, e.g. sold anodes,

— *export [t C]:* 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 [t C]:* stock increases of carbon within the boundaries of the mass balance.

The calculation shall then be as follows:

$$CO_2 \text{ emissions } [t\ CO_2] = (\Sigma\ (\text{activity data}_{input} * \text{carbon content}_{input}) - \Sigma\ (\text{activity data}_{products} * \text{carbon content}_{products}) - \Sigma\ (\text{activity data}_{export} * \text{carbon content}_{export}) - \Sigma\ (\text{activity data}_{stock\ changes} * \text{carbon content}_{stock\ changes})) * 3{,}664$$

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 (e.g. pitch, coke or packing coke) separately. Where the carbon content of a mass flow is usually related to energy content (fuels), the operator may determine and use the carbon content related to the energy content [t C/TJ] of the respective mass flow for the calculation of the mass balance.

Tier 1

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 7,5 %.

Tier 2

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 5 %.

Tier 3

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 4

Activity data over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

▼M4

(b) ***carbon content***

Tier 1

The carbon content of input or output streams is derived from reference emission factors for fuels or materials named in Section 11 of Annex I or in other activity-specific Annexes to these Guidelines. The carbon content is derived as follows:

C content [t/t or TJ] = Emission factor [t CO_2/t or TJ]/3,664 [t CO_2/t C]

Tier 2

The operator applies country-specific carbon content for the respective fuel or material 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 carbon content of input or output stream shall be derived following the provisions of Section 13 of Annex I in respect to representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction.

The carbon content can be derived from direct analysis as well as from indirect analysis, i.e. by subtracting the measured content of known constituents (such as sulphur, hydrogen and ash) from the total amount, as appropriate and subject to the approval of the competent authority.

2.2. MEASUREMENT OF CO_2 EMISSIONS

The measurement guidelines contained in Annexes I and XII shall be applied.

3. **DETERMINATION OF PFC EMISSIONS**

PFC-Emissions from primary aluminium production shall include CF_4 and C_2F_6 emissions expressed as CO_2-equivalents:

PFC emissions [t $CO_{2(e)}$] = CF_4-emissions [t $CO_{2(e)}$] + C_2F_6-emissions [t $CO_{2(e)}$]

Carbon dioxide equivalents (t $CO_{2(e)}$) shall be calculated using Global Warming Potential values provided in the Intergovernmental Panel on Climate Change's Second Assessment Report (1995 IPCC GWP value). These are:

$$GWP_{CF_4} = 6500 \text{ t } CO_{2(e)}/\text{t } CF_4$$

$$GWP_{C_2F_6} = 9200 \text{ t } CO_{2(e)}/\text{t } C_2F_6$$

Total PFC emissions are calculated from the emissions which are measurable in a duct or stack ('point source emissions') plus the fugitive emissions using the collection efficiency of the duct:

PFC emissions (total) = PFC emissions (duct)/collection efficiency

The collection efficiency is measured when the installation specific emission factors are determined. For its determination the most recent version of the guidance mentioned under Tier 3 of Section 4.4.2.4 of the 2006 IPCC Guidelines shall be used.

▼M4

Emissions of CF_4 and C_2F_6 emitted through a duct or stack shall be calculated by one of the following two approaches, depending on the control technologies used. Calculation method A is used where the anode effect minutes per cell-day are recorded, calculation method B shall be used where the anode effect overvoltage is recorded.

Calculation Method A – Slope Method

Where the anode effect minutes per cell-day are measured, the following equations shall be used for determining PFC emissions:

$$CF_4 \text{ emissions } [t\ CO_{2(e)}] = AEM \times (SEF_{CF_4}/1000) \times Pr_{Al} \times GWP_{CF_4}$$

$$C_2F_6\text{-emissions } [t\ CO_{2(e)}] = CF_4 \text{ emissions} * F_{C_2F_6} * GWP_{C_2F_6}$$

With:

AEM … Anode effect minutes/cell-day

SEF_{CF_4} … ([1]) Slope emission factor [(kg CF_4/t Al produced)/(anode effect minutes/cell-day)]

Pr_{Al} … Annual production of primary Aluminium [t]

$F_{C_2F_6}$ … Weight fraction of C_2F_6 (t C_2F_6/t CF_4)

With

Activity data

(a) **Primary Aluminium production**

Tier 1

The primary aluminium production over the reporting period is determined with a maximum uncertainty of less than ± 2,5 %.

Tier 2

The primary aluminium production over the reporting period is determined with a maximum uncertainty of less than ± 1,5 %.

(b) **Anode effect minutes (AEM)**

The Anode effect minutes per cell-day expresses the frequency of anode effects [number of anode effects/cell-day] multiplied by the average duration of anode effects [anode effect minutes/occurrence]:

$$AEM = \text{frequency} \times \text{average duration}$$

Tier 1

Frequency and average duration of anode effects over the reporting period are determined with a maximum uncertainty of less than ± 2,5 %.

Tier 2

Frequency and average duration of anode effects over the reporting period are determined with a maximum uncertainty of less than ± 1,5 %.

Emission factor

The emission factor for CF_4 (slope emission factor SEF_{CF_4}) expresses the amount [kg] of CF_4 emitted per ton of aluminium produced per anode effect minute/cell-day. The emission factor (weight fraction $F_{C_2F_6}$) of C_2F_6 expresses the amount [t] of C_2F_6 emitted as proportionate to the amount [t] of CF_4 emitted.

([1]) Where different cell-types are used, different SEFs can be applied.

▼M4

Tier 1

Technology specific emission factors from Table 1 are used.

Table 1

Technology specific emission factors related to the slope method

Technology	Emission Factor for CF_4 (SEF_{CF_4}) [(kg CF_4/t Al)/(AE-Minutes/cell-day)]	Emission Factor for C_2F_6 ($F_{C_2F_6}$) [t C_2F_6/t CF_4]
Centre Worked Prebake (CWPB)	0,143	0,121
Vertical Stud Søderberg (VSS)	0,092	0,053

Tier 2

Installation-specific emission factors for CF_4 and C_2F_6 established through continuous or intermittent field measurements are used. For the determination of these emission factors the most recent version of the guidance mentioned under Tier 3 of Section 4.4.2.4 of the 2006 IPCC Guidelines ([1]) shall be used. The emission factors are to be determined with a maximum uncertainty of ± 15 % each.

The emission factors shall be established at least every 3 years or earlier if necessary due to relevant changes at the installation. Relevant changes include a change in the distribution of anode effect duration, or a change in the control algorithm affecting the mix of types of anode effects or the nature of the anode effect termination routine.

Calculation Method B – Overvoltage Method

Where the anode effect overvoltage is measured, the following equations shall be used for determining PFC emissions:

$$CF_4 \text{ emissions } [t\ CO_{2(e)}] = OVC \times (AEO/CE) \times Pr_{Al} \times GWP_{CF_4} \times 0{,}001$$

$$C_2F_6 \text{ emissions } [t\ CO_{2\text{-}eq}] = CF_4 \text{ emissions} \times F_{C_2F_6} \times GWP_{C_2F_6}$$

with

OVC … Overvoltage coefficient (‘emission factor’) expressed as kg CF_4 per tonne aluminium produced per mV overvoltage

AEO … Anode effect overvoltage per cell [mV] determined as the integral of (time × voltage above the target voltage) divided by the time (duration) of data collection

([1]) International Aluminium Institute; The Aluminium Sector Greenhouse Gas Protocol; October 2006; US Environmental Protection Agency and International Aluminium Institute; Protocol for Measurement of Tetrafluoromethane (CF_4) and Hexafluoroethane (C_2F_6) Emissions from Primary Aluminium Production; April 2008.

▼M4

CE … average current efficiency of aluminium production [%]

Pr_{Al} … Annual production of primary Aluminium [t]

$F_{C_2F_6}$ … Weight fraction of C_2F_6 (t C_2F_6/t CF_4)

Activity data

(a) **Primary Aluminium Production**

Tier 1

The primary aluminium production over the reporting period is determined with a maximum uncertainty of less than ± 2,5 %.

Tier 2

The primary aluminium production over the reporting period is determined with a maximum uncertainty of less than ± 1,5 %.

(b) **Anode effect overvoltage**

The term AEO/CE (Anode effect overvoltage/current efficiency) expresses the time-integrated average anode effect overvoltage [mV overvoltage] per average current efficiency [%].

Tier 1

Anode effect overvoltage as well as current efficiency over the reporting period are each determined with a maximum uncertainty of less than ± 2,5 %.

Tier 2

Anode effect overvoltage as well as current efficiency over the reporting period are each determined with a maximum uncertainty of less than ± 1,5 %.

Emission factor

The emission factor for CF_4 ('overvoltage coefficient' OVC) expresses the amount [kg] of CF_4 emitted per t aluminium produced per millivolt overvoltage [mV]. The emission factor of C_2F_6 (weight fraction $F_{C_2F_6}$) expresses the amount [t] of C_2F_6 emitted as proportionate to the amount [t] of CF_4 emitted.

Tier 1

Technology specific emission factors as laid down under Table 2 are used:

Table 2

Technology specific emission factors related to overvoltage activity data

Technology	Emission Factor for CF_4 [(kg CF_4/t Al)/mV]	Emission Factor for C_2F_6 [t C_2F_6/t CF_4]
Centre Worked Prebake (CWPB)	1,16	0,121
Vertical Stud Søderberg (VSS)	N.A.	0,053

▼**M4**

Tier 2

Installation-specific emission factors for CF_4 [(kg CF_4/t Al)/mV] and C_2F_6 [t C_2F_6/t CF_4] established through continuous or intermittent field measurements are used. For the determination of these emission factors the most recent version of the guidance mentioned under Tier 3 of Section 4.4.2.4 of the 2006 IPCC Guidelines ([1]) shall be used. The emission factors are to be determined with a maximum uncertainty of ± 15 % each.

The emission factors shall be established at least every 3 years or earlier if necessary due to relevant changes at the installation. Relevant changes include a change in the distribution of anode effect duration or a change in the control algorithm affecting the mix of types of anode effects or the nature of the anode effect termination routine.

([1]) International Aluminium Institute; The Aluminium Sector Greenhouse Gas Protocol; October 2006; US Environmental Protection Agency and International Aluminium Institute; Protocol for Measurement of Tetrafluoromethane (CF_4) and Hexafluoroethane (C_2F_6) Emissions from Primary Aluminium Production; April 2008.