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ANNEXES 1 to 5

ANNEXES

to the

Commission Implementing Regulation

laying down rules for the application of Regulation (EU) 2023/956 of the European Parliament and the Council as regards the methods for the calculation of emissions embedded in goods

ANNEX I - Definitions, functional unit and system boundaries

1. DEFINITIONS

For the purpose of this Annex and of Annexes II to VII the following definitions apply:

- (1) ‘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, 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;
- (2) ‘combustion emissions’ means greenhouse gas emissions occurring during the exothermic reaction of a fuel with oxygen;
- (3) ‘emission factor’ means the average emission rate of a greenhouse gas relative to the activity data of a source stream assuming complete oxidation for combustion and complete conversion for all other chemical reactions;
- (4) ‘oxidation factor’ means the ratio of carbon oxidised to CO₂ as a consequence of combustion to the total carbon contained in the fuel, expressed as a fraction, considering carbon monoxide (CO) emitted to the atmosphere as the molar equivalent amount of carbon dioxide (CO₂);
- (5) ‘conversion factor’ means the ratio of carbon emitted as CO₂ to the total carbon contained in the source stream before the emitting process takes place, expressed as a fraction, considering CO emitted to the atmosphere as the molar equivalent amount of CO₂;
- (6) ‘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;
- (7) ‘calibration’ means the set of operations, which establishes, 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;
- (8) ‘conservative’ means that a set of assumptions is defined in order to ensure that no under-estimation of reported emissions or over-estimation of production of heat, electricity or goods occurs;
- (9) ‘biomass’ means biomass as defined in Article 2, point (24) of Directive (EU) 2018/2001¹; it includes bioliquids and biofuels as defined in Article 2, point (32) and (33), biomass fuels as defined in Article 2, point (27) and biogas as defined in Article 2 point (28) of Directive 2018/2001;

¹ Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82, ELI: <https://eur-lex.europa.eu/eli/dir/2018/2001/oj/eng>.)

- (10) 'waste' means any substance or object which the holder discards or intends or is required to discard, excluding substances that have been intentionally modified or contaminated in order to meet this definition;
- (11) 'residue' means a substance that is not the end product that a production process directly seeks to produce; it is not a primary aim of the production process and the process has not been deliberately modified to produce it;
- (12) 'agricultural, aquaculture, fisheries and forestry residues' means residues that are directly generated by agriculture, aquaculture, fisheries and forestry and that do not include residues from related industries or processing;
- (13) 'legal metrological control' means the control exercised by a public authority or regulator of the measurement tasks intended for the field of application of a measuring instrument, for reasons of public interest, public health, public safety, public order, protection of the environment, the levying of taxes and duties, the protection of consumers and fair trading;
- (14) 'data flow activities' mean activities related to the acquisition, processing and handling of data that are needed to draft an emissions report from primary source data;
- (15) 'net calorific value' (NCV) means the specific amount of energy released as heat when a fuel or material undergoes complete combustion with oxygen under standard conditions, less the heat of vaporisation of any water formed;
- (16) 'process emissions' means greenhouse gas emissions other than combustion emissions occurring as a result of intentional and unintentional reactions between substances or their transformation, for a primary purpose other than the generation of heat, including from the following processes:
- (a) the chemical, electrolytic or pyrometallurgical reduction of metal compounds in ores, concentrates and secondary materials;
 - (b) the removal of impurities from metals and metal compounds;
 - (c) the decomposition of carbonates, including those used for flue gas cleaning;
 - (d) chemical syntheses of products and intermediate products where the carbon bearing material participates in the reaction;
 - (e) the use of carbon containing additives or raw materials;
 - (f) the chemical or electrolytic reduction of metalloid oxides or non-metal oxides such as silicon oxides and phosphates.
- (17) '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;
- (18) 'mixed material' means a material which contains both biomass and fossil carbon;
- (19) 'preliminary emission factor' means the assumed total emission factor of a fuel or material based on the carbon content of its biomass fraction and its fossil fraction before multiplying it by the fossil fraction to produce the emission factor;

- (20) 'fossil fraction' means the ratio of fossil carbon to the total carbon content of a fuel or material, expressed as a fraction;
- (21) 'biomass fraction' means the ratio of carbon stemming from biomass to the total carbon content of a fuel or material, expressed as a fraction;
- (22) 'continuous emission measurement' means a set of operations having the objective of determining the value of a quantity by means of periodic measurements, applying either measurements in the stack or extractive procedures with a measuring instrument located close to the stack, whilst excluding measurement methodologies based on the collection of individual samples from the stack;
- (23) 'inherent CO₂' means CO₂ which is part of a source stream;
- (24) 'fossil carbon' means inorganic and organic carbon that is not biomass;
- (25) '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 CO₂ flow is determined using continuous measurement systems;
- (26) 'fugitive emissions' means irregular or unintended emissions from sources that are not localised, or too diverse or too small to be monitored individually;
- (27) 'standard conditions' means temperature of 273,15 K and pressure conditions of 101 325 Pa defining normal cubic metres (Nm³);
- (28) 'proxy data' means annual values which are empirically substantiated or derived from accepted sources and which an operator uses to substitute a data set for the purpose of ensuring complete reporting;
- (29) 'measurable heat' means a net heat flow transported through identifiable pipelines or ducts using a heat transfer medium, such as, in particular, steam, hot air, water, oil, liquid metals and salts, for which a heat meter is or could be installed;
- (30) 'heat meter' means a thermal energy meter or any other device to measure and record the amount of thermal energy produced based upon flow volumes and temperatures;
- (31) 'non-measurable heat' means all heat other than measurable heat;
- (32) 'waste gas' means a gas containing incompletely oxidised carbon in a gaseous state under standard conditions which is a result of any of the processes listed in point (16);
- (33) 'multifunctional process' means a process that delivers multiple outputs or whose outputs feed into several production processes;
- (34) 'co-product' means any of two or more products resulting from the same production process;
- (35) 'non-CBAM good' means any good produced in the installation that is not included in Annex I to Regulation (EU) 2023/956;
- (36) 'data set' means one type of data, either at installation level or production process level as relevant in the circumstances, as any of the following:
- (a) the amount of fuels or materials consumed or produced by a production process as relevant for the calculation-based methodology, expressed in terajoules, mass in tonnes, or for gases as volume in normal cubic metres, as appropriate, including for waste gases;

- (b) a calculation factor;
 - (c) net quantity of measurable heat, and the relevant parameters required for determining this quantity, in particular:
 - mass flow of heat transfer medium, and
 - enthalpy of transmitted and returned heat transfer medium, as specified by composition, temperature, pressure and saturation;
 - (d) quantities of non-measurable heat, specified by the relevant quantities of fuels used for producing the heat, and the NCV of the fuel mix;
 - (e) quantities of electricity;
 - (f) quantities of CO₂ transferred between installations;
 - (g) quantities of precursors received from outside the production process, and their relevant parameters, such as country of origin, used production route, specific direct and indirect emissions;
- (37) ‘minimum requirements’ means monitoring methods using the minimum efforts allowed for determining data in order to result in emission data acceptable for the purpose of Regulation (EU) 2023/956;
- (38) ‘recommended improvements’ means monitoring methods which are proven means to ensure that data are more accurate or less prone to mistakes than by mere application of minimum requirements;
- (39) ‘control system’ means the operator’s risk assessment and entire set of control activities, including the continuous management thereof, that an operator has established, documented, implemented and maintained pursuant to point A.2. of Annex II.

2. MAPPING OF CN CODES TO AGGREGATED GOODS CATEGORIES

Table 1 in this point defines aggregated goods categories for each CN code listed in Annex I to Regulation (EU) 2023/956. Those categories are used for the purpose of defining system boundaries of production processes of the goods listed in Annex I to that Regulation.

Table 1: Mapping of CN codes to aggregated goods categories

CN code	Aggregated goods category	Greenhouse gas
Cement		
2507 00 80 – Other kaolinic clays	Calcined clay	Carbon dioxide
2523 10 00 – Cement clinkers	Cement clinker	Carbon dioxide
2523 21 00 – White Portland cement, whether or not artificially coloured	Cement	Carbon dioxide

CN code	Aggregated goods category	Greenhouse gas
2523 29 00 – Other Portland cement		
2523 90 00 – Other hydraulic cements		
2523 30 00 – Aluminous cement	Aluminous cement	Carbon dioxide
Electricity		
2716 00 00 – Electrical energy	Electricity	Carbon dioxide
Fertiliser		
2808 00 00 – Nitric acid; sulphonitric acids	Nitric acid	Carbon dioxide and nitrous oxide
3102 10 – Urea, whether or not in aqueous solution	Urea	Carbon dioxide
2814 – Ammonia, anhydrous or in aqueous solution	Ammonia	Carbon dioxide
2834 21 00 – Nitrates of potassium	Mixed fertilisers	Carbon dioxide and nitrous oxide
3102 – Mineral or chemical fertilisers, nitrogenous except 3102 10 (Urea)		
3105 – Mineral or chemical fertilisers containing two or three of the fertilising elements nitrogen, phosphorus, and potassium; other fertilisers		
- Except: 3105 60 00 – Mineral or chemical fertilisers containing the two fertilising elements phosphorus and potassium		
Iron and Steel		
2601 12 00 – Agglomerated iron ores and concentrates, other than roasted iron pyrites	Sintered Ore	Carbon dioxide
7201 – Pig iron and spiegeleisen in pigs, blocks, or other primary forms	Pig Iron	Carbon dioxide
Some products under 7205 (Granules and powders, of pig iron, spiegeleisen, iron, or steel) may be covered here		
7202 1 – Ferro-manganese	FeMn	Carbon dioxide
7202 4 – Ferro-chromium	FeCr	Carbon dioxide
7202 6 – Ferro-nickel	FeNi	Carbon dioxide
7203 – Ferrous products obtained by direct reduction of iron ore and other spongy ferrous products	DRI	Carbon dioxide
7206 – Iron and non-alloy steel in ingots or other primary forms (excluding iron of heading 7203)	Crude steel	Carbon dioxide

CN code	Aggregated goods category	Greenhouse gas
7207 – Semi-finished products of iron or non-alloy steel 7218 – Stainless steel in ingots or other primary forms; semi-finished products of stainless steel 7224 – Other alloy steel in ingots or other primary forms; semi-finished products of other alloy steel		
7205 – Granules and powders, of pig iron, spiegeleisen, iron or steel (if not covered under category pig iron) 7208 – Flat-rolled products of iron or non-alloy steel, of a width of 600 mm or more, hot-rolled, not clad, plated or coated 7209 – Flat-rolled products of iron or non-alloy steel, of a width of 600 mm or more, cold-rolled (cold-reduced), not clad, plated or coated 7210 – Flat-rolled products of iron or non-alloy steel, of a width of 600 mm or more, clad, plated or coated 7211 – Flat-rolled products of iron or non-alloy steel, of a width of less than 600 mm, not clad, plated or coated 7212 – Flat-rolled products of iron or non-alloy steel, of a width of less than 600 mm, clad, plated or coated 7213 – Bars and rods, hot-rolled, in irregularly wound coils, of iron or non-alloy steel 7214 – Other bars and rods of iron or non-alloy steel, not further worked than forged, hot-rolled, hot-drawn or hot-extruded, but including those twisted after rolling 7215 – Other bars and rods of iron or non-alloy steel 7216 – Angles, shapes and sections of iron or non-alloy steel 7217 – Wire of iron or non-alloy steel 7219 – Flat-rolled products of stainless steel, of a width of 600 mm or more 7220 – Flat-rolled products of stainless steel, of a width of less than 600 mm 7221 – Bars and rods, hot-rolled, in irregularly wound coils, of stainless steel 7222 – Other bars and rods of stainless steel; angles, shapes and sections of stainless steel 7223 – Wire of stainless steel 7225 – Flat-rolled products of other alloy steel, of a width of 600 mm or more 7226 – Flat-rolled products of other alloy steel, of a width of less than 600 mm 7227 – Bars and rods, hot-rolled, in irregularly wound coils, of other alloy steel	Iron or steel products	Carbon dioxide

CN code	Aggregated goods category	Greenhouse gas
7228 – Other bars and rods of other alloy steel; angles, shapes and sections, of other alloy steel; hollow drill bars and rods, of alloy or non-alloy steel		
7229 – Wire of other alloy steel		
7301 – Sheet piling of iron or steel, whether or not drilled, punched or made from assembled elements; welded angles, shapes and sections, of iron or steel		
7302 – Railway or tramway track construction material of iron or steel, the following: rails, check-rails and rack rails, switch blades, crossing frogs, point rods and other crossing pieces, sleepers (cross-ties), fish- plates, chairs, chair wedges, sole plates (base plates), rail clips, bedplates, ties and other material specialised for jointing or fixing rails		
7303 – Tubes, pipes and hollow profiles, of cast iron		
7304 – Tubes, pipes and hollow profiles, seamless, of iron (other than cast iron) or steel		
7305 – Other tubes and pipes (for example, welded, riveted or similarly closed), having circular cross-sections, the external diameter of which exceeds 406,4 mm, of iron or steel		
7306 – Other tubes, pipes and hollow profiles (for example, open seam or welded, riveted or similarly closed), of iron or steel		
7307 – Tube or pipe fittings (for example, couplings, elbows, sleeves), of iron or steel		
7308 – Structures (excluding prefabricated buildings of heading 9406) and parts of structures (for example, bridges and bridge-sections, lock- gates, towers, lattice masts, roofs, roofing frameworks, doors and windows and their frames and thresholds for doors, shutters, balustrades, pillars and columns), of iron or steel; plates, rods, angles, shapes, sections, tubes and the like, prepared for use in structures, of iron or steel		
7309 – Reservoirs, tanks, vats and similar containers for any material (other than compressed or liquefied gas), of iron or steel, of a capacity exceeding 300 l, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment		
7310 – Tanks, casks, drums, cans, boxes and similar containers, for any material (other than compressed or liquefied gas), of iron or steel, of a capacity not exceeding 300 l, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment		
7311 – Containers for compressed or liquefied gas, of iron or steel		

CN code	Aggregated goods category	Greenhouse gas
7318 – Screws, bolts, nuts, coach screws, screw hooks, rivets, cotters, cotter pins, washers (including spring washers) and similar articles, of iron or steel		
7326 – Other articles of iron or steel		
Aluminium		
7601 – Unwrought aluminium	Unwrought aluminium	Carbon dioxide and perfluoro-carbons
7603 – Aluminium powders and flakes	Aluminium products	Carbon dioxide and perfluoro-carbons
7604 – Aluminium bars, rods and profiles		
7605 – Aluminium wire		
7606 – Aluminium plates, sheets and strip, of a thickness exceeding 0,2 mm		
7607 – Aluminium foil (whether or not printed or backed with paper, paper-board, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0,2 mm		
7608 – Aluminium tubes and pipes		
7609 00 00 – Aluminium tube or pipe fittings (for example, couplings, elbows, sleeves)		
7610 – Aluminium structures (excluding prefabricated buildings of heading 9406) and parts of structures (for example, bridges and bridge-sections, towers, lattice masts, roofs, roofing frameworks, doors and windows and their frames and thresholds for doors, balustrades, pillars and columns); aluminium plates, rods, profiles, tubes and the like, prepared for use in structures		
7611 00 00 – Aluminium reservoirs, tanks, vats and similar containers, for any material (other than compressed or liquefied gas), of a capacity exceeding 300 litres, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment		
7612 – Aluminium casks, drums, cans, boxes and similar containers (including rigid or collapsible tubular containers), for any material (other than compressed or liquefied gas), of a capacity not exceeding 300 litres, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment		
7613 00 00 – Aluminium containers for compressed or liquefied gas		
7614 – Stranded wire, cables, plaited bands and the like, of aluminium, not electrically insulated		

CN code	Aggregated goods category	Greenhouse gas
7616 – Other articles of aluminium		
Chemicals		
2804 10 000 – Hydrogen	Hydrogen	Carbon dioxide

3. FUNCTIONAL UNIT AND SYSTEM BOUNDARIES

3.1 Cross-sectoral rules

Specific embedded emissions shall be calculated as the emissions of the production process and, for complex goods, the embedded emissions of the precursors to produce the functional unit of the good during the reporting period.

The system boundaries are defined per aggregated goods categories and cover the direct emissions, the indirect emissions from electricity consumption where relevant under Regulation (EU) 2023/956, emitted by all processes directly or indirectly linked to the production processes, and the embedded emissions of precursors, independently of whether these precursors are produced in the installation or acquired from a different installation. In addition to these general rules, the specific details of each aggregated goods category are set out in points 3.2 to 3.19. Any CBAM goods produced by means of a production route not listed in points 3.2. to 3.19. is subject to the cross-sectoral rules described in this point, and to the sector-specific rules if the production route is a combination of the production routes listed in in points 3.2. to 3.19.

The purchase and maintenance of infrastructure and equipment are excluded from the system boundaries.

When the production process of complex goods listed in Annex II to Regulation (EU) 2023/956 includes one or more precursors not listed in that Annex, the indirect emissions of those precursors will be included in the calculation of the embedded emissions of the complex goods. When the production process of complex goods not listed in that Annex includes one or more precursors listed in that Annex, the indirect emissions of these precursors will not be included in the calculation of the embedded emissions of the complex goods.

3.2 Calcined clay

3.2.1. *Special provisions*

None

3.2.2. *System boundary*

For calcined clay, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes, such as raw material preparation, mixing, drying, and calcining, and flue gas cleaning;
- CO₂ emissions from the combustion of fuels as well as from raw materials, where relevant.

3.3 Cement clinker

3.3.1 Special provisions

No distinction shall be made between grey and white cement clinker.

3.3.2 System boundary

For cement clinker, direct emissions monitoring take into account:

- calcination of limestone and other carbonates in the raw materials, conventional fossil kiln fuels, alternative fossil-based kiln fuels and raw materials, biomass kiln fuels (such as waste-derived fuels), non-kiln fuels, non-carbonate carbon content in raw materials, or alternative raw materials such as fly ash used in the raw meal in the kiln and raw materials used for flue gas scrubbing;
- the additional provisions of point B.9.2. of Annex II.

3.4 Cement

3.4.1 Special provisions

None.

3.4.2 System boundary

For cement, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes, where relevant for drying of materials.

3.5 Aluminous cement

3.5.1 Special provisions

None.

3.5.2 System boundary

For aluminous cement, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes where fuel is combusted;
- process emissions from carbonates in raw materials, if applicable, and flue gas cleaning.

3.6 Hydrogen

3.6.1 Special provisions

Only the production of pure hydrogen or mixtures of hydrogen with nitrogen usable in ammonia production shall be considered. Not covered are the consumption of synthesis gas or of hydrogen as precursor within refineries or organic chemical installations, where hydrogen is exclusively used within those plants and not used for the production of goods listed in Annex I to Regulation (EU) 2023/956.

3.6.2 System boundary

3.6.2.1 Steam reforming and partial oxidation

For those production routes, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to hydrogen production and the separation of hydrogen and carbon monoxide, and flue gas cleaning;
 - all fuels used in the hydrogen production process irrespective of their energetic or non-energetic use, and fuels used for other combustion processes including for the purpose of producing hot water or steam.
- 3.6.2.2 *Steam cracking*

For that production route, direct emissions monitoring shall take into account:

- all processes directly linked to hydrogen production;
- all processes directly or indirectly linked to the production processes, and from flue gas cleaning.

3.7 Ammonia

3.7.1 Special provisions

None

3.7.2 System boundary

3.7.2.1 Haber-Bosch process with steam reforming of natural gas or biogas

For that production route, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes, and from flue gas cleaning;
- all fuels are to be monitored, irrespective of whether used as energetic or non-energetic input;
- where biogas is used, the provisions of point B.3.3. of Annex II

3.7.2.2 Haber-Bosch process with gasification of coal or other fuels

That production route applies where hydrogen is produced by gasification of coal, heavy refinery fuels or other fossil feedstock. Input materials may include biomass, for which the provisions of point B.3.3. of Annex II shall be taken into account.

For that production route, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes, and from flue gas cleaning;
- each fuel input shall be monitored as one fuel stream, irrespective of whether it is used as energetic or non-energetic input.

3.8 Nitric acid

3.8.1 Special provisions

None.

3.8.2 System boundary

For nitric acid, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes, and from flue gas cleaning;
- all sources emitting N₂O from the production process, including unabated and abated emissions. Any N₂O emissions from the combustion of fuels are excluded from monitoring.

3.9 Urea

3.9.1 Special provisions

None.

3.9.2 System boundary

For urea, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes, and from flue gas cleaning;
- where CO₂ is received from another installation as process input, the CO₂ received shall be considered an emission, if not already counted as emission of the installation where the CO₂ was produced.

3.10 Mixed fertilizers

3.10.1 Special provisions

This point applies to the production of all kinds of nitrogen containing fertilizers, including ammonium nitrate, calcium ammonium nitrate, ammonium sulphate, ammonium phosphates, urea ammonium nitrate solutions, as well as nitrogen-phosphorus (NP), nitrogen-potassium (NK) and nitrogen-phosphorus-potassium (NPK) fertilizers. All kinds of operations are included such as mixing, neutralisation, granulation, prilling, irrespective of whether only physical mixing or chemical reactions take place.

The amounts of different nitrogen compounds contained in the final product shall be recorded in accordance with Regulation (EU) 2019/1009⁽²⁾:

- content of N as ammonium (NH₄⁺);
- content of N as nitrate (NO₃⁻);
- content of N as Urea;

² Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003 (OJ L 170, 25.6.2019, p. 1)

- content of N in other (organic) forms.

3.10.2 System boundary

For mixed fertilisers, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes, such as driers and for heating input materials, and from flue gas cleaning.

3.11 Sintered Ore

3.11.1 Special provisions

This aggregated goods category includes all kinds of iron ore pellet production (for sale of pellets as well as for direct use in the same installation) and sinter production. To the extent covered by CN code 2601 12 00, also iron ores used as precursors for ferro-chromium (FeCr), ferro-manganese (FeMn) or ferro-nickel (FeNi) may be covered.

3.11.2 System boundary

For sintered ore, direct emissions monitoring shall encompass:

- all processes emitting CO₂ from process materials such as limestone and other carbonates or carbonate ores;
- all processes emitting CO₂ from all fuels including coke, waste gases such as coke oven gas, blast furnace gas or converter gas; directly or indirectly linked to the production process, and materials used for flue gas cleaning.

3.12 FeMn (Ferro-Manganese), FeCr (Ferro-Chromium) and FeNi (Ferro-Nickel)

3.12.1 Special provisions

This process covers only the production of the alloys identified under CN codes 7202 1, 7202 4 and 7202 6. Other iron materials with significant alloy content such as spiegeleisen are not covered. NPI (nickel pig iron) is included if the nickel content is greater than 10%.

Where waste gases or other flue gases are emitted without abatement, CO contained in the waste gas shall be considered as the molar equivalent of CO₂ emissions.

3.12.2 System boundary

For FeMn, FeCr and FeNi, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes emitting CO₂ emissions caused by fuel inputs, irrespective of whether they are used for energetic or non-energetic use;
- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from process inputs such as limestone and from flue gas cleaning;
- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from the consumption of electrodes or electrode pastes;
- carbon remaining in the product or in slags or wastes is taken into account by using a mass balance method in accordance with point B.3.2 of Annex II.

3.13 Pig Iron

3.13.1 Special provisions

This aggregated goods category includes non-alloyed pig iron from blast furnaces as well as alloy-containing pig irons (e.g., spiegeleisen), irrespective of the physical form (e.g. ingots, granules). NPI (nickel pig iron) is included if the nickel content is lower than 10%. In integrated steel plants, liquid pig iron (“hot metal”) directly charged to the oxygen converter is the product which separates the production process for pig iron from the production process of crude steel. Where the installation does not sell or transfer pig iron to other installations, a joint production process including crude steel can be established making subject to the rules of Article 4.

3.13.2 System boundary

3.13.2.1 Blast furnace route

For that production route, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes emitting CO₂ from fuels and reducing agents such as coke, coke dust, coal, fuel oils, plastic wastes, natural gas, wood wastes, charcoal, as well as from waste gases such as coke oven gas, blast furnace gas or converter gas;
- where biomass is used, the provisions of point B.3.3 of Annex II shall be taken into account;
- all processes directly or indirectly linked to the production processes emitting CO₂ from process materials such as limestone, magnesite, and other carbonates, carbonate ores; materials for flue gas cleaning;
- carbon remaining in the product or in slags or wastes is taken into account by using a mass balance method in accordance with point B.3.2 of Annex II.

3.13.2.2 Smelting reduction

For this production route, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes emitting CO₂ from fuels and reducing agents such as coke, coke dust, coal, fuel oils, plastic wastes, natural gas, wood wastes, charcoal, waste gases from the process or converter gas;
- where biomass is used, the provisions of point B.3.3 of Annex II shall be taken into account;
- all processes directly or indirectly linked to the production processes emitting CO₂ from process materials such as limestone, magnesite, and other carbonates, carbonate ores; materials for flue gas cleaning;
- carbon remaining in the product or in slags or wastes is taken into account by using a mass balance method in accordance with point B.3.2 of Annex II.

3.14 DRI (Direct Reduced Iron)

3.14.1 Special provisions

There is only one production route defined, although different technologies may use different qualities of ores, which may require pelletisation or sintering, and different reducing agents (natural gas, diverse fossil fuels or biomass, hydrogen). Therefore, precursors sintered ore or hydrogen may be relevant. As products, iron sponge, hot briquetted iron (HBI) or other forms of direct reduced iron may be relevant, including DRI which is immediately fed to electric arc furnaces or other downstream processes.

Where the installation does not sell or transfer DRI to other installations, a joint production process including steel can be established making subject to the rules of Article 4.

3.14.2 System boundary

For that production route, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes emitting CO₂ from fuels and reducing agents such as coal, natural gas, fuel oils, waste gases from the process or converter gas, etc;
- where biogas or other forms of biomass are used, the provisions of point B.3.3 of Annex II shall be taken into account;
- all processes directly or indirectly linked to the production processes emitting CO₂ from process materials such as limestone, magnesite, and other carbonates, carbonate ores, materials for flue gas cleaning;
- carbon remaining in the product or in slags or wastes is taken into account by using a mass balance method in accordance with point B.3.2 of Annex III.

3.15 Crude steel

3.15.1 Special provisions

The system boundary shall cover all necessary activities and units for obtaining crude steel:

- if the process starts from hot metal (liquid pig iron), the system boundary shall include the basic oxygen converter, vacuum degassing, secondary metallurgy, argon oxygen decarburisation / vacuum oxygen decarburisation, continuous casting or ingot casting, where relevant hot-rolling or forging, and all necessary auxiliary activities such as transfers, re-heating, and flue gas cleaning;
- if the process uses an electric arc furnace, the system boundary shall include all relevant activities and units such as the electric arc furnace itself, secondary metallurgy, vacuum degassing, argon oxygen decarburisation / vacuum oxygen decarburisation, continuous casting or ingot casting, where relevant hot-rolling or forging, and all necessary auxiliary activities such as transfers, heating of raw materials and equipment, re-heating, and flue gas cleaning;
- only primary hot-rolling and rough shaping by forging to obtain the semi-finished products under CN codes 7207, 7218 and 7224 are included in this aggregated goods category. All other rolling and forging processes are included in the aggregated goods category “iron or steel products”.

3.15.2 System boundary

3.15.2.1 Basic oxygen steelmaking

For that production route, direct emissions monitoring shall encompass:

- all processes directly or indirectly linked to the production processes emitting CO₂ from fuels such as coal, natural gas, fuel oils, waste gases such as blast furnace gas, coke oven gas or converter gas;
- all processes directly or indirectly linked to the production processes emitting CO₂ from process materials such as limestone, magnesite, and other carbonates, carbonate ores; materials for flue gas cleaning;
- carbon entering the process in scrap, alloys, graphite etc. and carbon remaining in the product or in slags or wastes is taken into account by using a mass balance method in accordance with Point B.3.2 of Annex III.

3.15.2.2 Electric arc furnace

For that production route, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes emitting CO₂ from fuels such as coal, natural gas, fuel oils, as well as from waste gases such as blast furnace gas, coke oven gas or converter gas;
- all processes directly or indirectly linked to the production processes emitting CO₂ from the consumption of electrodes and electrode pastes;
- all processes directly or indirectly linked to the production processes emitting CO₂ from process materials such as limestone, magnesite, and other carbonates, carbonate ores; materials for flue gas cleaning;
- carbon entering the process, e.g. in the form of scrap, alloys and graphite, and carbon remaining in the product or in slags or wastes is taken into account by using a mass balance method in accordance with Point B.3.2 of Annex III.

3.16 Iron or steel products

3.16.1 Special provisions

None

3.16.2 System boundary

For iron or steel products, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from combustion of fuels and process emissions from flue gas treatment, including re-heating, re-melting, casting, hot rolling, cold rolling, forging, annealing, coating, galvanizing, wire drawing, pickling and excluding the following processes: plating, cutting, welding and finishing of iron or steel products.

3.17 Unwrought aluminium

3.17.1 Special provisions

This aggregated goods category includes non-alloyed as well as alloyed aluminium, in physical form typical for unwrought metals, such as ingots, slabs, billets or granules. In integrated aluminium plants, liquid aluminium directly charged to the production of aluminium products is included, too.

3.17.2 System boundary

3.17.2.1 Primary (electrolytic) smelting

For that production route, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from the consumption of electrodes or electrode pastes;
- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from any fuels used (e.g. for drying and pre-heating of raw materials, heating of electrolysis cells, heating required for casting);
- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from any flue gas treatment, from soda ash or limestone if relevant;
- perfluorocarbon emissions caused by anode effects monitored in accordance with Point B.7 of Annex II.

3.17.2.2 Secondary melting (recycling)

Secondary melting (recycling) of aluminium uses aluminium scrap as main input. However, where unwrought aluminium from other sources is added, it is treated like a precursor.

For that production route, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from any fuels used for drying and pre-heating of raw materials, used in melting furnaces, in pre-treatment of scrap such as de-coating and de-oiling, and combustion of the related residues, and fuels required for casting of ingots, billets or slabs;
- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from any fuels used in associated activities such as treatment of skimmings and slag recovery;
- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from any flue gas treatment, from soda ash or limestone if relevant.

3.18 Aluminium products

3.18.1 Special provisions

None

3.18.2 System boundary

For aluminium products, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes emitting CO₂ emissions from combustion of fuels and process emissions from flue gas treatment,

excluding the following processes: cutting, welding and finishing of aluminium products.

3.19 Electricity

3.19.1 *Special provisions*

The emission factor for electricity shall be determined in accordance with Point D.2 of Annex III.

3.19.2 *System boundary*

For electricity, direct emissions monitoring shall take into account:

- all processes directly or indirectly linked to the production processes emitting combustion emissions and process emissions from flue gas treatment.

Documents provisionally published. Official versions are still to be published

ANNEX II - Rules for determining data set of production processes at installation level

A. PRINCIPLES AND GENERAL REQUIREMENTS

A.1. Overall approach

1. For the purpose of determining embedded emissions of goods the following activities shall be performed:
 - (a) the production processes relating to the functional units produced in the installation shall be identified, taking into account the rules for setting system boundaries of production processes in accordance with point A.4 of this Annex;
 - (b) at the level of the installation producing the goods, the direct emissions of the greenhouse gases specified in Annex II for those goods shall be monitored in line with the methods provided in point B of this Annex;
 - (c) where measurable heat is imported to, produced in, consumed in or exported from the installation, net heat flows shall be monitored in line with the methods provided in point C of this Annex;
 - (d) if the installation produces goods listed in Annex I to Regulation (EU) 2023/956, but not in Annex II to that Regulation, for the purpose of monitoring indirect emissions embedded in these goods, the consumption of electricity in the relevant production processes shall be monitored in line with the methods provided in point D.1 of this Annex. Where a direct technical link or a power purchase agreement is in place with the producer of electricity in accordance with point 6, of Annex IV of that Regulation, the emissions associated with that electricity production shall be monitored in order to determine the emission factor for that electricity. Any quantities of electricity transferred between production processes or exported from the installation shall be monitored as well;
 - (e) the direct emissions at the installations, with heat production and consumption, electricity production and consumption, and any relevant waste gas streams shall be attributed to the production processes associated with the goods produced by applying the rules provided in Annex III. Those attributed emissions shall be used to calculate the specific direct and, where relevant, indirect embedded emissions of the goods produced, applying the point B, of Annex III;
 - (f) for those goods whose production processes include precursors, making those goods 'complex goods', the embedded emissions of the precursor shall be determined in accordance with point E, of this Annex, and shall be added to the embedded emissions of the complex goods produced, by applying the rules provided in point B, of Annex III. Where precursors are themselves complex goods, that process shall be repeated recursively until no more precursors are at stake.
2. An operator can either determine actual values of embedded emissions, or make use of the default values made available in accordance with Annex IV of Regulation (EU) 2023/956, or combine actual values and default values.
3. The embedded emissions of goods shall be calculated as average of the reporting period chosen.

4. For precursors produced outside the installation and originating in third countries and territories that are not exempted pursuant to point 1 of Annex III to Regulation (EU) 2023/956, actual data obtained from the operator of the installation producing the precursor shall be used only if the following conditions are met:
 - (a) the data must be taken from a verification report that has been issued by a verifier having an accreditation in accordance with Article 18 of Commission Delegated Regulation (EU) XX/XX³ [OP please insert reference of C(2025)7845] valid at the time of issuing the verification report and for the sectoral scope required for the aggregated goods category of the precursor under consideration; and
 - (b) the verification report must cover the reporting period during which the precursor was produced.
5. Where the operator does not have a verification report meeting conditions a) and b), the relevant default values, made available in accordance with Annex IV of Regulation (EU) 2023/956, for the precursor shall be used.
6. Emissions data over a full reporting period shall be expressed in tonnes CO_{2e} rounded to full tonnes.
7. All parameters used to calculate the emissions shall be rounded to include all significant digits for the purpose of calculating and reporting emissions.
8. Specific direct and indirect embedded emissions shall be expressed in tonnes of CO_{2e} per tonne of goods, rounded to include all significant digits, with a maximum of 5 digits after the comma.

A.2. Monitoring principles

For the monitoring of actual data at installation level, and for data sets necessary for attributing emissions to goods, the following principles shall apply:

1. Completeness: The monitoring methodology shall cover all parameters necessary to determine the embedded emissions of the goods listed in Annex I to Regulation (EU) 2023/956 in accordance with the methods and formulae contained in this Annex. For this purpose, the following guiding principles shall apply:
 - (a) direct emissions at installation level include combustion and process emissions;
 - (b) direct embedded emissions include the attributed emissions of the relevant production process in accordance with Article 4 and Annex III, based on direct emissions at the installation, emissions related to relevant heat flows and to material flows between process system boundaries, including waste gases, if relevant. Direct embedded emissions furthermore include the direct embedded emissions of precursors;
 - (c) indirect emissions, if relevant, at the installation level cover the emissions related to electricity consumption within the installation;

³ Commission Delegated Regulation (EU) XX/XX on the conditions for granting accreditation to verifiers.

- (d) indirect embedded emissions, if relevant, include the indirect emissions of the goods produced within the installation, and the indirect embedded emissions of precursors;
 - (e) for each parameter, an appropriate method in accordance with Point A.3 of this Annex shall be selected, ensuring that neither double counting nor data gaps occur.
- 2. Consistency and comparability: Monitoring and reporting shall be consistent and comparable over time. To that end, the selected methods shall be laid down in a monitoring plan so that the methods are used consistently. The methodology shall be changed only if objectively justified. Relevant reasons include:
 - (a) changes in the configuration of the installation in the technology used, in the input materials and fuels, or in the goods produced;
 - (b) new data sources or monitoring methods have to be introduced because of changes of trade partners responsible for data used in the monitoring methodology;
 - (c) the accuracy of the data can be improved, data flows can be simplified or the control system can be improved.
- 3. Transparency: Monitoring data including assumptions, references, activity data, emission factors, calculation factors, data on embedded emissions of purchased precursors, measurable heat and electricity, default values of embedded emissions, and any other data relevant for the purpose of this Annex, shall be obtained, recorded, compiled, analysed and documented in a transparent manner that enables a verifier accredited in accordance with Article 18 of Regulation (EU) 2023/956 to verify with reasonable assurance that the data is free of material misstatements. Documentation shall include a record of all changes in the functioning of the installation, of the monitoring methodology and control system applied as documented in the monitoring plan.
- 4. Complete and transparent records shall be kept at the installation of all data relevant for determining embedded emissions of the goods produced, including necessary supporting documents, for at least six years after the reporting period.
- 5. Accuracy: The chosen monitoring methodology shall ensure that emission determination is neither systematically nor knowingly inaccurate. Any source of inaccuracies shall be identified and reduced as far as possible. Due diligence shall be exercised to ensure that the calculation and measurement of emissions exhibit the highest achievable accuracy.

Where data gaps have occurred or are expected to be unavoidable, substitute data shall consist of conservative estimates. Further cases where emissions data shall be based on conservative estimates include:

- (a) carbon monoxide (CO) emitted to the atmosphere shall be calculated as the molar equivalent amount of CO₂;
 - (b) all biomass emissions should be treated like fossil emission, unless evidence for meeting the criteria for zero rating in accordance with point B.3.3 of this Annex is provided.
- 6. Integrity of methodology: The chosen monitoring methodology shall enable reasonable assurance of the integrity of emission data to be reported. Emissions shall

be determined using the appropriate monitoring methodologies set out in this Annex. Reported emission data shall be free from material misstatement, avoid bias in the selection and presentation of information, and provide a credible and balanced account of the embedded emissions of installation's produced goods.

7. Data quality: a control system to ensure the quality of the data to be reported shall be applied.
8. Cost-effectiveness: In selecting a monitoring methodology, the improvements from greater accuracy shall be balanced against additional costs. Monitoring and reporting of emissions shall aim for the highest achievable accuracy, unless that is technically not feasible or incurs unreasonable costs.
9. Continuous improvement: Operators shall regularly check if the monitoring plan and its monitoring methodologies can be improved. If the verifier provides any recommendations for improvement in the verification report, the operator shall consider them for implementation within a reasonable timeframe, unless the improvement would incur unreasonable costs or would be technically not feasible.

A.3. Methods representing the best available data source

1. For the determination of embedded emissions of goods, and for underlying data sets, such as emissions related to individual source streams or emission sources, quantities of measurable heat and electricity, the overarching principle shall be to always select the best available data source. For this purpose, the following guiding principles shall apply:
 - (a) if for a specific data set there is no monitoring method referred to in this Annex, or it would incur unreasonable costs or is technically not feasible, default values in made available in accordance with Annex IV of Regulation (EU) 2023/956 shall be used;
 - (b) for direct or indirect determination methods, a method is deemed suitable where it is ensured that any metering, analyses, sampling, calibrations, and validations for the determination of the specific data set are carried out by applying methods defined in relevant EN or ISO standards. Where such standards are not available, national standards may be used. Where no applicable published standards exist, suitable draft standards, industry best practice or other scientifically proven methodologies shall be used, limiting sampling and measurement bias;
 - (c) measuring instruments shall be selected such that they exhibit the lowest uncertainty in use without incurring unreasonable costs. Instruments under legal metrological control are preferred, except where other instruments with significantly lower uncertainty in use are available. Instruments shall be used only in environments appropriate to their use specification;
 - (d) where laboratory analyses are used, or where laboratories carry out sample treatment, calibrations, method validations, or activities relating to continuous emissions measurements, the requirements of point B.5.4.3 .
2. Indirect determination methods: Where no direct determination method is available for a required data set, in particular for cases where net measurable heat going into different production processes needs to be determined, an indirect determination method may be used, such as:

- (a) calculation based on a known chemical or physical process, using appropriate accepted literature values for the chemical and physical properties of substances involved, appropriate stoichiometric factors and thermodynamic properties such as reaction enthalpies, as appropriate;
- (b) calculation based on the installation's design data such as the energy efficiencies of technical units or calculated energy consumption per unit of product;
- (c) correlations based on empirical tests for determining estimation values for the required data set from non-calibrated equipment or data documented in production protocols.

For the purpose of point (c) it shall be ensured that the correlation satisfies the requirements of good engineering practice and that it is applied only to determine values which fall into the range for which it was established. The validity of such correlations shall be evaluated at least once a year.

3. To determine the best available data sources, the data source highest in the ranking presented under point 1 and already available at the installation shall be selected. However, where it is technically feasible to apply a data source higher in the ranking without incurring unreasonable costs, such better data source shall be applied without undue delay. Where different data sources are available for the same data set at the same level in the ranking presented under point 1, the data source which ensures the clearest data flow with lowest inherent risk and control risk regarding misstatements shall be chosen.
4. The data sources chosen under point 3 shall be defined in the monitoring plan for use for the determination and reporting of embedded emissions.
5. To the extent feasible without incurring unreasonable costs, for the purpose of the control system in accordance with point A.5, additional data sources or methods for determining data sets shall be identified to allow corroboration of data sources under point 3. The selected data sources, if any, shall be laid down in the monitoring plan.
6. Recommended improvements: It shall be checked regularly, but at least once per year, whether new data sources have become available, for the purpose of improving the monitoring methods. In the case that such new data sources are considered more accurate in accordance with the ranking presented under point 1, they shall be laid down in the monitoring plan and be applied from the earliest date possible.
7. Technical feasibility: Where a claim is made that applying a specific determination methodology is technically not feasible, a justification for this fact shall be laid down in the monitoring plan. It shall be re-assessed during the regular checks in line with point 6. That justification shall be based on whether the installation has technical resources capable of meeting the needs of a proposed data source or monitoring method that can be implemented in the required time for the purposes of this Annex. Those technical resources shall include availability of required techniques and technology.
8. Unreasonable costs: Where a claim is made that applying a specific determination methodology for a data set incurs unreasonable costs, a justification for this fact shall be laid down in the monitoring plan. It shall be re-assessed during the regular checks in line with point 6. The unreasonable nature of the costs shall be determined as follows.

- (a) Costs for determining a specific data set is considered unreasonable where the operator's cost estimation exceeds the benefit of a specific determination methodology. To that end, the benefit shall be calculated by multiplying an improvement factor with a reference price of EUR 80 per tonne of CO₂e and costs shall include an appropriate depreciation period based on the economic lifetime of the equipment, where applicable.
- (b) The improvement factor shall be:
 - the improvement of estimated uncertainty in a measurement, expressed in per cent, multiplied with the estimated related emissions over the reporting period;
 - 1 % of the related emissions, where no improvement of measuring uncertainty is involved;
 - related emissions means:
 - the direct emissions caused by the source stream or emission source concerned;
 - emissions attributed to a quantity of measurable heat;
 - the indirect emissions related to the quantity of electricity concerned;
 - embedded emissions of a material produced or of a precursor consumed.
- (c) Measures relating to the improvement of an installation's monitoring methodology shall not be deemed to incur unreasonable costs up to an accumulated amount of EUR 4 000 per year.

A.4. Specific provisions of division of installations into production processes

For the goods under the aggregated goods categories crude steel, iron and steel products, unwrought aluminium and aluminium products, where different functional units that only differ in size or shape are produced with the same precursors in types, quantities and proportions, a single multifunctional production process shall be defined for that group of goods and attribution rules set out in point A.2 of Annex III shall apply.

For the goods under the aggregated goods categories fertilisers, where different functional units are produced with the same precursors in types, quantities and proportions or are composed by the same substance, and only differ in concentrations, a single multifunctional production process shall be defined for that group of goods and attribution rules set out in point A.2 of Annex III shall apply.

A.5. Monitoring plan

Template containing the minimum elements to be contained in the monitoring plan:

1. the date and version number of the monitoring plan;

2. a description of the installation and production processes carried out by the installation
3. a list of all relevant goods produced by CN code and functional unit, and where applicable the specific compositions in terms of clinker content and nitrogen content, including precursors not covered by separate production processes in accordance with Article 4;
4. a list of all CBAM production processes and routes carried out at the installation and list of goods delivered per production processes;
5. if relevant, a list of non-CBAM goods produced per production process and the quantity produced;
6. a list of the relevant CBAM benchmarks to be used for the determination of the free allocation adjustment for all relevant goods produced;
7. the methods for monitoring data per each production process including:
 - (a) a detailed description of the calculation-based methodology when applied, including a list of input data and calculation formulae
 - (b) a description of the measurement systems used, and exact location of the measuring instruments to be used for each of the source streams to be monitored
8. the methods for determining calculation factors and sampling plan for each source stream, if applicable;
9. a list of source streams and emission sources and their description for each production process;
10. a list of source streams for which the calculation-based standard method or the mass balance method is used, including the detailed description of the determination of each relevant parameter provided in point B.3.4;
11. a list of emission sources for which a measurement-based methodology is used, including the description of all relevant elements provided in point B.6;
12. A description of the monitoring methodology as far as perfluorocarbons from primary aluminium production are monitored
13. a suitable diagram and process description of the installation including the system boundaries of the installations and different production processes, providing evidence that there is neither double counting nor data gaps in the emissions of the installation;
14. the precursors used in each production process and if produced in other installation, name and country of origin of their suppliers;
15. whether any zero-rated fuels are used and how the operator demonstrates the applicability of zero-rating of the fuels;
16. whether measurable heat is imported from or exported to other installations, and an identification of those installations, a detailed description of the methods to determine the emissions attributed to the heat flows for each production process;
17. for indirect emissions, whether electricity is produced inside the installation; if so, , whether electricity is:
 - (a) produced by co-generation;

- (b) produced by separate generation;
 - (c) produced from fossil or renewable sources;
 - (d) exported from the system boundaries of a production process;
18. where the indirect emissions are determined on the basis of actual emissions, the information needed to provide the relevant parts of the elements of evidence laid down in point D.4.3;
 19. where the embedded emissions of electricity imported into the customs territory of the Union are determined on the basis of actual emissions, the information needed to provide the elements of evidence laid down in point D.2.4, including, where this information is not directly available to the operator, how the operator plans to receive it;
 20. whether waste gases are produced and used in the installation, or imported from or exported to other installations, and an identification of those installations;
 21. whether CO₂ capture, storage and/or use in accordance with point B.8.2. apply, the identity and contact data of a responsible person of the receiving installations or transport infrastructure or entities to which it is transferred, and the monitoring methodology in accordance with point B.8.3;
 22. a control system to ensure the data quality which shall include, where applicable:
 - (a) quality assurance of the relevant measurement equipment ensuring that all 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, and proportionate to the relevance of the measurement equipment;
 - (b) risk assessment where sources of risks of errors in the data flow from primary data to final data are identified
 - (c) quality assurance of information technology systems ensuring that the relevant systems are designed, documented, tested, implemented, controlled and maintained in a way that ensures processing reliable, accurate and timely data in accordance with the risks identified in the risk assessment;
 - (d) segregation of duties in the data flow activities and control activities, as well as management of necessary competencies;
 - (e) internal reviews and validation of data;
 - (f) corrections and corrective action;
 - (g) control of out-sourced processes;
 - (h) keeping records and documentation including the management of document versions.

B. MONITORING OF DIRECT EMISSIONS AT INSTALLATION LEVEL

B.1 Completeness of source streams and emission sources

The boundaries of the installation and its production processes shall be clearly known to the operator and defined in the monitoring plan, taking into account the sector-specific

requirements laid down in point 3 of Annex I and point B.9. The following principles shall apply:

- (a) as a minimum, all relevant greenhouse gas emissions emission sources and source streams associated directly or indirectly with the production of goods listed in point 2 of Annex I shall be covered;
- (b) all emissions from regular operations shall be included, as well as from abnormal events, including start-up, shut-down and emergency situations, over the reporting period;
- (c) emissions from mobile machinery for transportation purposes shall be excluded.

B.2 Choice of monitoring methodology

The applicable methodology shall be either of the following:

- (a) the calculation-based methodology, which consists in determining emissions from source streams on the basis of activity data obtained by means of measurement systems and additional parameters from laboratory analyses or standard values. The calculation-based methodology may be implemented in accordance with the standard method or the mass balance method;
- (b) the measurement-based methodology, which consists in determining emissions from emission sources by means of continuous measurement of the concentration of the relevant greenhouse gas in the flue gas and of the flue gas flow.

The monitoring methodology that gives the most accurate and reliable results shall be chosen, except where sector-specific requirements in accordance with point B.9 require one particular methodology. The applied monitoring methodology may be a combination of methodologies such that different parts of the installation's emissions are monitored by either of the applicable methodologies.

The installation's emissions shall be determined by

$$Em_{Inst} = \sum_{i=1}^n Em_{calc,i} + \sum_{j=1}^m Em_{meas,j} \quad (\text{Equation 4})$$

Where:

Em_{Inst} are the (direct) emissions of the installation expressed in tonnes $\underline{CO_2e}$;

$Em_{calc,i}$ are the emissions from source stream i determined using a calculation-based methodology expressed in tonnes CO_2e ;

$Em_{meas,j}$ are the emissions from emission source j determined using a measurement-based methodology expressed in tonnes CO_2e .

B.3 Formulae and parameters for the calculation-based methodology for CO_2

B.3.1 Standard method

Emissions shall be calculated separately for each source stream as follows:

B.3.1.1 Combustion emissions:

Combustion emissions shall be calculated using the standard method as follows:

$$Em_i = AD_i \cdot EF_i \cdot OF_i \quad (\text{Equation 5})$$

Where:

Em_i are the emissions [t CO₂] caused by fuel i ;

EF_i is the emission factor [t CO₂ / TJ] of fuel i ;

AD_i is the activity data [TJ] of fuel i , calculated as $AD_i = FQ_i \cdot NCV_i$ (Equation 6);

FQ_i is the fuel quantity consumed [t or m³] of fuel i ;

NCV_i is the net calorific value (lower heating value) [TJ/t or TJ/m³] of fuel i ;

OF_i is the oxidation factor (dimensionless) of fuel i , calculated as

$$OF = 1 - C_{ash}/C_{total} \quad (\text{Equation 7});$$

C_{ash} is the carbon contained in ash and flue gas cleaning dust, and

C_{total} is the total carbon contained in the fuel combusted.

The conservative assumption that $OF = 1$ may always be used in order to reduce monitoring efforts.

Provided that this leads to a higher accuracy, the standard method for combustion emissions may be modified as follows:

- (a) the activity data is expressed as fuel quantity (i.e. in t or m³);
- (b) the EF is expressed in t CO₂/t fuel or t CO₂/m³ fuel, as applicable, and
- (c) the NCV may be omitted from the calculation.

If the emission factor of a fuel i is to be calculated from the analyses of carbon content and NCV, the following equation shall be used:

$$EF_i = CC_i \cdot f / NCV_i \quad (\text{Equation 8})$$

Where:

CC_i is the carbon content of the fuel i .

If the emission factor of a material or fuel expressed in t CO₂/t is to be calculated from an analysed carbon content, the following equation is used:

$$EF_i = CC_i \cdot f \quad (\text{Equation 9})$$

Where:

f is the ratio of the molar masses of CO₂ and C: $f = 3.664$ t CO₂/t C.

As the emission factor of biomass shall be zero provided that the criteria given in Point B.3.3 are met, this fact may be taken into account for mixed fuels (i.e. fuels which contain both fossil and biomass components) as follows:

$$EF_i = EF_{pre,i} \cdot (1 - BF_i) \quad (\text{Equation 10})$$

Where:

$EF_{pre,i}$ is the preliminary emission factor of fuel i (i.e. emission factor assuming the total fuel is fossil) and

BF_i is the biomass fraction (dimensionless) of fuel i .

For fossil fuels and where the biomass fraction is not known, BF_i shall be set to the conservative value zero.

B.3.1.2 Process emissions:

Process emissions shall be calculated using the standard method as follows:

$$Em_j = AD_j \cdot EF_j \cdot CF_j \quad (\text{Equation 11})$$

Where:

AD_j is the activity data [t of material] of material j ;

EF_j is the emission factor [t CO₂ / t] of material j , and

CF_j is the conversion factor (dimension-less) of material j .

The conservative assumption that $CF_j = 1$ may always be used in order to reduce monitoring efforts.

In the case of mixed process input materials which contain inorganic as well as organic forms of carbon, the operator may choose either:

- to determine a total preliminary emission factor for the mixed material by analysing the total carbon content (CC_j), and using a conversion factor and, where applicable a biomass fraction and net calorific value related to that total carbon content; or
- to determine the organic and inorganic contents separately and treat them as two separate source streams.

Considering the available measurement systems for activity data and methods for determining the emission factor, for emissions from the decomposition of carbonates, the method giving the more accurate results shall be chosen for each source stream from the following two methods:

- method A (Input based): The emission factor, conversion factor and activity data shall be related to the amount of material input into the process. The standard emission factors of pure carbonates as set out in Table 3 of point G shall be used, taking into account the composition of the material as determined in line with point B.5;
- method B (Output based): The emission factor, conversion factor and activity data shall be related to the amount of output from the process. The standard emission factors of metal oxides after decarbonatisation as provided in Table 4 of point G shall be used, taking into account the composition of the relevant material as determined in line with point B.5.

For CO₂ process emissions other than from carbonates, method A shall be applied.

B.3.2 Mass balance method

The CO₂ quantities relevant for each source stream shall be calculated based on the carbon content in each material, without distinguishing fuels and process materials. Carbon leaving the installation in products instead of being emitted is taken into account by output source streams, which have therefore negative activity data.

The emissions corresponding to each source stream shall be calculated as follows:

$$Em_k = f \cdot AD_k \cdot CC_k \quad (\text{Equation 12})$$

Where:

AD_k is the activity data [t] of material k ; for outputs, AD_k is negative;

f is the ratio of the molar masses of CO_2 and C: $f = 3.664 \text{ t CO}_2/\text{t C}$, and

CC_k is the carbon content of material k (dimensionless and positive).

If the carbon content of a fuel k is calculated from an emission factor expressed in $\text{t CO}_2/\text{TJ}$, the following equation shall be used:

$$CC_k = EF_k \cdot NCV_k / f \quad (\text{Equation 13})$$

If the carbon content of a material or fuel k is calculated from an emission factor expressed in $\text{t CO}_2/\text{t}$, the following equation shall be used:

$$CC_k = EF_k / f \quad (\text{Equation 14})$$

For mixed fuels, the zero-rated biomass fraction may be taken into account, provided that the criteria provided in Point B.3.3 are met as follows:

$$CC_k = CC_{pre,k} \cdot (1 - BF_k) \quad (\text{Equation 15})$$

Where:

$CC_{pre,k}$ is the preliminary carbon content of fuel k (i.e. emission factor assuming the total fuel is fossil) and

BF_k is the zero rated biomass fraction of fuel k (dimensionless).

For fossil fuels or materials and where the biomass fraction is not known, BF shall be set to the conservative value zero. Where biomass is used as input material or fuel, and output materials contain carbon, the overall mass balance shall treat the biomass fraction conservatively, meaning that the total mass of carbon corresponding to the zero-rated carbon fractions of the carbon contained in all relevant output materials is not lower than the total mass of zero-rated fractions of the carbon contained in input materials and fuels, except if the operator provides evidence of a lower biomass fraction in the output materials by a “trace the atom” (stoichiometric) method or by carbon-14 analyses.

B.3.3 Criteria for zero-rating of biomass emissions

1. Where biomass is used as a fuel for combustion, it shall fulfil the criteria of this point. Where the biomass used for combustion does not comply with these criteria, its carbon content shall be considered as fossil carbon.
2. The biomass shall comply with the sustainability and the greenhouse gas emissions saving criteria laid down in Article 29(2) to (7) and (10) of Directive (EU) 2018/2001⁴

⁴ Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (OJ L 328, 21.12.2018, p. 82, ELI: <https://eur-lex.europa.eu/eli/dir/2018/2001/oj/eng>.)

3. By way of derogation from point 2, biomass contained in or produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues shall fulfil only the criteria laid down in Article 29(10) of Directive (EU) 2018/2001. This point shall also apply to waste and residues that are first processed into a product before being further processed into fuels.
4. Electricity, heating and cooling produced from municipal solid waste shall not be subject to the criteria laid down in Article 29(10) of Directive (EU) 2018/2001.
5. The criteria laid down Article 29(2) to (7) and (10) of Directive (EU) 2018/2001 shall apply irrespective of the geographical origin of the biomass.
6. The compliance with the criteria laid down in paragraphs Article 29(2) to (7) and (10) of Directive (EU) 2018/2001 shall be assessed in accordance with Article 30 and Article 31(1) of that Directive. The criteria may be considered complied with if the operator provides evidence of the purchase of a quantity of biofuel, bioliquid or biogas connected to the cancellation of the respective quantity in the Union Database set up pursuant to Article 31a or a proof of sustainability by a recognized voluntary scheme.

B.3.4 Relevant parameters

In line with the formulae given in points B.3.1 to B.3.2, the following parameters shall be determined for each source stream:

- (a) Standard method, combustion:
 - Minimum requirement: Fuel quantity (t or m³), Emission factor (t CO₂ /t or t CO₂/m³).
 - Recommended improvement: Fuel quantity (t or m³), NCV (TJ/t or TJ/m³), Emission factor (t CO₂ /TJ), Oxidation factor, Biomass fraction, evidence for meeting the criteria of point B.3.3.
- (b) Standard method, process emissions:
 - Minimum requirement: Activity data (t or m³), Emission factor (t CO₂ /t or t CO₂/m³).
 - Recommended improvement: Activity data (t or m³), Emission factor (t CO₂ /t or t CO₂/m³), conversion factor.
- (c) Mass balance:
 - Minimum requirement: Material quantity (t), Carbon content (t C /t material).
 - Recommended improvement: Material quantity (t), Carbon content (t C /t material), NCV (TJ/t), biomass fraction, evidence for meeting the criteria of point B.3.3.

B.4 Requirements for activity data

B.4.1 Continual or batch-wise metering

Where quantities of fuels or materials, including goods or intermediate products, have to be determined for a reporting period, one of the following methods may be chosen and laid down in the monitoring plan:

- (a) based on continual metering at the process where the material is consumed or produced;
- (b) based on aggregation of metering of quantities separately (batch-wise) delivered or produced taking into account relevant stock changes. For this purpose the following shall apply:
 - the quantity of fuel or material consumed during the reporting period shall be calculated as the quantity of fuel or material imported during the reporting period, minus the quantity of fuel or material exported, plus the quantity of fuel or material in stock at the beginning of the reporting period, minus the quantity of fuel or material in stock at the end of the reporting period;
 - the production levels of goods or intermediate products shall be calculated as the quantity exported during the reporting period, minus the quantity imported, minus the quantity of product or material in stock at the beginning of the reporting period, plus the quantity of product or material in stock at the end of the reporting period. For avoiding any double counting, products of a production process returned into the same production process are deducted from production levels.

Where it is technically not feasible or would incur unreasonable costs to determine quantities in stock by direct measurement, those quantities may be estimated based on one of the following:

- (a) data from previous years and correlated with appropriate activity levels for the reporting period;
- (b) documented procedures and respective data in audited financial statements for the reporting period.

Where the determination of quantities of products, materials or fuels for the entire reporting period is technically not feasible or would incur unreasonable costs, the next most appropriate day may be chosen to separate a reporting period from the following one. It shall be reconciled accordingly to the reporting period required. The deviations involved for each product, material or fuel shall be clearly recorded to form the basis of a value representative for the reporting period and to be considered consistently in relation to the next year.

B.4.2 Operator's control over measurement systems

The preferred method for determining quantities of products, materials or fuels shall be that the operator of the installation uses measurement systems under its own control. Measurement systems outside the operator's own control, in particular if under the control of the supplier of the material or fuel, may be used in the following cases:

- where the operator does not have an own measurement system available for determining the respective data set;
- where determining the data set by the operator's own measurement system is technically not feasible or would incur unreasonable costs;

- where the operator has evidence that the measurement system outside the operator's control gives more reliable results and is less prone to risks of misstatements.

In the case that measurement systems outside the operator's own control are used, applicable data sources shall be the following:

- amounts from invoices issued by a trade partner, provided that a commercial transaction between two independent trade partners takes place;
- direct readings from the measurement systems.

B.4.3 Requirements for measurement systems

A thorough understanding of the uncertainty associated with metering quantities of fuels and materials, including the influence of the operating environment and, where applicable, the uncertainty of stock determination shall be available. Measuring instruments shall be chosen that ensure the lowest uncertainty available without incurring unreasonable costs and that are fit for the environment they are used in, in accordance with applicable technical standards and requirements. If available, instruments subject to legal metrological control shall be preferred. In this case, the maximum permissible error in service allowed by the relevant national legislation on legal metrological control for the relevant measuring task may be used as the uncertainty value.

Where a measuring instrument needs to be replaced because of malfunction or because calibration demonstrates that requirements are not met anymore, it shall be replaced by instruments that ensure meeting the same or a better uncertainty level compared to the existing instrument.

B.4.4 Recommended improvement

It is considered a recommended improvement to achieve a measurement uncertainty commensurate with the total emissions of the source stream or emission source, with lowest uncertainty for the biggest parts of the emissions. For orientation purposes, for emissions of more than 500 000 t CO₂ per year, the uncertainty over the full reporting period taking into account stock changes, if applicable, shall be 1,5 % or better. For emissions below 10 000 t CO₂ per year, uncertainty lower than 7,5 % shall be acceptable.

B.5 Requirements for calculation factors for CO₂

B.5.1 Methods for determining calculation factors

For the determination of calculation factors required for the calculation-based methodology, one of the following methods may be chosen:

- use of standard values;
- use of proxy data based on empirical correlations between the relevant calculation factor and other properties better accessible to measurement;
- use of values based on laboratory analysis.

Calculation factors shall be determined consistently with the state used for related activity data, referring to the fuel's or material's state in which the fuel or material is purchased or used in the emission causing process, before it is dried or otherwise treated for laboratory analysis. Where this incurs unreasonable costs or where higher accuracy can be achieved,

activity data and calculation factors may be consistently reported referring to the state in which laboratory analyses are carried out.

B.5.2 Applicable standard values

Type I standard values, shall be applicable only if no type II standard value is available for the same parameter and material or fuel.

Type I standard values shall be the following:

- standard factors provided in point G;
- standard factors contained in the latest IPCC guidelines for GHG inventories⁵;
- values based on laboratory analyses carried out in the past, not older than five years and considered representative for the fuel or material.

Type II standard values, shall be the following:

- standard factors used by the country where the installation is located for its latest national inventory submission to the Secretariat of the United Nations Framework Convention on Climate Change;
- values published by national research institutions, public authorities, standardisation bodies, statistical offices etc. for the purpose of more disaggregated emissions reporting than under the point a;
- values specified and guaranteed by the supplier of a fuel or material where there is evidence that the carbon content exhibits a 95 % confidence interval of not more than 1 %;
- stoichiometric values for the carbon content and related literature values for the NCV of a pure substance;
- values based on laboratory analyses carried out in the past not older than two years and considered representative for the fuel or material.

In order to ensure consistency over time, any standard values used shall be laid down in the monitoring plan, and only changed if there is evidence that the new value is more adequate and representative for the fuel or material used than the previous one. Where the standard values change on an annual basis, the authoritative applicable source of that value shall be laid down in the monitoring plan instead of the value itself.

B.5.3 Establishing correlations for determining proxy data

A proxy for the carbon content or emission factor may be derived from the following parameters, in combination with an empirical correlation determined at least once per year in accordance with the requirements for laboratory analyses given in point B.5.4 as follows:

⁵ United Nations International Panel on Climate Change (IPCC): IPCC Guidelines for National Greenhouse Gas Inventories.

- density measurement of specific oils or gases, including those common to the refinery or steel industry;
- net calorific value for specific coal types.

The correlation has to satisfy the requirements of good industrial practice and may be applied only to values of the proxy which fall into the range for which it was established.

B.5.4 Requirements for laboratory analyses

Where laboratory analyses are required for determining properties (including moisture, purity, concentration, carbon content, biomass fraction, net calorific value, density) of products, materials, fuels or waste gases, or for establishing correlations between parameters for the purpose of indirect determination of required data, the analyses shall comply with the requirements of this point.

The result of any analysis shall be used only for the delivery period or batch of fuel or material for which the samples have been taken, and for which the samples were intended to be representative. When determining a specific parameter, the results of all analyses made shall be used with regard to that parameter.

B.5.4.1 Use of standards

Any analyses, sampling, calibrations and validations for the determination of calculation factors shall be carried out by applying methods based on corresponding ISO standards. Where such standards are not available, the methods shall be based on suitable EN or national standards. Where no applicable published standards exist, suitable draft standards, industry best practice guidelines or other scientifically proven methodologies may be used, limiting sampling and measurement bias.

B.5.4.2 Recommendations on sampling plan and minimum frequency of analyses

The minimum frequencies for analyses for relevant fuels and materials listed in Table 1 of this point is recommended to be used. Another analysis frequency may be used in the following cases:

- where Table 1 does not contain an applicable minimum frequency;
- where the minimum frequency listed in Table 1 would incur unreasonable cost;
- where it can be demonstrated that based on historical data, including analytical values for the respective fuels or materials in the reporting period immediately preceding the current reporting period, any variation in the analytical values for the respective fuel or material does not exceed 1/3 of the uncertainty in determining the activity data of the relevant fuel or material.

Where an installation operates for part of the year only, or where fuels or materials are delivered in batches that are consumed over more than one reporting period, a more appropriate schedule for analyses may be chosen, provided that it results in a comparable uncertainty as set out in point (c) of the first subparagraph.

Table 1: Minimum analyses frequencies

Fuel/material	Minimum frequency of analyses
Natural gas	At least weekly
Other gases, in particular synthesis gas and process gases such as refinery mixed gas, coke oven gas, blast-furnace gas, converter gas, oilfield, and gas field gas	At least daily — using appropriate procedures at different parts of the day
Fuel oils (for example light, medium, heavy fuel oil, bitumen)	Every 20 000 tonnes of fuel and at least six times a year
Coal, coking coal, coke, petroleum coke, peat	Every 20 000 tonnes of fuel/material and at least six times a year
Other fuels	Every 10 000 tonnes of fuel and at least four times a year
Untreated solid waste (pure fossil or mixed biomass/fossil)	Every 5 000 tonnes of waste and at least four times a year
Liquid waste, pre-treated solid waste	Every 10 000 tonnes of waste and at least four times a year
Carbonate minerals (including limestone and dolomite)	Every 50 000 tonnes of material and at least four times a year
Clays and shales	Amounts of material corresponding to emissions of 50 000 tonnes of CO ₂ and at least four times a year
Other materials (primary, intermediate, and final product)	Depending on the type of material and the variation, amounts of material corresponding to emissions of 50 000 tonnes of CO ₂ and at least four times a year

Samples shall be representative for the total batch or time period of deliveries for which they are taken. In order to ensure representativeness, the heterogeneity of the material has to be taken into account, as well as all other relevant aspects such as the available sampling equipment, possible segregation of phases or local distribution of particle sizes, stability of samples, etc. The sampling method is recommended to be laid down in the monitoring plan.

It is considered a recommended improvement to use a dedicated sampling plan for each relevant material or fuel, following applicable standards, containing the relevant information on methodologies for the preparation of samples, including information on responsibilities, locations, frequencies and quantities, and methodologies for the storage and transport of samples.

B.5.4.3 Recommendations for laboratories

Laboratories used to carry out analyses for the determination of calculation factors are recommended to be accredited in accordance with ISO/IEC 17025, for the relevant analytical methods. Laboratories not accredited may be used for the determination of calculation factors where there is evidence that access to accredited laboratories is technically not feasible or would incur unreasonable costs, and that the non-accredited laboratory is sufficiently competent. A laboratory shall be considered sufficiently competent if it complies with all of the following:

- it is economically independent of the operator;
- it applies the applicable standards for the analyses requested;
- it employs personnel competent to carry out the specific tasks assigned;
- it appropriately manages the sampling and sample preparation, including control of sample integrity;
- it regularly carries out quality assurance on calibrations, sampling and analytical methods, by suitable methods, including regular participation in proficiency testing schemes, applying analytical methods to certified reference materials, or inter-comparison with an accredited laboratory;
- it manages equipment appropriately, including by maintaining and implementing procedures for calibration, adjustment, maintenance and repair of equipment, and record keeping thereof.

B.5.5 Recommended methods for determination of calculation factors

It is considered a recommended improvement to apply standard values only for source streams which correspond to minor emission quantities, and to apply laboratory analyses for all major source streams. The following list presents the applicable methods in sequence of increasing data quality:

- type I standard values;
- type II standard values;
- correlations for determining proxy data;
- analyses carried out outside the operator's control, e.g. by the supplier of the fuel or material, contained in purchase documents, without further information on the methods applied;
- analyses in non-accredited laboratories, or in accredited laboratories, but with simplified sampling methods;
- analyses in accredited laboratories, applying best practice regarding sampling.

B.6 Requirements for a measurement-based methodology for CO₂ and N₂O

B.6.1 General provisions

A measurement-based methodology requires the use of a Continuous Emission Measurement System (CEMS) installed at a suitable measurement point.

For the monitoring of N₂O emissions, the use of the measurement-based methodology, is mandatory. For CO₂ it shall be used only if there is evidence that it leads to more accurate data than the calculation-based methodology. The requirements on uncertainty of measurement systems pursuant to Point B.4.3 of this Annex shall apply.

CO emitted to the atmosphere shall be treated as the molar equivalent amount of CO₂.

Where several emission sources exist in one installation and cannot be measured as one emission source, the operator shall measure emissions from those sources separately and add the results to obtain the total emissions of the gas in question over the reporting period.

B.6.2 Method and calculation

B.6.2.1 Emissions of a reporting period (annual emissions)

The total emissions from an emission source over the reporting period shall be determined by summing up over the reporting period all hourly values of the measured greenhouse gas concentration multiplied by the hourly values of the flue gas flow, where the hourly values shall be averages over all individual measurement results of the respective operating hour, applying the formula:

$$GHG\ EM_{total}[t] = \sum_{i=1}^{HoursOp} (GHG\ conc_{hourly,i} \cdot V_{hourly,i}) \cdot 10^{-6}[t/g] \quad \text{(Equation 16)}$$

Where:

$GHG\ Em_{total}$ are the total annual GHG emissions in tonnes;

$GHG\ conc_{hourly,i}$ are the hourly concentrations of GHG emissions in g/Nm³ in the flue gas flow measured during operation for hour or shorter reference period i ;

$V_{hourly,i}$ is the flue gas volume in Nm³ for one hour or a shorter reference period i , determined by integrating the flow rate over the reference period, and

$HoursOp$ = are the total number of hours (or shorter reference periods) for which the measurement-based methodology is applied, including the hours for which data has been substituted in accordance with point B.6.2.6.

The index i refers to the individual operating hour (or reference periods).

Hourly averages for each measured parameter shall be calculated before further processing, by using all data points available for that specific hour. Where data for shorter reference periods can be generated without additional cost, those periods shall be used for the determination of the annual emissions.

B.6.2.2 Determination of GHG concentration

The concentration of the GHG under consideration in the flue gas shall be determined by continuous measurement at a representative point through one of the following:

- direct measurement of the concentration of the GHG;
- indirect measurement: in the case of high concentration in the flue gas, the concentration of the GHG may be calculated using an indirect concentration measurement taking into account the measured concentration values of all other components i of the gas stream, using the following formula:

$$GHG\ conc\ [\%] = 100\% - \sum_i Conc_i[\%] \quad \text{(Equation 17)}$$

Where:

$conc_i$ is the concentration of gas component i .

B.6.2.3 CO₂ emissions from biomass

Where relevant, any CO₂ amount stemming from biomass which complies with the criteria given in point B.3.3 may be subtracted from the total measured CO₂ emissions, provided one of the following methods is used for the amount of biomass CO₂ emissions:

- a calculation-based methodology, including methodologies using analyses and sampling based on ISO 13833 (Stationary source emissions — Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide — Radiocarbon sampling and determination);
- another method based on a relevant standard, including ISO 18466 (Stationary source emissions — Determination of the biogenic fraction in CO₂ in stack gas using the balance method);

B.6.2.4 Determining CO₂e emissions from N₂O

In the case of N₂O measurements, the total annual N₂O emissions from all emissions sources, measured in tonnes to three decimal places, shall be converted to annual CO₂e in rounded tonnes, using the following formula and the GWP values given in point G:

$$CO_2e [t] = N_2O_{annual}[t] \times GWP_{N_2O} \quad (\text{Equation 18})$$

Where:

N_2O_{annual} is the total annual N₂O emissions, calculated in accordance with point B.6.2.1.

B.6.2.5 Determination of flue gas flow

The flue gas flow may be determined by one of the following methods:

- calculation by means of a suitable mass balance, taking into account all significant parameters on the input side, including for CO₂ emissions at least input material loads, input airflow and process efficiency, and on the output side, including at least the product output and the concentration of oxygen (O₂), sulphur dioxide (SO₂) and nitrogen oxides (NO_x);
- determination by continuous flow measurement at a representative point.

B.6.2.6 Treatment of measurement gaps

Where the continuous measurement equipment for a parameter is out of control, out of range or out of operation for part of the hour or reference period, the related hourly average shall be calculated pro rata to the remaining data points for that specific hour or shorter reference period, provided that at least 80 % of the maximum number of data points for a parameter are available.

Where fewer than 80 % of the maximum number of data points for a parameter are available, the following methods shall be used.

In the case of a parameter directly measured as concentration, a substitution value as the sum of an average concentration and twice the standard deviation associated with that average is used, applying the following equation:

$$C_{subst}^* = \bar{C} + 2 \sigma_c \quad (\text{Equation 19})$$

Where:

\bar{C} is the arithmetic mean of the concentration of the specific parameter over the whole reporting period or, where specific circumstances applied when data loss occurred, an appropriate period reflecting the specific circumstances and

σ_c is the best estimate of the standard deviation of the concentration of the specific parameter over the whole reporting or, where specific circumstances applied when data loss occurred, an appropriate period reflecting the specific circumstances.

Where the reporting period is not applicable for determining such substitution values due to significant technical changes at the installation, another sufficiently representative timeframe shall be chosen for determining the average and standard deviation, where possible of a duration of at least six months.

In the case of a parameter other than concentration, substitute values shall be determined through a suitable mass balance model or an energy balance of the process. This model shall be validated by using the remaining measured parameters of the measurement-based methodology and data at regular working conditions, considering a time period of the same duration as the data gap.

B.6.3 Quality requirements

All measurements shall be carried out applying methods based on:

- ISO 20181:2023 Stationary source emissions — Quality assurance of automated measuring systems
- ISO 14164:1999 Stationary source emissions — Determination of the volume flowrate of gas streams in ducts — Automated method
- other relevant ISO standards, in particular ISO 16911-2 (Stationary source emissions — Manual and automatic determination of velocity and volume flow rate in ducts).

Where no applicable published standards exist, suitable draft standards, industry best practice guidelines or other scientifically proven methodologies shall be used, limiting sampling and measurement bias.

All relevant aspects of the continuous measurement system shall be considered, including the location of the equipment, calibration, measurement, quality assurance and quality control.

Laboratories carrying out measurements, calibrations and relevant equipment assessments for continuous measurement systems shall be accredited in accordance with ISO/IEC 17025 for the relevant analytical methods or calibration activities. Where the laboratory does not have such accreditation, sufficient competence in line with point B.5.4.3 shall be ensured.

B.6.4 Corroborating calculations

CO₂ emissions determined by a measurement-based methodology shall be corroborated by calculating the annual emissions of each greenhouse gas in question for the same emission sources and source streams. For this purpose, the requirements laid down in points B.4 to B.6 may be simplified as appropriate.

B.6.5 Minimum requirements for continuous emissions measurements

As a minimum requirement, an uncertainty 7,5 % of the GHG emissions of an emission source over the full reporting period shall be achieved. For minor emission sources, or under exceptional circumstances 10 % uncertainty may be allowed. It is a recommended improvement to achieve an uncertainty of 2,5 % at least for emission sources emitting more than 100 000 tonnes of fossil CO_{2e} per reporting period.

B.7 Requirements for determining perfluorocarbon emissions

Monitoring shall cover emissions of perfluorocarbons (PFCs) resulting from anode effects including fugitive emissions of perfluorocarbons. Emissions not related to anode effects shall be determined based on estimation methods in accordance with industry best practice, in particular guidelines provided by the International Aluminium Institute.

PFC emissions shall be calculated from the emissions measurable in a duct or stack ('point source emissions') as well as fugitive emissions using the collection efficiency of the duct:

$$PFC \text{ emissions (total)} = PFC \text{ emissions (duct)} / \text{collection efficiency} \quad (\text{Equation 20})$$

The collection efficiency shall be measured when the installation-specific emission factors are determined.

The emissions of CF₄ and C₂F₆ emitted through a duct or stack shall be calculated by using one of the following methods:

- method A where the anode effect minutes per cell-day are recorded;
- method B where the anode effect overvoltage is recorded.

B.7.1 Calculation Method A – Slope Method

The following equations for determining PFC emissions shall be used:

$$CF_4 \text{ emissions [t]} = AEM \times (SEF_{CF_4}/1\,000) \times Pr_{Al} \quad (\text{Equation 21})$$

$$C_2F_6 \text{ emissions [t]} = CF_4 \text{ emissions} \times F_{C_2F_6} \quad (\text{Equation 22})$$

Where:

AEM is the anode effect minutes / cell-day;

SEF_{CF₄} is the slope emission factor expressed in (kg CF₄ / t Al produced) / (anode effect minutes / cell-day)]. Where different cell-types are used, different SEF may be applied as appropriate;

PrAl is the production of primary aluminium [t] during the reporting period, and

$F_{C_2F_6}$ is the weight fraction of C_2F_6 [$t C_2F_6 / t CF_4$].

The anode effect minutes per cell-day expresses the frequency of anode effects (number anode effects / cell-day) multiplied by the average duration of anode effects (anode effect minutes / occurrence):

$$AEM = frequency \times average duration \quad (\text{Equation 23})$$

Emission factor: The emission factor for CF_4 (slope emission factor, SEF_{CF_4}) expresses the amount [kg] of CF_4 emitted per tonne of aluminium produced per anode effect minute per cell-day. The emission factor (weight fraction $F_{C_2F_6}$) of C_2F_6 expresses the amount [kg] of C_2F_6 emitted proportionate to the amount [kg] of CF_4 emitted.

Minimum requirement: Technology-specific emission factors from Table 2 of this point are used.

Recommended improvement: Installation-specific emission factors for CF_4 and C_2F_6 are established through continuous or intermittent field measurements. For the determination of those emission factors industry best practice shall be applied, in particular the most recent guidelines provided by the International Aluminium Institute. The emission factor shall also take into account emissions related to non-anode effects. Each emission factor shall be determined with a maximum uncertainty of $\pm 15\%$. The emission factors shall be determined at least every three years or earlier where necessary due to relevant changes at the installation. Relevant changes shall include a change in the distribution of anode effect duration, or a change in the control algorithm affecting the mix of the types of anode effects or the nature of the anode effect termination routine.

Table 2: Technology-specific emission factors related to activity data for the slope method.

Technology	Emission factor for CF_4 (SEF_{CF_4}) [(kg CF_4 /t Al) / (AE-Mins/cell-day)]	Emission factor for C_2F_6 ($F_{C_2F_6}$) [t C_2F_6 / t CF_4]
Legacy Point Feed Pre Bake (PFPB L)	0,122	0,097
Modern Point Feed Pre Bake (PFPB M)	0,104	0,057
Modern Point-Fed Prebake without fully automated anode effect intervention strategies for PFC emissions (PFPB MW)	– (*)	– (*)
Centre Worked Prebake (CWPB)	0,143	0,121
Side Worked Prebake (SWPB)	0,233	0,280
Vertical Stud Söderberg (VSS)	0,058	0,086
Horizontal Stud Söderberg (HSS)	0,165	0,077

(*) The installation operator has to determine the factor by own measurements. If this is technically not feasible or involves unreasonable costs, the values for CWPB methodology shall be used.

B.7.2 Calculation Method B – Overvoltage Method

For the overvoltage method, the following equations shall be used:

$$CF_4 \text{ emissions [t]} = OVC \times (AEO/CE) \times Pr_{Al} \times 0,001 \quad (\text{Equation 24})$$

$$C_2F_6 \text{ emissions [t]} = CF_4 \text{ emissions} \times F_{C_2F_6} \quad (\text{Equation 25})$$

Where:

OVC is the overvoltage coefficient ('emission factor') expressed in kg CF₄ per tonne of aluminium produced per mV overvoltage;

AEO is the 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;

CE is the average current efficiency of aluminium production [%];

Pr_{Al} is the annual production of primary aluminium [t], and

F_{C₂F₆} is the weight fraction of C₂F₆ [t C₂F₆ / t CF₄].

the term AEO/CE (Anode effect overvoltage / current efficiency) expresses the time-integrated average anode effect overvoltage [mV overvoltage] per average current efficiency [%].

Minimum requirement: Technology-specific emission factors from Table 3 of this Annex shall be used.

Recommended improvement: Installation-specific emission factors are used for CF₄ [(kg CF₄ / t Al) / (mV)] and C₂F₆ [t C₂F₆ / t CF₄] established through continuous or intermittent field measurements. For the determination of those emission factors industry best practice shall be applied, in particular the most recent guidelines provided by the International Aluminium Institute. The emission factors shall be determined with a maximum uncertainty of ±15% each. The emission factors shall be determined at least every three years or earlier where necessary due to relevant changes at the installation. Relevant changes shall include a change in the distribution of anode effect duration, or a change in the control algorithm affecting the mix of the types of anode effects or the nature of the anode effect termination routine

Table 3: 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 ₂ F ₆ [t C ₂ F ₆ / t CF ₄]
Centre Worked Prebake (CWPB)	1,16	0,121
Side Worked Prebake (SWPB)	3,65	0,252

B.7.3 Determination of CO_{2e} emissions

CO_{2e} emissions shall be calculated from CF₄ and C₂F₆ emissions as follows, using the global warming potentials listed in Point G of this Annex.

$$\text{PFC emissions [t CO}_2\text{e]} = \text{CF}_4 \text{ emissions [t]} \times \text{GWP}_{\text{CF}_4} + \text{C}_2\text{F}_6 \text{ emissions [t]} \times \text{GWP}_{\text{C}_2\text{F}_6}$$

(Equation 26)

B.8 Requirements for CO₂ transfers

B.8.1 CO₂ contained in gases (“inherent CO₂”)

Inherent CO₂ that is transferred into an installation, including that contained in natural gas, a waste gas (including blast furnace or coke oven gas) or in process inputs (including synthesis gas), shall be included in the emission factor for that source stream.

Where inherent CO₂ transferred out is emitted (e.g., vented or flared), it shall be counted as emissions of the installation where it originates.

B.8.2 Eligibility to deduct stored or used CO₂

- (1) In the following cases CO₂ originating from fossil carbon and originating from combustion or processes leading to process emissions, or which is imported from other installations, including in the form of inherent CO₂, may be accounted for as not emitted, provided they comply with point (2):
 - (a) if the CO₂ is used within the installation or transferred out of the installation to any of the following:
 - an installation for the purpose of CO₂ capture which monitors emissions for the purpose of this Regulation;
 - an installation or transport network with the purpose of long-term geological storage of CO₂ which monitors emissions for the purpose of this Regulation;
 - a storage site for the purpose of long-term geological storage which monitors emissions for the purpose of this Regulation, providing for conditions equivalent to those laid out in Union law.
 - (b) if the CO₂ is used within the installation or transferred out of the installation to an entity which monitors emissions for the purpose of this Regulation, in order to produce products in which the carbon stemming from CO₂ is permanently chemically bound so that it does not enter the atmosphere under normal use, including any normal activity taking place after the end of the life of the product, as defined in Commission Delegated Regulation (EU) 2024/2620⁶.
- (2) CO₂ transferred to another installation for the purposes referred to in point (1) may be accounted for as not emitted only to the extent evidence is provided across the

⁶ Commission Delegated Regulation (EU) 2024/2620 of 30 July 2024 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards the requirements for considering that greenhouse gases have become permanently chemically bound in a product (OJ L, 4.10.2024, ELI: https://eur-lex.europa.eu/eli/reg_del/2024/2620/oj/eng)

whole chain of custody to the storage site or installation of CO₂ use and including any transport operators, of the fraction of CO₂ actually stored or used for the production of chemically stable products compared to the total amount of CO₂ transferred out of the originating installation. In addition, installation operators shall comply with the monitoring rules set in point B.8.3.

B.8.3 Monitoring rules for CO₂ transfers

The identity and contact data of a responsible person of the receiving installations or entities shall be clearly laid down in the monitoring plan. The amount of CO₂ considered not emitted shall be reported in the emission report pursuant to Annex IV.

The identity and contact data of a responsible person of the installations or entities from which CO₂ was received shall be clearly laid down in the monitoring plan. The amount of CO₂ received shall be reported in the emission report pursuant to Annex IV.

For the determination of the quantity of CO₂ transferred from one installation to another, a measurement-based methodology shall be used.

For the amount of CO₂ permanently chemically bound in products, a calculation-based methodology shall be used, preferably using a mass balance. The chemical reactions applied, and all relevant stoichiometric factors shall be laid down in the monitoring plan.

If CO₂ is used for the purposes referred to in point (1) of point B.8.2., the monitoring methods set out in points 21 to 23 of Annex IV to Commission Implementing Regulation (EU) 2018/2066⁷ shall be applied.

B.9 Sector specific requirements

B.9.1 Additional rules for combustion units

Combustion emissions shall cover all CO₂ emissions from the combustion of carbon-containing fuels, including wastes, independent of any other classification of such emissions or fuels. Where it is unclear if a material acts as fuel or as process input, e.g., for reducing metal ores, that material's emissions shall be monitored the same way as combustion emissions. All stationary combustion units shall be considered, including boilers, burners, turbines, heaters, furnaces, incinerators, calciners, kilns, ovens, dryers, engines, fuel cells, chemical looping combustion units, flares, thermal or catalytic post-combustion units.

Monitoring shall furthermore include CO₂ process emissions from flue gas scrubbing, in particular CO₂ from limestone or other carbonates for desulphurisation and similar scrubbing, and from urea used in de-NO_x units.

B.9.1.1 Desulphurisation and other acid gas scrubbing

Process CO₂ emissions from the use of carbonates for acid gas scrubbing from the flue gas stream shall be calculated on the basis of carbonate consumed (Method A). In the case of desulphurisation, calculation may be based alternatively on the quantity of gypsum produced

⁷ Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L334, 31.12.2018, p.1, ELI: https://eur-lex.europa.eu/eli/reg_impl/2018/2066/oj/eng).

(Method B). In the latter case, the emission factor shall be the stoichiometric ratio of dry gypsum ($\text{CaSO}_4 \times 2\text{H}_2\text{O}$) to CO_2 emitted: 0,2558 t CO_2 /t gypsum.

B.9.1.2 De- NO_x

If urea is used as reduction agent in a de- NO_x unit, process CO_2 emissions from its use shall be calculated using method A, applying an emission factor based on the stoichiometric ratio of 0,7328 t CO_2 /t urea.

B.9.1.3 Monitoring of flares

When calculating emissions from flares, routine flaring as well as operational flaring (trips, start-up, and shutdown as well as emergency relieves) shall be covered. Inherent CO_2 in the flared gases is to be included.

If more accurate monitoring is technically not feasible or would lead to unreasonable costs, a reference emission factor of 0,00393 t CO_2 /Nm³ shall be used, derived from the combustion of pure ethane used as a conservative proxy for flare gases.

It is a recommended improvement to determine installation-specific emission factors 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 shall be derived for the molecular weight of the flare gas.

For activity data, higher measurement uncertainty than for other fuels combusted is acceptable.

B.9.2 Additional rules for emissions from cement clinker production

B.9.2.1 Additional rules for Method A (input based)

Where method A (kiln input based) is used for determining process emissions, the following special rules shall apply:

- Where cement kiln dust (CKD) or bypass dust leave the kiln system, the related quantities of raw material shall not be considered as process input. Emissions from CKD shall be calculated separately in accordance with point B.9.2.3.
- Either raw meal as a whole, or separate input materials may be characterised, avoiding double counting or omissions from returned or by-passed materials. Where activity data is determined based on the clinker produced, the net amount of raw meal may be determined by means of a site-specific empirical raw meal/clinker ratio. That ratio shall be updated at least once per year applying industry best practice guidelines.

B.9.2.2 Additional rules for Method B (output based)

Where method B (clinker output based) is used for determining process emissions, the following special rules shall apply:

Activity data shall be determined as the clinker production [t] over the reporting period in one of the following ways:

- by direct weighing of clinker;

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

$$Cli_{prod} = (Cem_{deliv} - Cem_{SV}) \cdot CCR - Cli_s + Cli_d - Cli_{SV} \quad (\text{Equation 27})$$

- Where:
- Cli_{prod} is the amount of clinker produced expressed in tonnes;
- Cem_{deliv} is the amount of cement deliveries expressed in tonnes;
- Cem_{SV} are the cement stock variations expressed in tonnes;
- CCR is the clinker to cement ratio (tonnes clinker per tonne cement);
- Cli_s is the amount of clinker supplied expressed in tonnes;
- Cli_d is the amount of clinker dispatched expressed in tonnes, and
- Cli_{SV} is the amount of clinker stock variations expressed in tonnes.

The clinker to cement ratio shall either be derived separately for each of the different cement products based on laboratory analyses in line with the provisions of Point B.5.4 or calculated as ratio 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.

As minimum requirement to determine the emission factor, a standard value of 0,525 t CO₂/t clinker shall be applied.

B.9.2.3 Emissions related to discarded dust

CO₂ process emissions from bypass dust or cement kiln dust (CKD) leaving the kiln system, shall be added to the emissions, corrected for a partial calcination ratio of CKD.

Minimum requirement: An emission factor of 0,525 t CO₂/t dust shall be applied.

Recommended improvement: The emission factor (EF) is determined at least once annually in line with the provisions of point B.5.4 and using the following formula:

$$EF_{CKD} = \left(\frac{EF_{Cli}}{1+EF_{Cli}} \cdot d \right) / \left(1 - \frac{EF_{Cli}}{1+EF_{Cli}} \cdot d \right) \quad (\text{Equation 28})$$

Where:

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

EF_{Cli} is the installation-specific emission factor of clinker [t CO₂/t clinker], and

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

B.9.3 Additional rules for emissions from nitric acid production

B.9.3.1 General rules for N₂O measurement

N₂O emissions shall be determined using a measurement-based methodology. N₂O concentrations in the flue gas from each emission source shall be measured at a representative point, after the NO_x/N₂O abatement equipment, where abatement is used. Techniques capable of measuring N₂O concentrations of all emission sources during both abated and unabated

conditions shall be applied. All measurements shall be adjusted to a dry gas basis where required and consistently reported.

B.9.3.2 Determination of flue gas flow

For monitoring flue gas flow, the mass balance method set out in point B.6.2.5 shall be used, unless it is technically not feasible. In that case, an alternative method may be used, including by another mass balance method based on significant parameters such as ammonia input load, or determination of flow by continuous emissions flow measurement.

The flue gas flow shall be calculated in accordance with the following formula:

$$V_{\text{flue gas flow}} [\text{Nm}^3/\text{h}] = V_{\text{air}} \times (1 - O_{2,\text{air}}) / (1 - O_{2,\text{flue gas}}) \quad (\text{Equation 29})$$

Where:

V_{air} is the total input air flow in Nm^3/h at standard conditions;

$O_{2,\text{air}}$ is the volume fraction of O_2 in dry air ($= 0,2095$), and

$O_{2,\text{flue gas}}$ is the volume fraction of O_2 in the flue gas.

V_{air} shall be calculated as the sum of all air flows entering the nitric acid production unit, in particular primary and secondary input air, and seal input air, where applicable.

All measurements shall be adjusted to a dry gas basis and reported consistently.

B.9.3.3 Oxygen (O_2) concentrations

Where necessary for calculating the flue gas flow in accordance with point B.9.3.2, the oxygen concentrations in the flue gas shall be measured, applying the requirements laid down in point B.6.2.2. All measurements shall be adjusted to a dry gas basis and reported consistently.

C. HEAT FLOWS

C.1 Rules for determining net measurable heat

C.1.1 Principles

All specified amounts of measurable heat shall always refer to net amount of measurable heat, determined as the heat content (enthalpy) of the heat flow transmitted to the heat-consuming process or external user minus the heat content of the return flow.

Heat-consuming processes necessary for operating the heat production and distribution, such as deaerators, make-up water preparation, and regular blow offs, shall be taken into account in the efficiency of the heat system and shall be accounted for in the embedded emissions of goods.

Where the same heat medium is used by several consecutive processes and its heat is consumed starting from different temperature levels, the quantity of heat consumed by each heat-consuming process shall be determined separately, unless the processes are part of the overall production process of the same goods. Re-heating of the transfer medium between consecutive heat-consuming processes shall be treated like additional heat production.

Where heat is used to provide cooling via an absorption cooling process, that cooling process shall be considered as the heat-consuming process.

C.1.2 Methodology for determining net amounts of measurable heat

For the purpose of selecting data sources for quantification of energy flows in accordance with Article 4, the following methods for determining net amounts of measurable heat shall be considered:

C.1.2.1 Method 1: Using measurements

Under this method, all relevant parameters shall be measured, in particular temperature, pressure, state of the transmitted as well as the returned heat medium. In the case of steam, the state of the medium shall refer to its saturation or degree of superheating. The (volumetric) flow rate of the heat transfer medium shall be measured. Based on the measured values, the enthalpy and the specific volume of the heat transfer medium shall be determined using suitable steam tables or engineering software.

The mass flow rate of the medium shall be calculated as

$$\dot{m} = \dot{V} / v \quad (\text{Equation 30})$$

Where:

\dot{m} is the mass flow rate in kg/s;

\dot{V} is the volumetric flow rate in m³/s, and

v is the specific volume in m³/kg.

As the mass flow rate is considered the same for transmitted and returned medium, the heat flow rate shall be calculated using the difference in enthalpy between the transmitted flow and the return, as follows:

$$\dot{Q} = (h_{\text{flow}} - h_{\text{return}}) \cdot \dot{m} \quad (\text{Equation 31})$$

Where:

\dot{Q} is the heat flow rate in kJ/s;

h_{flow} is the specific enthalpy of the transmitted flow in kJ/kg;

h_{return} is the specific enthalpy of the return flow in kJ/kg, and

\dot{m} is the mass flow rate in kg/s.

In the case of steam or hot water used as heat transfer medium, where the condensate is not returned, or where it is not feasible to estimate the enthalpy of the returned condensate, h_{return} shall be determined based on a temperature of 90°C.

If the mass flow rates are known to be not identical, the following shall apply:

where evidence is available that condensate remains in the product (e.g., in ‘life steam injection’ processes), the respective amount of condensate enthalpy is not deducted;

where heat transfer medium is known to be lost (e.g., due to leakages or sewerage), an estimate for the respective mass flow is deducted from the mass flow of the transmitted heat transfer medium.

For determining the annual net heat flow from the above data, one of the following methods shall be used, subject to the measurement equipment and data processing available:

determine annual average values for the parameters determining the annual average enthalpy of the transmitted and returned heat medium, multiplied by the total annual mass flow, using Equation 31;

determine hourly values of the heat flow and sum up those values over the annual total operating time of the heat system. Subject to the data processing system, hourly values may be substituted by other time intervals as appropriate.

C.1.2.2 Method 2: Calculation of a proxy based on measured efficiency

The amounts of net measurable heat shall be determined based on the fuel input and the measured efficiency related to the heat production and transmission:

$$Q = \eta_H \cdot E_{In} \quad (\text{Equation 32})$$

$$E_{In} = \sum_i AD_i \cdot NCV_i \quad (\text{Equation 33})$$

Where:

Q is the amount of heat expressed in TJ;

η_H is the measured efficiency of heat production and transmission;

E_{In} is the energy input from fuels;

AD_i are the annual activity data (i.e., quantities consumed) of the fuels i , and

NCV_i are the net calorific values of the fuels i .

The value of η_H is either measured over a reasonably long period, which sufficiently takes into account different load states of the installation or taken from the manufacturer's documentation. In that regard the specific part load curve shall be taken into account by using an annual load factor, as follows:

$$L_F = \frac{E_{In}}{E_{Max}} \quad (\text{Equation 34})$$

Where:

L_F is the load factor;

E_{In} the energy input as determined using Equation 33 over the reporting period, and

E_{Max} the maximum fuel input if the heat producing unit had been running at 100 % nominal load for the full calendar year.

The efficiency shall be based on a situation in which all condensate is returned. A temperature of 90 °C shall be assumed for the returned condensate.

C.1.2.3 Method 3: Calculating a proxy based on the reference efficiency

This method is identical to method 3, but using a reference efficiency of 70 % ($\eta_{Ref,H} = 0,7$) in Equation 32.

C.1.3 Special rules

Where an installation consumes measurable heat produced from exothermic chemical processes other than combustion, such as in ammonia or nitric acid production, that amount of heat consumed shall be determined separately from other measurable heat and that heat consumption shall be assigned zero CO_{2e} emissions.

D. ELECTRICITY

D.1 Calculation of the emissions related to electricity

The emissions relating to electricity production or consumption shall be calculated using the following equation:

$$Em_{el} = E_{el} \cdot EF_{el} \quad (\text{Equation 35})$$

Where:

Em_{el} are the emissions related to electricity produced or consumed, expressed in t CO₂;

E_{el} is the electricity produced or consumed expressed in MWh, and

EF_{el} is the emission factor for electricity applied, expressed in t CO₂/MWh.

D.2 Rules for determining the emission factor of electricity imported into the customs territory of the Union

For determining the specific embedded emissions of electricity imported into the customs territory of the Union, only direct emissions shall be applicable in accordance with Point 2 of Annex IV to Regulation (EU) 2023/956.

The emission factor for calculating the specific embedded emissions of electricity shall be established as follows:

- the specific default value for a third country, group of third countries or region within a third country, as the relevant CO₂ emission factor as set out in point D.2.1 shall be used;
- where no specific default value is available pursuant to point (a), the CO₂ emission factor in the EU as set out in point D.2.2 be used;
- where a country, or group of third countries, submits sufficient evidence based on official and public information to demonstrate that the CO₂ emission factor in the third country, group of third countries or region within a third country from where electricity is imported is lower than the values in accordance with points (a) and (b), and where the conditions provided in point D.2.3 are fulfilled, the alternative default value determined on the basis of the available and reliable data provided will be used;
- an authorised CBAM declarant may apply actual embedded emissions instead of default values for the calculation of embedded emissions of the imported electricity, if it can be demonstrated, through the elements of evidence outlined in point D.2.4 of this Annex, that the cumulative criteria (a) to (d) provided in point 5 of Annex IV to Regulation (EU) 2023/956 are met, and the calculation is based on data determined in accordance with this Annex by the producer of the electricity, calculated using point D.4.1 or D.4.2. of this Annex.

D.2.1 CO₂ emission factor based on specific default values

In accordance with point 4.2.1 of Annex IV to Regulation (EU) 2023/956, CO₂ emission factors in the third country, group of third countries or region within a third country, shall be used, based on the best data available to the

D.2.2 CO₂ emission factor of the EU

Pursuant to point 4.2.2 of Annex IV to Regulation (EU) 2023/956, the CO₂ emission factor for the Union shall apply.

D.2.3 CO₂ emission factor based on alternative reliable data

For the purpose of point (c) of point D.2, alternative default values may be used for electricity imported from a given third country during a given year, where a third country or group of third countries provides the Commission, by 30 June of that year, with the datasets from reliable alternative official sources, including national statistics, demonstrating that the CO₂ emission factor calculated on the basis of equations 36 and 37 is lower than the CO₂ emission factor laid down in accordance with Annex IV of Regulation (EU) 2023/956. Where the Commission considers the provided alternative official sources reliable, it shall amend, where feasible by 30 June of the following year, the relevant default values. The modified default values shall be applicable to electricity imported during the year in which the datasets from alternative official sources were provided.

Where a third country or group of third countries provides the datasets from alternative official sources after 30 June of a given year, and where the Commission considers them reliable, it shall amend, where feasible by 30 June of the second year following the year during which the datasets from alternative official sources were provided, the relevant default values. The modified default values shall be applicable to electricity imported during the year following the year in which the datasets from alternative official sources were provided. Where the Commission manages to amend the relevant default values in the year following the year during which the datasets from alternative official sources were provided and before the deadline for submitting CBAM declarations in accordance with Article 6 of Regulation (EU) 2023/956, the modified default values shall be applicable to electricity imported during the year in which the datasets from alternative official sources were provided.

The alternative CO₂ emission factor shall be calculated on the basis of the average of the yearly CO₂ emission factors for the most recent five-years period for which reliable data is available.

For this purpose, the yearly CO₂ emission factors shall be calculated, based on the following equation:

$$Em_{el,y} = \frac{\sum_i^n EF_i \times E_{el,i,y}}{E_{el,y}} \quad (\text{Equation 36})$$

Where:

$Em_{el,y}$ is the yearly CO₂ emission factor for all fossil fuel technologies in the given year in the third country, group of third countries, or region within a third country, capable of exporting electricity to the EU;

$E_{el,y}$ is the total gross electricity generation from all fossil fuel technologies in that year; EF_i is the CO₂ emission factor for each fossil fuel technology 'i', and

$E_{el,i,y}$ is the yearly gross electricity generation for each fossil fuel technology 'i'.

The CO₂ emission factor shall be calculated as a moving average of those years starting with the current year minus two, based on the following equation:

$$Em_{el} = \frac{\sum_{y-6}^{y-2} Em_{el,i}}{5} \quad (\text{Equation 37})$$

Where:

Em_{el} is the CO₂ emission factor resulting from the moving average of the yearly CO₂ emission factors of the five previous years, starting from the current year, minus two years, until the current year, minus 6 years;

$Em_{el,y}$ is the CO₂ emission factor for each year 'i';

i is the variable index for the years to consider, and

y is the current year.

Should more recent, reliable data be available, the moving average may start from the current year, minus one year, until the current year, minus five years.

D.2.4 Elements of evidence for using actual embedded emissions for electricity imported into the Union

Pursuant to point 5 of Annex IV to Regulation (EU) 2023/956, an authorised CBAM declarant may apply actual embedded emissions instead of default values for the calculation of embedded emissions of a given quantity of imported electricity if the cumulative criteria (a) to (d) provided in that point are met.

The following elements of evidence shall be submitted to demonstrate that the criteria required to justify the use of actual emissions are fulfilled pursuant to point 5 of Annex IV to Regulation (EU) 2023/956 are fulfilled.

- For criterion (a) as laid down in point 5 of Annex IV to Regulation (EU) 2023/956:
 - (a) contractual evidence demonstrating the existence of a power purchase agreement (PPA) concluded directly between the authorised CBAM declarant and a producer of electricity located in a third country for the physical delivery of electricity. The PPA shall be applicable at the time of electricity import for which actual emissions are claimed and shall cover at least the amount of electricity for which actual emissions are claimed. Where the PPA was concluded through an intermediary, the contractual evidence shall demonstrate that only one single contract was concluded between the three contracting parties.
- For criterion (b) as laid down in point 5 of Annex IV to Regulation (EU) 2023/956, one of the following:
 - (a) a single line diagram demonstrating the existence of a direct connection between the installation producing electricity and the Union transmission system;
 - (b) written documentation, either from the transmission system operator or from another entity with access to relevant information, attesting that at the time of export, determined on an hourly basis, there was no physical network congestion at any point in the network between the installation and the Union transmission system.
- For criterion (c) as laid down in point 5 of Annex IV to Regulation (EU) 2023/956:
 - (a) data showing that the installation producing electricity does not emit more than 550 grammes of CO₂ of fossil fuel origin per kilowatt-hour of electricity.
- For criterion (d) as laid down in point 5 of Annex IV to Regulation (EU) 2023/956:

- (a) written documentation, either from the person who nominated the relevant capacity at the interconnector or from the relevant transmission system operator, demonstrating that a given quantity of electricity has been nominated in the country of origin, the country of destination and, if relevant, each country of transit, and demonstrating the period of time to which the nomination of capacity refers; and
- (b) data from a smart metering system demonstrating that the production of a corresponding amount of electricity by the installation occurred within the same measurement period as the nomination of the capacity. This period shall not exceed one hour.

– For criteria (e) as laid down in point 5 of Annex IV to Regulation (EU) 2023/956:

- (a) monthly interim reports containing the elements of evidence laid down in this point demonstrating how criteria (a) to (d) as laid down in point 5 of Annex IV to Regulation (EU) 2023/956 are fulfilled.

D.3 Rules for determining electricity quantities used for the production of goods other than electricity

For the purpose of determining embedded emissions, metering of electricity quantities shall apply to real power, not apparent power (complex power). Only the active power component shall be metered, and the reactive power shall be disregarded.

For the production of electricity, the activity level shall refer to net electricity leaving the system boundaries of the power plant or cogeneration unit, after subtraction of internally consumed electricity.

D.4 Rules for determining the embedded indirect emissions of electricity used for the production of goods other than electricity

Emission factors for electricity shall be determined based on either:

- the average emission factor of the country of origin electricity grid, made available in accordance with Annex IV of Regulation (EU) 2023/956; or
- where sufficient evidence is submitted based on official and public information to demonstrate that the average emission factor of the grid of a third country or group of third countries, in which electricity was produced, is lower than the values established in accordance with point (a), an alternative default value shall be established in accordance with point D.4.4.
- actual emission factors for electricity may be used in accordance with points D.4.1 to D.4.3.

D.4.1 Emission factor of electricity produced by methods other than cogeneration

Where the criteria for the use of actual emissions for electricity or indirect emissions, as laid down in Annex IV to Regulation (EU) 2023/956, are met, for electricity produced from the combustion of fuels, except electricity produced by cogeneration, the emission factor of electricity EF_{El} shall be determined based on the relevant fuel mix and the emissions attributable to the electricity production shall be calculated as:

$$EF_{El} = (\sum AD_i \cdot NCV_i \cdot EF_i + Em_{FGC}) / El_{prodIs}$$

(Equation 38)

Where:

AD_i are the annual activity data (i.e., quantities consumed) of the fuels i used for the electricity production expressed in tonnes or Nm^3 ;

NCV_i are the net calorific values of the fuels i expressed in TJ/t or TJ/Nm^3 ;

EF_i is the emission factors of the fuels i expressed in $\text{t CO}_2/\text{TJ}$;

Em_{FGC} are the process emissions from flue gas cleaning expressed in t CO_2 , and

El_{prod} is the net amount of electricity produced expressed in MWh . It may include quantities of electricity produced from sources other than combustion of fuels.

Where a waste gas is part of the fuel mix used, and where the emission factor of the waste gas is higher than the standard emission factor of natural gas given in Table 1 of point G, that standard emission factor shall be used to calculate EF_{EI} instead of the emission factor of the waste gas.

D.4.2 Emission factor of electricity produced by cogeneration

Where the criteria for the use of actual emissions for indirect emissions, as laid down in Annex IV to Regulation (EU) 2023/956, are met, the emission factor of electricity production by cogeneration shall be determined according to point A.2.2 of Annex III.

D.4.3 Elements of evidence for using actual indirect embedded emission

Pursuant to point 6 of Annex IV to Regulation (EU) 2023/956, an authorised CBAM declarant may apply actual embedded emissions instead of default values for the calculation of embedded indirect emissions if the required criteria are met. Where the criteria are met, the emission factor shall be determined in accordance with points D.4.1 or D.4.2 of this Annex.

The following elements of evidence shall be provided to demonstrate that the criteria required to justify the use of actual embedded emissions for indirect emissions pursuant to point 6 of Annex IV to Regulation (EU) 2023/956 are fulfilled.

- For the demonstration of a direct technical link:
 - (a) single line diagram demonstrating the existence of a direct technical link between the installation in which the imported good is produced and the electricity generation source;
 - (b) data from a smart metering system demonstrating that the amount of electricity for which the actual emissions are claimed was produced by the installation producing electricity connected by the direct technical link, and demonstrating the time during which the electricity production occurred, with reference to measurement periods not exceeding an hour;
 - (c) data from a smart metering system demonstrating that the amount of electricity for which the actual emissions are claimed, was delivered, within the same measurement period not exceeding one hour, to an installation connected by the direct technical link and producing a good listed in Annex I of Regulation (EU) 2023/956;
 - (d) where the direct technical link connects multiple installations producing electricity with one or multiple installations producing a good listed in Annex I to Regulation (EU) 2023/956, a contract between the operators of the two installations requiring the delivery of at least the amount of electricity for which the actual emissions are claimed from one installation to the other. Where the electricity production

installation and the installation producing a good listed in Annex I to Regulation (EU) 2023/956 are owned by the same legal entity, an intra-company off-take agreement requiring the delivery of at least the corresponding amount of electricity.

– For the demonstration of a power purchase agreement:

- (a) contractual evidence demonstrating the existence of a PPA concluded directly between an installation producing goods listed in Annex I to Regulation (EU) 2023/956 and a producer of electricity located in a third country for the physical delivery of electricity. Where the PPA was concluded through an intermediary, the contractual evidence shall demonstrate that only one single contract was concluded between the three contracting parties;
- (b) data from a smart metering system demonstrating that a given amount of electricity was produced by the installation producing electricity and demonstrating the period of time of production;
- (c) data from a smart metering system demonstrating that an equivalent amount of electricity was delivered, within the same measurement period which shall not exceed one hour, to the installation producing goods listed in Annex I to Regulation (EU) 2023/956;
- (d) written documentation, either from transmission system operators, public authorities or from other sources of relevant public and reliable information, demonstrating a physical grid connection between the installation producing electricity and the installation producing goods listed in Annex I to Regulation (EU) 2023/956.

D.4.4 Emission factor based on alternative reliable data

For the purpose of point (2) of point D.4, alternative default values may be used for electricity used in the production of goods imported during a given year, where a third country or group of third countries demonstrates to the Commission, within 30 June of that year, based on datasets from reliable alternative official sources, including national statistics, that the five years average emission intensity for the third country electricity grid thus calculated on the basis of equation 45 and 56 is lower than the one laid down in accordance with Annex IV of Regulation (EU) 2023/956. Where the Commission considers the provided alternative official sources reliable, it shall amend, where feasible by 30 June of the following year, for that third country or group of third countries, the default value of electricity. The modified default value shall be applicable to electricity used in the production of goods imported during the year in which the datasets from alternative official sources were provided.

Where a third country or group of third countries provides datasets from alternative official sources after 30 June of a given year, and where the Commission considers them reliable, it shall amend, where feasible by 30 June of the second year following the year during which the datasets from alternative official sources were provided, for that third country or group of third countries, the default value of electricity. The modified default value shall be applicable to electricity used in the production of goods imported during year following the year in which the datasets from alternative official sources were provided. Where the Commission manages to amend the relevant default values in the year following the year during which the datasets from alternative official sources were provided and before the deadline for submitting CBAM declarations in accordance with Article 6 of Regulation (EU) 2023/956, the modified default values shall be applicable to electricity used in the production of goods imported during the year in which the datasets from alternative official sources were provided.

The emission factor shall be calculated on the basis of the simple average of the emission factor for the most recent five-years period before the reporting for which reliable data is available.

For the purpose of calculating alternative default values, the Commission shall calculate the yearly emission factors and its respective gross electricity generation in the third country or group of third countries based on the following equation:

$$Em_{el,y} = \frac{\sum_i^n EF_i \times E_{el,i,y}}{E_{el,y}} \quad (\text{Equation 39})$$

Where:

$Em_{el,y}$ is the yearly emission factor for all electricity sources in the given year in the third country;

$E_{el,y}$ is the total gross electricity generation from all electricity sources in that year; EF_i is the emission factor for each electricity source 'i', and

$E_{el,i,y}$ is the yearly gross electricity generation for each electricity source 'i'.

The Commission shall calculate the emission factor as a moving average of those years starting with the current year minus two, based on the following equation:

$$Em_{el} = \frac{\sum_{y-6}^{y-2} Em_{el,i}}{5} \quad (\text{Equation 40})$$

Where:

Em_{el} is the emission factor resulting from the moving average of the emission factors of the five year period starting with the current year minus two;

$Em_{el,y}$ is the emission factor for each year 'i';

i is the variable index for the years to consider, and

y is the current year.

Should more recent, reliable data be available, the moving average may start from the current year, minus one year, until the current year, minus five years.

E. MONITORING OF PRECURSORS

The quantity of each precursor consumed in each production process shall be determined in order to calculate the total embedded emissions of the complex goods produced in accordance with point B of Annex III.

If the precursors are covered by the same production process in accordance to Article 4(9), only the quantity of additional precursor used and obtained from other installations or from other production processes shall be determined.

The quantity used and emission properties shall be determined separately for each production process from which the precursor is sourced. The methods used for determining the required data shall be laid down in the monitoring plan of the installation, applying the following provisions:

- (1) Where the precursor is produced within the installation, but in a different production process as assigned by applying Article 4, the data sets to be determined shall include:
- (a) specific embedded direct and indirect emissions of the precursor as average over the reporting period, expressed in tonnes CO₂e per tonne of precursor;
 - (b) quantity of the precursor used in each production process of the installation.
- (2) Where the precursor is obtained from another installation, data sets to be determined shall include:
- (a) the country of origin of the imported goods;
 - (b) the installation where it was produced, identified by
 - the unique installation identifier, if available;
 - the applicable United Nations Code for Trade and Transport Location (UN/LOCODE) of the location;
 - a full address and its English transcript; and
 - the geographical coordinates of the installation.
 - (c) If the precursor originates in third countries and territories that are not exempted pursuant to point 1 of Annex III to Regulation (EU) 2023/956
 - (d) the production routes used as defined in Annex I ;
 - (e) the values of applicable specific parameters required for determining the embedded emissions, as listed in point 2 of Annex IV ;
 - (f) specific embedded direct and indirect emissions of the precursor as average over the most recent available reporting period, expressed in tonnes CO₂e per tonne of precursor;
 - (g) the start and end date of the reporting period used by the installation from which the precursor was obtained;
 - (h) If the precursor originates in third countries and territories that are exempted pursuant to Annex III, Point 1 of Regulation (EU) 2023/956, the specific embedded emissions are considered zero.
 - (i) quantity of the precursor used in each production process of the installation.
- (3) For each quantity of precursor for which incomplete or inconclusive data under point (2) was received, the applicable default values made available in accordance with Annex IV of Regulation (EU) 2023/956 shall be used.

- (4) When a type of precursor is produced in different production processes, the specific embedded emissions of that precursors will be calculated as a weighted average of those different production processes.

F. MONITORING OF ACTIVITY LEVELS

The activity level of a production process shall be calculated as the total mass of the goods leaving the production process during the reporting period measured in functional units and in tonnes of goods. Where production processes are defined such that also the production of precursors is included, double counting shall be avoided by counting only the final products of the production process.

Only goods which can be sold or directly used as precursor in another production process shall be taken into account. Off-spec products, by-products, waste, and scrap produced in a production process, irrespective of whether they are returned to production processes, delivered to other installations, or disposed of, shall not be included in the determination of the activity level. They shall therefore be assigned zero embedded emissions when entering another production process.

For determining activity levels, the metering requirements laid down in point B.4 apply.

G. Standard factors used in the monitoring of direct emissions at installation level

Fuel emission standard factors related to net calorific values (NCV)

Table 1: Fuel emission factors related to NCV and net calorific values per mass of fuel.

Fuel type description	Emission factor (t CO ₂ /TJ)	Net calorific value (TJ/Gg)	Source
Crude oil	73,3	42,3	IPCC 2006 GL
Orimulsion	77,0	27,5	IPCC 2006 GL
Natural gas liquids	64,2	44,2	IPCC 2006 GL
Motor gasoline	69,3	44,3	IPCC 2006 GL
Kerosene (other than jet kerosene)	71,9	43,8	IPCC 2006 GL
Shale oil	73,3	38,1	IPCC 2006 GL
Gas/Diesel oil	74,1	43,0	IPCC 2006 GL
Residual fuel oil	77,4	40,4	IPCC 2006 GL
Liquefied petroleum gases	63,1	47,3	IPCC 2006 GL
Ethane	61,6	46,4	IPCC 2006 GL
Naphtha	73,3	44,5	IPCC 2006 GL
Bitumen	80,7	40,2	IPCC 2006 GL
Lubricants	73,3	40,2	IPCC 2006 GL
Petroleum coke	97,5	32,5	IPCC 2006 GL
Refinery feedstocks	73,3	43,0	IPCC 2006 GL
Refinery gas	57,6	49,5	IPCC 2006 GL

Fuel type description	Emission factor (t CO ₂ /TJ)	Net calorific value (TJ/Gg)	Source
Paraffin waxes	73,3	40,2	IPCC 2006 GL
White spirit and SBP	73,3	40,2	IPCC 2006 GL
Other petroleum products	73,3	40,2	IPCC 2006 GL
Anthracite	98,3	26,7	IPCC 2006 GL
Coking coal	94,6	28,2	IPCC 2006 GL
Other bituminous coal	94,6	25,8	IPCC 2006 GL
Sub-bituminous coal	96,1	18,9	IPCC 2006 GL
Lignite	101,0	11,9	IPCC 2006 GL
Oil shale and tar sands	107,0	8,9	IPCC 2006 GL
Patent fuel	97,5	20,7	IPCC 2006 GL
Coke oven coke and lignite coke	107,0	28,2	IPCC 2006 GL
Gas coke	107,0	28,2	IPCC 2006 GL
Coal tar	80,7	28,0	IPCC 2006 GL
Gas works gas	44,4	38,7	IPCC 2006 GL
Coke oven gas	44,4	38,7	IPCC 2006 GL
Blast furnace gas	260	2,47	IPCC 2006 GL
Oxygen steel furnace gas	182	7,06	IPCC 2006 GL
Natural gas	56,1	48,0	IPCC 2006 GL
Industrial wastes	143	n.a.	IPCC 2006 GL
Waste oils	73,3	40,2	IPCC 2006 GL
Peat	106,0	9,76	IPCC 2006 GL
Waste tyres	85,0 ⁽⁸⁾	n.a.	World Business Council for Sustainable Development - Cement Sustainability Initiative (WBCSD CSI)
Carbon monoxide	155,2 ⁽⁹⁾	10,1	J. Falbe and M. Regitz, Römpp Chemie Lexikon, Stuttgart, 1995

⁸ This value is the preliminary emission factor, i.e., before application of a biomass fraction, if applicable.

⁹ Based on NCV of 10,12 TJ/t.

Fuel type description	Emission factor (t CO ₂ /TJ)	Net calorific value (TJ/Gg)	Source
Methane	54,9 ⁽¹⁰⁾	50,0	J. Falbe and M. Regitz, Römpp Chemie Lexikon, Stuttgart, 1995

Table 2: Fuel emission factors related to NCV and net calorific values per mass of biomass material.

Biomass material	Preliminary EF [t CO ₂ / TJ]	NCV [GJ/t]	Source
Wood / Wood waste (air dry ⁽¹¹⁾)	112	15,6	IPCC 2006 GL
Sulphite lyes (black liquor)	95,3	11,8	IPCC 2006 GL
Other primary solid biomass	100	11,6	IPCC 2006 GL
Charcoal	112	29,5	IPCC 2006 GL
Biogasoline	70,8	27,0	IPCC 2006 GL
Biodiesels	70,8	37,0	IPCC 2006 GL ⁽¹²⁾
Other liquid biofuels	79,6	27,4	IPCC 2006 GL
Landfill gas ⁽¹³⁾	54,6	50,4	IPCC 2006 GL
Sludge gas ⁽¹⁰⁾	54,6	50,4	IPCC 2006 GL
Other biogas ⁽¹⁰⁾	54,6	50,4	IPCC 2006 GL
Municipal waste (biomass fraction) ⁽¹⁴⁾	100	11,6	IPCC 2006 GL

¹⁰ Based on NCV of 50,01 TJ/t.

¹¹ The given emission factor assumes around 15% water content of the wood. Fresh wood can have water content of up to 50%. For determining the NCV of completely dry wood, the following equation shall be used:

$$NCV = NCV_{dry} \cdot (1 - w) - \Delta H_v \cdot w$$

Where NCV_{dry} is the NCV of the absolute dry material, w is the water content (mass fraction) and $\Delta H_v = 2,4 \text{ GJ/t } H_2O$ is the evaporation enthalpy of water. Using the same equation, the NCV for a given water content can be back-calculated from the dry NCV.

¹² The NCV value is taken from Annex III of Directive (EU) 2018/2001.

¹³ For landfill gas, sludge gas and other biogas: Standard values refer to pure Biomethane. For arriving at the correct standard values, a correction is required for the methane content of the gas.

¹⁴ The IPCC guidelines also give values for the fossil fraction of municipal waste: EF = 91,7 t CO₂/TJ; NCV = 10 GJ/t

Emission factors related to process emissions

Table 3: Stoichiometric emission factor for process emissions from carbonate decomposition (Method A)

Carbonate	Emission factor [t CO ₂ / t Carbonate]
CaCO ₃	0,440
MgCO ₃	0,522
Na ₂ CO ₃	0,415
BaCO ₃	0,223
Li ₂ CO ₃	0,596
K ₂ CO ₃	0,318
SrCO ₃	0,298
NaHCO ₃	0,524
FeCO ₃	0,380
General	$\text{Emission factor} = \frac{[M(\text{CO}_2)]}{\{Y * [M(x)] + Z * [M(\text{CO}_3^{2-})]\}}$ <p> $X = \text{metal}$ $M(x) = \text{molecular weight of } X \text{ in [g/mol]}$ $M(\text{CO}_2) = \text{molecular weight of CO}_2 \text{ in [g/mol]}$ $M(\text{CO}_3^{2-}) = \text{molecular weight of CO}_3^{2-} \text{ in [g/mol]}$ $Y = \text{stoichiometric number of } X$ $Z = \text{stoichiometric number of CO}_3^{2-}$ </p>

Table 4: Stoichiometric emission factor for process emissions from carbonate decomposition based on alkali earth oxides (Method B)

Oxide	Emission factor [t CO ₂ / t Oxide]
CaO	0,785
MgO	1,092
BaO	0,287

Oxide	Emission factor [t CO ₂ / t Oxide]
general: X _Y O _Z	$\text{Emission factor} = \frac{[M(\text{CO}_2)]}{\{Y * [M(x)] + Z * [M(\text{O})]\}}$ <p> X = alkali earth or alkali metal M(x) = molecular weight of X in [g/mol] M(CO₂) = molecular weight of CO₂ [g/mol] M(O) = molecular weight of O [g/mol] Y = stoichiometric number of X = 1 (for alkali earth metals) = 2 (for alkali metals) Z = stoichiometric number of O = 1 </p>

Table 5: Emission factors for process emissions from other process materials (production of iron or steel, and processing of ferrous metals) ⁽¹⁵⁾

Input or output material	Carbon content (t C/t)	Emission factor (t CO ₂ /t)
Direct reduced iron (DRI)	0,0191	0,07
EAF carbon electrodes	0,8188	3,00
EAF charge carbon	0,8297	3,04
Hot briquetted iron (HBI)	0,0191	0,07
Oxygen steel furnace gas	0,3493	1,28
Petroleum coke	0,8706	3,19
Pig iron	0,0409	0,15
Iron / iron scrap	0,0409	0,15
Steel / steel scrap	0,0109	0,04

Global warming potentials for non-CO₂ greenhouse gases

Table 6: Global warming potentials

Gas	Global warming potential
N ₂ O	265 t CO ₂ e / t N ₂ O
CF ₄	6 630 t CO ₂ e / t CF ₄
C ₂ F ₆	11 100 t CO ₂ e / t C ₂ F ₆

¹⁵

IPCC 2006 Guidelines for National Greenhouse Gas Inventories

ANNEX III – Rules for attributing emissions to goods

A. PRINCIPLES FOR ATTRIBUTING DATA TO PRODUCTION PROCESSES

A.1. Attribution if data is available

The methods for monitoring data per each production process shall be laid down in the monitoring plan in accordance with Annex II . They shall be regularly reviewed in order to improve the data quality, where possible, in line with point A of this Annex.

Where several measuring instruments of different quality are contributing to measurement results, and the sum of the production process data is different from the data determined separately for the installation, a uniform ‘reconciliation factor’ is applied for uniform correction to meet the total figure of the installation as follows:

$$RecF = D_{Inst} / \sum D_{PP} \quad (\text{Equation 41})$$

Where:

$RecF$ is the reconciliation factor;

D_{Inst} is the data value determined for the installation as a whole, and

D_{PP} are the data values for the different production processes.

The data for each production process are then corrected as follows, with $D_{PP,corr}$ being the corrected value of D_{PP} :

$$D_{PP,corr} = D_{PP} \times RecF \quad (\text{Equation 42})$$

Where data for a specific data set are not available for each production process, inputs, outputs, and corresponding emissions shall be attributed based on the rules set in point A.2

A.2. Attribution in case of lack of data or multi-functional processes.

In case of lack of data as referred to in point A.1 or in case of multi-functional processes, attribution will be based on a relevant underlying physical relationship, which refers to partitioning the input and output flows of a multi-functional process or facility in line with a relevant, quantifiable physical relationship between the process inputs and co-product outputs.

With the exception of the rules specified in points A.2.1, A.2.2 and A.2.3. of this Annex, inputs, outputs, and corresponding emissions shall be attributed based on the functional unit of individual goods produced.

The same attribution rule will be used to attribute both emissions and captured and stored emissions to goods.

In the case that a production process requires the application of different attribution rules, they must be applied in the following order:

- (1) attribution of emissions to heat flows;
- (2) attribution of emissions to waste gases;
- (3) functional unit attribution or molar ratio attribution, as applicable.

A.2.1. Chemicals and fertilisers

If a chemical substance under the aggregated goods categories chemicals or fertilisers is produced as co-product of a multi-functional process, the attribution among the chemical substances shall be based on molar ratio.

The emissions of the production process shall be attributed to hydrogen based on molar proportions using the following equation:

$$Em_i = Em_{total} \left(\frac{\frac{m_{i,prod}}{M_i}}{\sum_i^n \frac{m_{i,prod}}{M_i}} \right) \quad (\text{Equation 43})$$

Where:

Em_i are either the direct or indirect emissions attributed to each co-product i produced over the reporting period, expressed in tonnes of CO₂;

Em_{total} are either the direct or indirect emissions of the whole production process over the reporting period, expressed in tonnes of CO₂;

$m_{i,prod}$ is the mass of each co-product i produced in the installation over the reporting period, expressed in tonnes;

M_i is the molar mass of each co-product i

If the molar mass of one of the co-products is not known, the emissions will be attributed based on mass of the co-products.

A.2.2. Heat flows and cogeneration

Measurable heat from processes other than combustion or partial oxidation of fuels

Measurable heat produced from exothermic chemical processes other than combustion and partial oxidation of fuels, such as in ammonia or nitric acid production, shall be assigned zero CO_{2e} emissions.

Measurable heat produced in the installation other than by cogeneration

For measurable heat produced from the combustion of fuels within the installation except heat produced by cogeneration, the emission factor of the relevant fuel mix shall be determined and the emissions attributable to the production process shall be calculated as:

$$Em_{Heat} = EF_{mix} \cdot Q_{consumed} / \eta \quad (\text{Equation 44})$$

Where:

Em_{Heat} is the heat-related emissions of the production process in t CO₂;

EF_{mix} is the emission factor of the respective fuel mix expressed in t CO₂/TJ including emissions from flue gas cleaning, where applicable;

$Q_{consumed}$ is the amount of measurable heat consumed in the production process expressed in TJ, and

η is the efficiency of the heat production process.

EF_{mix} shall be calculated as:

$$EF_{mix} = (\sum AD_i \cdot NCV_i \cdot EF_i + Em_{FGC}) / (\sum AD_i \cdot NCV_i) \quad (\text{Equation 45})$$

Where:

AD_i are the annual activity data (i.e., quantities consumed) of the fuels i used for the measurable heat production expressed in tonnes or Nm^3 ;

NCV_i are the net calorific values of the fuels i expressed in TJ/t or TJ/ Nm^3 ;

EF_i are the emission factors of the fuels i expressed in t CO_2 /TJ, and

Em_{FGC} are the process emissions from flue gas cleaning expressed in t CO_2 .

Measurable heat produced in the installation by cogeneration

Where measurable heat and electricity are produced by cogeneration (i.e. by combined heat and power (CHP)), the relevant emissions attributed to measurable heat and electricity shall be determined as required by this point. The rules regarding electricity shall also apply to the production of mechanical energy, if relevant.

The emissions of a cogeneration unit shall be determined as follows:

$$Em_{CHP} = \sum_i AD_i \cdot NCV_i \cdot EF_i + Em_{FGC} \quad (\text{Equation 46})$$

Where:

Em_{CHP} are the emissions of the cogeneration unit during the reporting period expressed in t CO_2 ;

AD_i are the annual activity data (i.e. quantities consumed) of the fuels i used for the CHP unit expressed in tonnes or Nm^3 ;

NCV_i are the net calorific values of the fuels i expressed in TJ/t or TJ/ Nm^3 ;

EF_i are the emission factors of the fuels i expressed in t CO_2 /TJ and

Em_{FGC} are the process emissions from flue gas cleaning expressed in t CO_2 .

The energy input to the CHP unit shall be calculated in accordance with Equation 33. The respective average efficiencies over the reporting period of heat production and electricity (or mechanical energy, if applicable) production shall be calculated as follows:

$$\eta_{heat} = \frac{Q_{net}}{E_{In}} \quad (\text{Equation 47})$$

$$\eta_{el} = \frac{E_{El}}{E_{In}} \quad (\text{Equation 48})$$

Where:

η_{heat} is the average efficiency of heat production during the reporting period (dimensionless),

Q_{net} is the net amount of heat produced during the reporting period by the cogeneration unit expressed in TJ as determined in accordance with point C.1.2;

E_{In} is the energy input of fuels expressed in TJ;

η_{el} is the average efficiency of electricity production during the reporting period (dimensionless), and

E_{el} is the net electricity production of the cogeneration unit during the reporting period, expressed in TJ.

Where the determination of the efficiencies η_{heat} and η_{el} is technically not feasible or would incur unreasonable costs, values based on technical documentation (design values) of the installation shall be used. If no such values are available, conservative standard values of $\eta_{heat} = 0,55$ and $\eta_{el} = 0,25$ shall be used.

The attribution factors for heat and electricity from CHP shall be calculated as follows:

$$F_{CHP,heat} = \frac{\frac{\eta_{heat}}{\eta_{ref,heat}}}{\frac{\eta_{heat}}{\eta_{ref,heat}} + \frac{\eta_{el}}{\eta_{ref,el}}} \quad (\text{Equation 49})$$

$$F_{CHP,el} = \frac{\frac{\eta_{el}}{\eta_{ref,el}}}{\frac{\eta_{heat}}{\eta_{ref,heat}} + \frac{\eta_{el}}{\eta_{ref,el}}} \quad (\text{Equation 50})$$

Where:

$F_{CHP,Heat}$ is the attribution factor for heat (dimensionless);

$F_{CHP,El}$ is the attribution factor for electricity (or mechanical energy, if applicable) (dimensionless);

$\eta_{ref, heat}$ is the reference efficiency for heat production in a stand-alone boiler (dimensionless), and

$\eta_{ref,el}$ is the reference efficiency of electricity production without cogeneration (dimensionless).

The appropriate fuel-specific reference efficiencies are given in point G of Annex II.

The specific emission factor of the CHP-related measurable heat to be used for the attribution of heat-related emissions to production processes shall be calculated as

$$EF_{CHP,Heat} = Em_{CHP} \cdot F_{CHP,Heat} / Q_{net} \quad (\text{Equation 51})$$

Where:

$EF_{CHP, heat}$ is the emission factor for the production of measurable heat in the cogeneration unit expressed in t CO₂/TJ and

Q_{net} is the net heat produced by the cogeneration unit expressed in TJ.

The emissions from heat produced in the cogeneration attributable to the production process shall be calculated as

$$Em_{Heat} = EF_{CHP, heat} \cdot Q_{consumed}$$

Where:

$Q_{consumed}$ is the amount of measurable heat consumed in the production process expressed in TJ

The specific emission factor of the CHP-related electricity to be used for the attribution of indirect emissions to production processes shall be calculated as:

$$EF_{CHP,El} = Em_{CHP} \cdot F_{CHP,El} / E_{El,prod} \quad (\text{Equation 52})$$

Where:

$E_{El,prod}$ is the electricity produced by the CHP unit.

Where a waste gas is part of the fuel mix used, and where the emission factor of the waste gas is higher than the standard emission factor of natural gas given in Table 1 of Point G of Annex II, that standard emission factor is used to calculate EF_{mix} instead of the emission factor of the waste gas.

Measurable heat produced outside the installation

Where a production process consumes measurable heat produced outside the installation, the heat-related emissions are to be included independently on whether the heat stems from the production process of a good listed in Annex I to Regulation (EU) 2023/956 or not. In this case, the heat related emissions shall be determined using one of the following methods.

- (1) Where the installation producing the heat carries out emission monitoring in line with this Regulation and verification of the emission sources and the quantities of measurable heat exported in line with Commission Delegated Regulation (EU) XX/XX [OP please insert reference of C(2025)7845], the emission factor of measurable heat shall be determined using relevant equations of previous points, based on emission data provided by the operator of the installation producing the measurable heat.
- (2) Where the method pursuant to point 1 is not available, a standard value is used, based on the standard emission factor of the fuel most commonly used in the industrial sector of the country, assuming a boiler efficiency of 90%.

Further rules for the attribution of emissions from measurable heat

Where losses of measurable heat are determined separately from the amounts used in production processes, emissions related to these heat losses shall be added proportionally to the emissions of all production processes in which measurable heat produced in the installation is used, in order to ensure that 100 % of the quantity of net measurable heat produced within the installation, or imported or exported by the installation, as well as quantities transferred between production processes, are attributed to production processes without any omission or double counting.

A.2.3. Waste gases

If waste gases from a different production process are consumed in the production process of the good, the emissions are attributed on the basis of Equation 53.

$$WG_{corr,imp} = V_{WG} \cdot NCV_{WG} \cdot EF_{NG}$$

Where:

V_{WG} is the volume of the waste gas imported;

NCV_{WG} is the net calorific value of the waste gas imported, and

EF_{NG} is the standard emission factor of natural gas as given in Point G of Annex II;

If waste gases from the production process of the good are consumed in a different production process, the emissions are attributed according to the Equation 54, if the installation operator can provide sufficient evidence for verification.

$$WG_{corr,exp} = V_{WG,exp} \cdot NCV_{WG} \cdot EF_{NG} \cdot Corr_{\eta}$$

Where:

$V_{WG,exported}$ is the volume of waste gas exported from the production process;

NCV_{WG} is the net calorific value of the waste gas;

EF_{NG} is the standard emission factor of natural gas as given in Point G of Annex II, and;

$Corr_{\eta}$ is the factor that accounts for the difference in efficiencies between the use of waste gas and the use of the reference fuel natural gas. The standard value is $Corr_{\eta} = 0,667$;

A.3 Calculation methods

For the purpose of assigning the installation's emissions to goods, the emissions, inputs, and outputs shall be attributed to production processes defined in accordance with point A.4 using Equation 55 for direct emissions and Equation 56 for indirect emissions, using total figures over the whole reporting period for the parameters given in the equation. The attributed direct and indirect emissions shall then be converted into specific embedded direct and indirect emissions of the goods resulting from the production process using Equations 57 and 58.

$$AttrEm_{Dir} = DirEm^* + Em_{H,imp} - Em_{H,exp} + WG_{corr,imp} - WG_{corr,exp} - Em_{el,prod} \quad (\text{Equation 55})$$

Where $AttrEm_{Dir}$ is calculated to have a negative value, it shall be set to zero.

$$AttrEm_{indir} = Em_{el,cons} \quad (\text{Equation 56})$$

$$SEE_{g,Dir} = \frac{AttrEm_{g,Dir}}{AL_g} \quad (\text{Equation 57})$$

$$SEE_{g,Indir} = \frac{AttrEm_{g,Indir}}{AL_g} \quad (\text{Equation 58})$$

Where:

$AttrEm_{Dir}$ are the attributed direct emission of the production process over the whole reporting period, expressed in t CO₂e;

$AttrEm_{indir}$ are the attributed indirect emission of the production process over the whole reporting period, expressed in t CO₂e;

$DirEm^*$ are the directly attributable emissions from the production process, determined for the reporting period using the rules provided in point B of Annex II and Point A of this Annex, and the following rules:

Measurable heat: Where fuels are consumed for the production of measurable heat which is consumed outside the production process under consideration, or which is used in more than one production process (which includes situations with imports from and exports to other installations), the fuels' emissions are not included in the directly attributable emissions of the production process, but added under the parameter $Em_{H,import}$ in order to avoid double counting.

Waste gases:

The emissions caused by waste gases produced and fully consumed within the same production process are included in $DirEm^*$.

The emissions from the combustion of waste gases exported from the production process are fully included in $DirEm^*$ irrespective of where they are consumed. However, for exports of waste gases the term $WG_{corr,export}$ shall be calculated.

Emissions from the combustion of waste gases imported from other production processes are not taken into account in $DirEm^*$. Instead the term $WG_{corr,import}$ shall be calculated;

$Em_{H,imp}$ are the emissions equivalent to the quantity of measurable heat imported to the production process, determined for the reporting period using the rules provided in Point A.2 of this Annex, and the following rules:

Emissions related to measurable heat imported to the production process include imports from other installations, other production processes within the same installation, as well as heat received from a technical unit (e.g. a central power house at the installation, or a more complex steam network with several heat producing units) that supplies heat to more than one production process.

Emissions from measurable heat shall be calculated using the following formula:

$$Em_{H,imp} = Q_{imp} \cdot EF_{heat}$$

Where:

EF_{heat} is the emission factor for the production of measurable heat determined in accordance with point A.2 of this Annex, expressed in $t\ CO_2/TJ$ and

Q_{imp} is the net heat imported to and consumed in the production process expressed in TJ ;

$Em_{H,exp}$ are the emissions equivalent to the quantity of measurable heat exported from the production process, determined for the reporting period using the rules provided in point A.2 of this Annex. For the exported heat either the emissions of the actually known fuel mix in accordance with point A.2 of this Annex shall be used, or – if the actual fuel mix is unknown – the standard emission factor of fuel most commonly used in the country and industrial sector, assuming a boiler efficiency of 90%.

Heat recovered from electricity-driven processes and from nitric acid

	production shall not be accounted;
$WG_{corr,imp}$	are the attributed direct emissions of a production process consuming waste gases imported from other production processes, corrected for the reporting period
$WG_{corr,exp}$	are the emissions equivalent to the quantity of waste gases exported from the production process, determined for the reporting period
$Em_{el,prod}$	are the emissions equivalent to the quantity of electricity produced within the boundaries of the production process, determined for the reporting period using the rules provided in point D of Annex II;
$Em_{el,cons}$	are the emissions equivalent to the quantity of electricity consumed within the boundaries of the production process, determined for the reporting period using the rules provided in point D of Annex II;
$SEE_{g,Dir}$	are the specific direct embedded emissions of goods g expressed in t CO _{2e} per functional unit, valid for the reporting period;
$SEE_{g,Indir}$	are the specific indirect embedded emissions of goods g expressed in t CO _{2e} per functional unit, valid for the reporting period;
AL_g	is the activity level of the goods g , i.e. the quantity of the goods g produced in the reporting period in that installation, determined in accordance with point F of Annex II, expressed in functional units.

B. CALCULATION OF SPECIFIC EMBEDDED EMISSIONS OF COMPLEX GOODS

In accordance with Annex IV to Regulation (EU) 2023/956, the specific embedded emissions SEE_g of complex goods g shall be calculated as follows:

$$SEE_g = \frac{AttrEm_g + EE_{InpMat}}{AL_g} \quad (\text{Equation 59})$$

$$EE_{InpMat} = \sum_{i=1}^n M_i \cdot SEE_i \quad (\text{Equation 60})$$

Where:

SEE_g are the specific direct or indirect embedded emissions of (complex) goods g expressed in t CO_{2e} per functional unit;

$AttrEm_g$ are the attributed direct or indirect emissions of the production process yielding goods g determined in accordance with point A.3 of this Annex for the reporting period, expressed in t CO_{2e};

AL_g is the activity level of the production process yielding goods g for the reporting period determined in accordance with point F of Annex II, expressed in functional units;

EE_{InpMat} are the embedded direct or indirect emissions of all precursors consumed during the reporting period, expressed in t CO_{2e};

M_i is the mass of precursor i used in the production process yielding g during the reporting period, expressed in functional units of precursor i , and

SEE_i are the specific direct or indirect embedded emissions of precursor i expressed in t CO_{2e} per functional unit of precursor i .

In this calculation, only precursors not covered by the same production process as goods g are taken into account. Where the same precursor is obtained from different production processes, the precursor from each installation shall be treated separately.

If a precursor i originates in the Union or in one of the countries or territories exempted pursuant to point 1 of Annex III to Regulation (EU) 2023/956 the specific direct or indirect embedded emissions of that precursor shall be counted as zero.

Where a precursor i itself has precursors, those precursors are first taken into account using the same calculation method in order to calculate the embedded emissions of the precursor i before they are used for calculating the embedded emissions of goods g . This method is used recursively to all precursors which are complex goods.

The parameter M_i refers to the total mass of precursor required to produce the amount AL_g . It also includes quantities of the precursor which do not end up in the complex goods but may be spilt, cut off, combusted, chemically modified, etc. in the production process and leave the process as by-products, scrap, residues, wastes, or emissions.

In order to provide data which can be used independently of activity levels, the specific mass consumption m_i for each precursor i shall be determined and included in the communication pursuant to Annex IV:

$$m_i = M_i / AL_g \quad (\text{Equation 61})$$

Thereby the specific embedded emissions of complex goods g may be expressed as:

$$SEE_g = ae_g + \sum_{i=1}^n (m_i \cdot SEE_i) \quad (\text{Equation 62})$$

Where:

ae_g are the specific attributed direct or indirect emissions of the production process yielding goods g , expressed in t CO_{2e} per tonne of g , being equivalent to specific embedded emissions without precursors' embedded emissions:

$$ae_g = AttrEm_g / AL_g \quad (\text{Equation 63})$$

m_i is the specific mass consumption of precursor i used in the production process yielding one functional unit of goods g , expressed in functional unit of precursor i per functional unit of goods g (i.e., dimensionless), and

SEE_i are the specific direct or indirect embedded emissions of precursor i expressed in t CO_{2e} per functional unit of precursor i .

For goods whose functional units are tonnes of clinker content and are commercialised in different ranges of composition, the operator will calculate the specific embedded emissions of goods according to the clinker contained in the goods averaged for each range of composition, applying Equation 64.

$$SEE_{g(cki)} = SEE_g \cdot CK_i \quad (\text{Equation 64})$$

Where:

$SEE_{g(cki)}$ is the specific embedded emissions of the good with clinker content CKi

SEE_g is the specific embedded emissions calculated in Equation 59 or 62

CK_i is the average clinker content of the goods within a range of composition in tonnes of clinker per tonnes of goods.

For goods whose functional units are kilograms of nitrogen content and are commercialised in different ranges of composition, the operator will calculate the specific embedded emissions of goods according to the nitrogen contained in the goods averaged for each range of composition, applying Equation 65.

$$SEE_{g(Ni)} = SEE_g \cdot N_i \quad (\text{Equation 65})$$

Where:

$SEE_{g(Ni)}$ is the specific embedded emissions of the good with nitrogen content Ni.

SEE_g is the specific embedded emissions calculated in Equation 59 or 62

N_i is the average nitrogen content of the goods within a range of composition in kilograms of nitrogen per tonnes of goods.

For goods whose functional units are the supplementary unit kg of nitrogen content and are commercialised in different ranges of composition, the operator will calculate the specific embedded emissions of goods according to the nitrogen contained in the goods averaged for each range of composition, applying Equation 66.

$$SEE_{g(Ni)} = SEE_g \cdot N_i \quad (\text{Equation 66})$$

Where:

$SEE_{g(Ni)}$ is the specific embedded emissions of the good with nitrogen content Ni.

SEE_g is the specific embedded emissions calculated in Equation 59 or 62

N_i is the average nitrogen content of the goods within a range of composition in kg of nitrogen per tonnes of goods.

The ranges of composition for clinker content and nitrogen content shall not be larger than 10%.

For goods whose functional units are tonnes of clinker content, kilograms of nitrogen content or the supplementary unit kg of nitrogen content and are commercialised in custom-made compositions on request of the client, the installation operator will issue a declaration of clinker content or nitrogen content for each consignment and with the calculation of specific embedded emissions according to the correspondent Equations 64, 65 or 66, where CKi and Ni will be the specific clinker content or nitrogen content of the consignment.

C. HARMONISED EFFICIENCY REFERENCE VALUES FOR SEPARATE PRODUCTION OF ELECTRICITY AND HEAT

In the tables below the harmonised efficiency reference values for separate production of electricity and heat are based on net calorific value and standard atmospheric ISO conditions (15 °C ambient temperature, 1,013 bar, 60 % relative humidity).

Table 1: Reference efficiency factors for electricity production

Category		Type of fuel	Year of construction		
			Before 2012	2012-2015	From 2016
Solids	S1	Hard coal including anthracite, bituminous coal, sub-bituminous coal, coke, semi-coke, pet coke	44,2	44,2	44,2
	S2	Lignite, lignite briquettes, shale oil	41,8	41,8	41,8
	S3	Peat, peat briquettes	39,0	39,0	39,0
	S4	Dry biomass including wood and other solid biomass including wood pellets and briquettes, dried woodchips, clean and dry waste wood, nut shells and olive and other stones	33,0	33,0	37,0
	S5	Other solid biomass including all wood not included under S4 and black and brown liquor	25,0	25,0	30,0
	S6	Municipal and industrial waste (non-renewable) and renewable/bio-degradable waste	25,0	25,0	25,0
Liquids	L7	Heavy fuel oil, gas/diesel oil, other oil products	44,2	44,2	44,2
	L8	Bio-liquids including bio-methanol, bioethanol, bio-butanol, biodiesel, and other bio-liquids	44,2	44,2	44,2
	L9	Waste liquids including biodegradable and non-renewable waste (including tallow, fat and spent grain)	25,0	25,0	29,0
Gaseous	G10	Natural gas, LPG, LNG and biomethane	52,5	52,5	53,0
	G11	Refinery gases hydrogen and synthesis gas	44,2	44,2	44,2
	G12	Biogas produced from anaerobic digestion, landfill, and sewage treatment	42,0	42,0	42,0
	G13	Coke oven gas, blast furnace gas, mining gas, and other recovered gases (excluding refinery gas)	35,0	35,0	35,0
Other	O14	Waste heat (including high temperature process exhaust gases, product from exothermic chemical reactions)			30,0

Table 2: Reference efficiency factors for heat production

Category		Type of fuel	Year of construction					
			Before 2016			From 2016		
			Hot water	Steam ⁽¹⁶⁾	Direct use of exhaust gases ⁽¹⁷⁾	Hot water	Steam ⁽¹⁶⁾	Direct use of exhaust gases ⁽¹⁷⁾
Solids	S1	Hard coal including anthracite, bituminous coal, sub-bituminous coal, coke, semi-coke, pet coke	88	83	80	88	83	80
	S2	Lignite, lignite briquettes, shale oil	86	81	78	86	81	78
	S3	Peat, peat briquettes	86	81	78	86	81	78
	S4	Dry biomass including wood and other solid biomass including wood pellets and briquettes, dried woodchips, clean and dry waste wood, nut shells and olive and other stones	86	81	78	86	81	78
	S5	Other solid biomass including all wood not	80	75	72	80	75	72

¹⁶ If steam plants do not account for the condensate return in their calculation of CHP (combined heat and power) heat efficiencies, the steam efficiencies shown in the table above shall be increased by 5 percentage points.

¹⁷ Values for direct use of exhaust gases shall be used if the temperature is 250 °C or higher.

		included under S4 and black and brown liquor						
	S6	Municipal and industrial waste (non-renewable) and renewable/bio-degradable waste	80	75	72	80	75	72
Liquids	L7	Heavy fuel oil, gas/diesel oil, other oil products	89	84	81	85	80	77
	L8	Bio-liquids including bio-methanol, bioethanol, bio-butanol, biodiesel, and other bio-liquids	89	84	81	85	80	77
	L9	Waste liquids including biodegradable and non-renewable waste (including tallow, fat and spent grain)	80	75	72	75	70	67
Gaseous	G10	Natural gas, LPG, LNG and biomethane	90	85	82	92	87	84
	G11	Refinery gases hydrogen and synthesis gas	89	84	81	90	85	82
	G12	Biogas produced from anaerobic digestion, landfill, and sewage treatment	70	65	62	80	75	72
	G13	Coke oven	80	75	72	80	75	72

		gas, blast furnace gas, mining gas, and other recovered gases (excluding refinery gas)						
Other	O14	Waste heat (including high temperature process exhaust gases, product from exothermic chemical reactions)	—	—	—	92	87	—

Documents provisionally published. Official versions are available on the EN ISO website.

ANNEX IV - Template of the operator's emissions report

1. OUTLINE OF THE OPERATOR'S EMISSIONS REPORT

1.1. Template containing the minimum elements to be contained in the operator's emissions report as compared to the summary emissions report

1. Identification of the operator and the installation:

- (a) name of the operator;
- (b) corporate or activity registration number of the operator;
- (c) full address in English
- (d) the installation under verification, identified by the following data:
 - name of the installation;
 - unique installation identifier in the CBAM Registry;
 - applicable United Nations Code for Trade and Transport Location (UN/LOCODE) of the location;
 - full address in English transcript;
 - and geographical coordinates of the installation's main emission source.

2. Summary of the installation's monitoring plan, containing at least the following information:

- (a) list of all CBAM production processes and routes carried out at the installation;
- (b) list of non-CBAM production processes carried out at the installation;
- (c) list of the five most important (by mass) goods produced per production process, identified by CN code;
- (d) list of the five most important (by energy content provided) fuels used at the installation;
- (e) list of the five most important (by emissions) materials used at the installation leading to process emissions;
- (f) if continuous emissions measurement is used at the installation, the relevant greenhouse gases and the five biggest emissions sources, to which it is applied.
- (g) whether any zero-rated fuels are used and how the operator demonstrates the applicability of zero-rating of the fuels;
- (h) whether measurable heat is imported from or exported to other installations, and an identification of those installations;

3. For indirect emissions, whether electricity is consumed from different sources and in which quantities. If the sources include other installations, the name and country of origin of the suppliers;
4. For indirect emissions, where electricity is produced inside the installation, whether electricity is:
 - (a) produced by co-generation;
 - (b) produced by separate generation;
 - (c) produced from fossil or renewable sources;
 - (d) exported from the system boundaries of a production process;
5. Whether waste gases are produced and used in the installation, or imported from or exported to other installations, and an identification of those installations;
6. Whether CO₂ transfer applies, and the identity and contact data of a responsible person of the receiving installations or transport infrastructure or entities to which it is transferred.
7. The total direct emissions of the installation during the reporting period;
8. If applicable, for new installations, time period (in months) used for the monitoring of emissions.
9. Where an installation produces goods listed in Annex I to Regulation (EU) 2023/956 but not in Annex II to that Regulation, the total quantity of electricity consumed in the installation;
10. Where an installation produces goods listed in Annex I to Regulation (EU) 2023/956 but not in Annex II of that Regulation, the quantity of electricity consumed in the installation for the production of these goods;
11. Where an installation produces goods listed in Annex I to Regulation (EU) 2023/956 but not in Annex II to that Regulation, the identification of the installations from which the electricity is obtained;
12. Where relevant, if the installation consumes electricity from different sources, the quantity of electricity consumed per source, the country of origin of the electricity per source, the emission factor per source, and the emission factor calculated for the purpose of determining embedded indirect emissions pursuant to Article 9.
13. Total goods produced at the installation and per production process, and the quantity produced;
14. If relevant, non-CBAM goods produced per production process and the quantity produced;
15. For each of the goods:
 - (a) the specific direct embedded emissions of each of the goods, expressed in tonnes of CO₂ per functional unit;

- (b) the specific direct embedded emissions of each of the compositions of the goods, where applicable.
- (c) information on the data quality and methods used, in particular if the embedded emissions have been completely determined based on monitoring, or whether any of the default values made available in accordance with Annex IV of Regulation (EU) 2023/956 have been used;
- (d) the share of embedded emissions for which default values were used;
- (e) for goods that are not listed in Annex II to Regulation (EU) 2023/956:
 - the share of indirect emissions determined on the basis of actual values in accordance with Article 9 of this Regulation;
 - the share of indirect emissions determined on the basis of default values in accordance with Article 9 of this Regulation;
 - for the share of indirect emissions determined on the basis of actual values, confirmation that the criteria for the use of actual values laid down in Point 6 of Annex IV to Regulation (EU) 2023/956 are met, and confirmation that the related elements of evidence laid down in point D.4.3 of Annex II were submitted to the verifier;
 - the specific indirect emissions calculated pursuant to Article 9 of this Regulation for each good produced.
- (f) for electricity imported into the customs territory of the Union:
 - confirmation, where relevant, that the criterion for the use of actual values laid down in point 5(b) of Annex IV to Regulation (EU) 2023/956, related to the direct connection between the installation producing electricity and the Union transmission system, is met, and a confirmation that the related elements of evidence laid down in point D.2.4 of Annex II were submitted to the verifier;
 - confirmation that the criterion for the use of actual values laid down in point 5(c) of Annex IV to Regulation (EU) 2023/956 is met, and a confirmation that the related elements of evidence laid down in point D.2.4 of Annex II were submitted to the verifier;
 - an indication that the relevant declarant-specific addenda containing the elements laid down in point 1.1.1. of this Annex were sent to the verifier;
 - the emission factor for the imported electricity determined on the basis of actual emissions.

16. Total emissions of the installation, including:

- (a) activity data per production process and calculation factors for each source stream used;

- (b) emissions of each emission source monitored using a measurement-based methodology;
 - (c) emissions determined by other methods;
 - (d) quantities of CO₂ received from other installations or exported to other installations, for the purpose of geological storage or as input to products in which the CO₂ is permanently chemically bound.
 - (e) information about data gaps and estimates used.
17. A balance of imported, produced, consumed, and exported measurable heat, waste gases and electricity per production process.
18. The quantity of each type of precursor, produced at the installation and used by that installation, excluding precursors produced in the production process in accordance with Article 4(9).
19. The quantity of each type of precursor, produced at the installation and used in each production process, excluding precursors produced in the production process in accordance with Article 4(9).
20. The quantity of each type of precursor, produced outside the installation, and used by the installation.
21. The quantity of each type of precursors, produced outside the installation, and used in each production process.
22. Data on each type of precursor that was used by the installation, and for which default values were used, excluding precursors produced in the production process in accordance with Article 4(9):
- (a) CN code;
 - (b) name of the good;
 - (c) country of origin, where it is known and where the precursor was produced outside the installation;
 - (d) the applicable default value.
23. Data on each type of precursor that was used by the installation, and for which actual values were used, excluding precursors produced in the production process in accordance with Article 4(9):
- (a) CN code;
 - (b) name of the good;
 - (c) country of origin, where the precursor was produced outside the installation;

- (d) reporting period, and indication of whether it was determined using the default reporting period or the actual time of production;
 - (e) specific embedded (direct and, if applicable, indirect) emissions.
24. Where an installation producing complex goods receives, from another installation, precursors under a given CN code produced during different reporting periods, the specific embedded emissions (direct and, if applicable, indirect) to be used for that precursor in accordance with Article 14(1).
25. Where the production process of a complex good used a precursor under a given CN code obtained from multiple installations, the specific embedded (direct and, if applicable, indirect) emissions to be used for that precursor, and an indication whether they were determined by using the default method laid down in Article 14(2) or by calculating the embedded emissions of the precursor obtained from a specific installation or subset of installations in accordance with Article 14(3).
26. Where relevant, the quantity of electricity used in each production process.
27. The quantity of precursors produced at the installation and used in each production process, excluding precursors produced in the production process, in accordance with Article 4.
28. Information on the operator and the installation of origin of the precursor: name of the operator; name of the installation; unique installation identifier in the CBAM Registry, if applicable; applicable reporting period.
29. Information on how the attributed direct and indirect emissions of each production process were calculated.
30. The activity level and attributed emissions of each production process.
31. A list of all relevant goods produced measured in the functional unit for each CN code, including precursors not covered by separate production processes than the complex goods in accordance with Article 4;
32. Information on the electricity emissions factor if actual values are used, where appropriate;
33. Information on the electricity emissions factor in the power purchase agreement, where appropriate;
34. Quantity of goods per production route, as follows:
- (a) quantities of each good, measured in the functional unit for each CN code;
 - (b) where the functional unit pursuant to Article 4 is different from the tonnes of goods per CN code, quantities of goods expressed in functional unit produced in the reporting period per production process;

35. The values for the sector-specific parameters required for each good in accordance with Point 2 of this Annex.

1.1.1. Declarant-specific addendum to the operator's emissions report for electricity imported into the customs territory of the Union

The addendum to the operator's emissions report created for each authorised CBAM declarant in accordance with Article 8(4) shall contain the following:

- (1) the EORI number of the authorised CBAM declarant to whom the declarant-specific addendum refers.
- (2) an indication that the criteria for the use of actual values laid down in point 5, first subparagraph, points (a) and (d) of Annex IV of Regulation (EU) 2023/956, as well as, where relevant, laid down in point 5 first subparagraph, point (b) of Annex IV of that Regulation in relation to the lack of physical network congestion, are met, and a confirmation that the related elements of evidence laid down in point D.2.4 of Annex II were submitted to the verifier.
- (3) the quantity of electricity imported by that authorised CBAM declarant from the relevant installation for which the criteria laid down in point 5 of Annex IV to Regulation (EU) 2023/956 are met.

1.2 Operator's summary emissions report

The following information contained in the operator's emissions report shall also be contained in the operator's summary emissions report:

- (1) Identification of the operator and the installation:
 - (a) name of the operator;
 - (b) corporate or activity registration number of the operator;
 - (c) full address in English
- (2) the installation under verification, identified by the following data:
 - (a) name of the installation;
 - (b) unique installation identifier in the CBAM Registry;
 - (c) applicable United Nations Code for Trade and Transport Location (UN/LOCODE) of the location;
 - (d) full address in English
 - (e) and geographical coordinates of the installation's main emission source.
- (3) A list of all CBAM production processes and routes carried out at the installation with a specification of goods per production process.
- (4) For each of the goods:
 - (a) the specific direct embedded emissions of each of the goods;
 - (b) the share of embedded emissions for which default values were used;

- (c) for goods that are not listed in Annex II to Regulation (EU) 2023/956:
 - The share of indirect emissions determined on the basis of actual values in accordance with Article 9 of this Regulation;
 - The share of indirect emissions determined on the basis of default values in accordance with Article 9 of this Regulation;
 - For the share of indirect emissions determined on the basis of actual values, confirmation that the criteria for the use of actual values laid down in point 6 of Annex IV to Regulation (EU) 2023/956 are met;
 - The specific indirect emissions calculated pursuant to Article 9 of this Regulation for each good produced.
 - (d) for electricity imported into the customs territory of the Union:
 - confirmation, where relevant, that the criterion for the use of actual values laid down in point 5(b) of Annex IV to Regulation (EU) 2023/956, related to the direct connection between the installation producing electricity and the Union transmission system, is met;
 - confirmation that the criterion for the use of actual values laid down in point 5(c) of Annex IV to Regulation (EU) 2023/956 is met, and a confirmation that the related elements of evidence laid down in point D.2.4 of Annex II were submitted to the verifier;
 - the emission factor for the imported electricity determined on the basis of actual emissions.
 - (e) The specific embedded free allocation of each of the goods produced;
 - (f) Confirmation of the use of the applicable CBAM benchmarks and the methods used for determining the specific embedded free allocation.
- (5) The total direct emissions of the installation during the reporting period and total direct emissions per production process;
 - (6) If the installation produces goods which are not listed in Annex II to Regulation (EU) 2023/956, the indirect emissions of the installation during the reporting period;
 - (7) Whether measurable heat is imported from or exported to other installations
 - (8) Whether any zero-rated fuels are used and how the operator demonstrates the applicability of zero-rating of the fuels;
 - (9) Whether waste gases are produced and used in the installation, or imported from or exported to other installations
 - (10) Whether CO₂ capture is used, and an identification of the installation or transport infrastructure to which it is transferred.
 - (11) For indirect emissions, where electricity is produced inside the installation, whether electricity is:
 - (a) produced by co-generation;

- (b) produced by separate generation;
 - (c) produced from fossil or renewable sources;
 - (d) exported from the system boundaries of a production process;
- (12) Data on each precursor used, and for which default values were used, excluding precursors produced in the production process in accordance with Article 4(9):
- a) CN code;
 - b) name of the good;
 - c) country of origin, where it is known and where the precursor was produced outside the installation;
 - d) the applicable default value.;
- (13) Data on each precursor used, and for which actual values were used, excluding precursors produced in the production process in accordance with Article 4(9):
- a) CN code;
 - b) name of the good;
 - c) country of origin, where the precursor was produced outside the installation;
 - d) reporting period, and indication of the year during which the precursor was used for the production of a complex good;
 - e) specific embedded (direct and, if applicable, indirect) emissions.
- (14) Where an installation producing complex goods receives, from another installation, precursors under a given CN code produced during different reporting periods, the specific embedded emissions (direct and, if applicable, indirect) to be used for that precursor in accordance with Article 14(1).
- (15) Where the production process of a complex good used a type of precursor obtained from multiple installations, the specific embedded (direct and, if applicable, indirect) emissions to be used for that precursor, and an indication whether they were determined by using the default method laid down in Article 14 or by calculating the embedded emissions of the precursor obtained from a specific installation or subset of installations in accordance with that Article.
- (16) Information on the operator and the installation of origin of the precursor: name of the operator; name of the installation; unique installation identifier in the CBAM Registry, if applicable; applicable reporting period.

2. SECTOR-SPECIFIC PARAMETERS TO BE INCLUDED IN THE EMISSIONS REPORT

Aggregated goods category	Reporting requirement
Calcined clay	– N.a.

Aggregated goods category		Reporting requirement
Cement clinker		– N.a.
Cement		– Mass ratio of tonnes cement clinker consumed per produced tonne of cement (clinker to cement ratio expressed in per cent).
Aluminous cement		– N.a.
Hydrogen		– N.a.
Urea		– Purity (mass % urea contained, % N contained). – Content of N
Nitric acid		– Concentration (mass %). – Content of N
Ammonia		– Concentration, if hydrous solution. – Content of N
Mixed fertilisers		– Information required anyway under Regulation (EU) 2019/1009: – content of N as ammonium (NH_4^+); – content of N as nitrate (NO_3^-); – content of N as urea; – content of N in other (organic) forms. – Content of N total
Sintered Ore		– N.a.
Pig Iron		– The main reducing agent used. – Mass % of Mn, Cr, Ni, total of other alloy elements.
FeMn	Ferro-Manganese	– Mass % of Mn and carbon.
FeCr	Ferro-Chromium	– Mass % of Cr and carbon.
FeNi	Ferro-Nickel	– Mass % of Ni and carbon.
DRI	(Direct Reduced Iron)	– The main reducing agent used. – Mass % of Mn, Cr, Ni, total of other alloy elements.
Crude steel		– The main reducing agent of the precursor, if known. – Mass % of Mn, Cr, Ni, total of other alloy elements. – Tonnes scrap used for producing 1 t crude steel. – % of scrap that is pre-consumer scrap.
Iron or steel products		– The main reducing agent used in precursor production, if known. – Mass % of Mn, Cr, Ni, total of other alloy elements. – Tonnes scrap used for producing 1 t of the product.

Aggregated goods category	Reporting requirement
	– % of scrap that is pre-consumer scrap.
Unwrought aluminium	<ul style="list-style-type: none"> – Tonnes scrap used for producing 1 t of the product. – % of scrap that is pre-consumer scrap. – If the total content of elements other than aluminium exceeds 1%, the total percentage of such elements.
Aluminium products	<ul style="list-style-type: none"> – Tonnes scrap used for producing 1 t of the product. – % of scrap that is pre-consumer scrap. – If the total content of elements other than aluminium exceeds 1%, the total percentage of such elements.

ANNEX V - Region-specific adaptations of default values

For the purpose of point 7 of Annex IV to Regulation (EU) 2023/956, alternative region-specific adaptations of default values may be used for a good imported during a given year, where the authorised CBAM declarant demonstrates to the Commission, by 30 June of that year, based on datasets from reliable alternative official sources, including national statistics, covering one calendar year, that alternative region-specific adaptations of default values are lower than the default values laid down in accordance with Annex IV of Regulation (EU) 2023/956.

Where the Commission considers the provided alternative official sources reliable, it shall modify, where feasible by 30 June of the following year, the relevant default values laid down in accordance with Annex IV of Regulation (EU) 2023/956. The modified default values shall be applicable to goods imported during the year in which the datasets from alternative official sources were provided.

Where an authorised CBAM declarant provides the datasets from alternative official sources after 30 June of the year of import of a good, and where the Commission considers them reliable, it shall modify, where feasible by 30 June of the second year following the year during which the datasets from alternative official sources were provided, the relevant default values laid down in accordance with Annex IV of Regulation (EU) 2023/956. The modified default values shall be applicable to goods imported during the year following the year in which the datasets from alternative official sources were provided. Where the Commission manages to modify the relevant default values in the year following the year during which the datasets from alternative official sources were provided and before the deadline for submitting CBAM declarations in accordance with Article 6 of Regulation (EU) 2023/956, the modified default values shall be applicable to goods imported during the year in which the datasets from alternative official sources were provided.