Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (Text with EEA relevance) (repealed)

ANNEX IV

Activity-specific monitoring methodologies related to installations (Article 20(2))

1.   **Specific monitoring rules for emissions from combustion processes**

A.   *Scope*

Operators shall monitor CO_2 emissions from all types of combustion processes taking place
under all activities as listed in Annex I to Directive 2003/87/EC or included in the Union
Scheme under Article 24 of that Directive including the related scrubbing processes using the
rules laid down in this Annex. Any emissions from fuels used as process input shall be treated
like combustion emissions with regard to monitoring and reporting methodologies, without
prejudice to other classifications applied to emissions.

The operator shall not monitor and report emissions from internal combustion engines for
transportation purposes. The operator shall assign all emissions from the combustion of fuels at
the installation to the installation, regardless of exports of heat or electricity to other installations.
The operator shall not assign emissions associated with the production of heat or electricity that
is imported from other installations to the importing installation.

The operator shall include at least the following emission sources: boilers, burners, turbines,
heaters, furnaces, incinerators, kilns, ovens, dryers, engines, flares, scrubbers (process
emissions) and any other equipment or machinery that uses fuel, excluding equipment or
machinery with combustion engines that are used for transportation purposes.

B.   *Specific monitoring rules*

The emissions from combustion processes shall be calculated in accordance with Article 24(1),
unless the fuels are included in a mass balance in accordance with Article 25. The tiers defined
in section 2 of Annex II shall apply. In addition, process emissions from flue gas scrubbing shall
be monitored using the provisions laid down in subsection C.

For emissions from flares special requirements shall apply, as laid down in subsection D of this
section.

Combustion processes taking place in gas processing terminals may be monitored using a mass
balance in accordance with Article 25.

C.   *Flue gas scrubbing*

Process CO_2 emissions from the use of carbonate for acid gas scrubbing from the flue gas stream
shall be calculated in accordance with Article 24(2) on the basis of carbonate consumed, Method
A as follows, or gypsum produced, Method B as follows.

Method A:	*Emission factor*
Tier 1	: The emission factor shall be determined from stoichiometric ratios as laid down in section 2 of Annex VI. The determination of the amount of $CaCO_3$ and $MgCO_3$ in the relevant input material shall be carried out using best industry practice guidelines.

Method B:	*Emission factor*
Tier 1	: The emission factor shall be the stoichiometric ratio of dry gypsum $(CaSO_4 \times 2H_2O)$ to CO_2 emitted: 0,2558 t CO_2/t gypsum.

D.   *Flares*

When calculating emissions from flares the operator shall include routine flaring and operational flaring (trips, start-up and shutdown as well as emergency relieves). The operator shall also include inherent CO_2 in accordance with Article 48.

By way of derogation from section 2.1 of Annex II, tiers 1 and 2b for the emission factor shall be defined as follows:

Tier 1   :   The operator shall use a reference emission factor of 0,00393 t CO_2/ Nm^3 derived from the combustion of pure ethane used as a conservative proxy for flare gases.

Tier 2b   :   Installation-specific emission factors shall be 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.

By way of derogation from section 2.3 of Annex II, only tiers 1 and 2 shall be applied for the oxidation factor in the case of flares.

2.   **Refining of Mineral Oil as Listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall monitor and report all CO_2 emissions from combustion and production processes as occurring in refineries.

The operator shall include at least the following potential sources of CO_2 emissions: boilers, process heaters/treaters, internal combustion engines/turbines, catalytic and thermal oxidisers, coke calcining kilns, firewater pumps, emergency/standby generators, flares, incinerators, crackers, hydrogen production units, Claus process units, catalyst regeneration (from catalytic cracking and other catalytic processes) and cokers (flexi-coking, delayed coking).

B.   *Specific monitoring rules*

The monitoring of mineral oil refining activities shall be carried out in accordance with section 1 of this Annex for combustion emissions including flue gas scrubbing. The operator may choose to use the mass balance methodology in accordance with Article 25 for the whole refinery or individual process units such as heavy oil gasification or calcinations plants. Where combinations of standard methodology and mass balance are used, the operator shall provide evidence to the competent authority demonstrating the completeness of emissions covered, and that no double counting of emissions occurs.

By way of derogation from Article 24 and 25, emissions from catalytic cracker regeneration, other catalyst regeneration and flexi-cokers shall be monitored using a mass balance, taking into account the state of the input air and the flue gas. All CO in the flue gas shall be accounted for as CO_2, applying the mass relation: t CO_2 = t CO * 1,571. The analysis of input air and flue gases and the choice of tiers shall be in accordance with the provisions of Articles 32 to 35. The specific calculation methodology shall be approved by the competent authority.

By way of derogation from Article 24, emissions from hydrogen production shall be calculated as activity data (expressed as tonnes of hydrocarbon feed) multiplied by the emission factor (expressed as t CO_2/t feed). The following tiers are defined for the emission factor:

Tier 1	:	The operator shall use a reference value of 2,9 t CO_2 per tonne feed processed, conservatively based on ethane.
Tier 2	:	The operator shall use an activity-specific emission factor calculated from the carbon content of the feed gas determined in accordance with Articles 32 to 35.

3.   **Production of coke as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: raw materials (including coal or petroleum coke), conventional fuels (including natural gas), process gases (including blast furnace gas — BFG), other fuels and waste gas scrubbing.

B.   *Specific monitoring rules*

For the monitoring of emissions from the production of coke, the operator may choose to use a mass balance in accordance with Article 25 and section 3 of Annex II, or the standard methodology in accordance with Article 24 and sections 2 and 4 of Annex II.

4.   **Metal ore roasting and sintering as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: raw materials (calcination of limestone, dolomite and carbonatic iron ores, including $FeCO_3$), conventional fuels (including natural gas and coke/coke breeze), process gases (including coke oven gas — COG, and blast furnace gas — BFG), process residues used as input material including filtered dust from the sintering plant, the converter and the blast furnace, other fuels and flue gas scrubbing.

B.   *Specific monitoring rules*

For the monitoring of emissions from metal ore roasting, sintering or pelletisation, the operator may choose to use a mass balance in accordance with Article 25 and section 3 of Annex II or the standard methodology in accordance with Article 24 and sections 2 and 4 of Annex II.

5.   **Production of pig iron and steel as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: raw materials (calcination of limestone, dolomite and carbonatic iron ores, including $FeCO_3$), conventional fuels (natural gas, coal and coke), reducing agents (including coke, coal and plastics), process gases (coke oven gas — COG, blast furnace gas — BFG and basic oxygen furnace gas — BOFG), consumption of graphite electrodes, other fuels and waste gas scrubbing.

B.   *Specific monitoring rules*

For the monitoring of emissions from production of pig iron and steel, the operator may choose to use a mass balance in accordance with Article 25 and section 3 of Annex II, or the standard methodology in accordance with Article 24 and sections 2 and 4 of Annex II, at least for a part of the source streams, avoiding any gaps or double counting of emissions.

By way of derogation from section 3.1 of Annex II, tier 3 for the carbon content is defined as follows:

Tier 3 : The operator shall derive the carbon content of input or output stream following Articles 32 to 35 in respect to the representative sampling of fuels, products and by-products, the determination of their carbon contents and biomass fraction. The operator shall base the carbon content of products or semi-finished products on annual analyses following Articles 32 to 35 or derive the carbon content from mid-range composition values as specified by relevant international or national standards.

6. **Production or processing of ferrous and non-ferrous metals as listed in Annex I to Directive 2003/87/EC**

A. *Scope*

The operator shall not apply the provisions in this section for the monitoring and reporting of CO_2 emissions from the production of pig iron and steel and primary aluminium.

The operator shall consider at least the following potential emission sources for CO_2 emissions: conventional fuels; alternative fuels including plastics granulated material from post shredder plants; reducing agents including coke, graphite electrodes; raw materials including limestone and dolomite; carbon containing metal ores and concentrates; and secondary feed materials.

B. *Specific monitoring rules*

Where carbon stemming from fuels or input materials used at this installation remains in the products or other outputs of the production, the operator shall use a mass balance in accordance with Article 25 and section 3 of Annex II. Where this is not the case the operator shall calculate combustion and process emission separately using the standard methodology in accordance with Article 24 and sections 2 and 4 of Annex II.

Where a mass balance is used, the operator may choose to include emissions from combustion processes in the mass balance or to use the standard methodology in accordance with Article 24 and section 1 of this Annex for a part of the source streams, avoiding any gaps or double counting of emissions.

7. **CO_2 Emissions from production or processing of primary aluminium as listed in Annex I to Directive 2003/87/EC**

A. *Scope*

The operator shall apply the provisions of this section to the monitoring and reporting of CO_2 emissions from the production of electrodes for primary aluminium smelting, including stand-alone plants for the production of such electrodes.

The operator shall consider at least the following potential sources for CO_2 emissions: fuels for the production of heat or steam, electrode production, reduction of Al_2O_3 during electrolysis which is related to electrode consumption, and use of soda ash or other carbonates for waste gas scrubbing.

The associated emissions of perfluorocarbons — PFCs, resulting from anode effects, including fugitive emissions, shall be monitored in accordance with section 8 of this Annex.

B. *Specific monitoring rules*

The operator shall determine CO_2 emissions from the production or processing of primary aluminium using the mass balance methodology in accordance with Article 25. The mass balance methodology shall consider all carbon in inputs, stocks, products and other exports from

the mixing, forming, baking and recycling of electrodes as well as from electrode consumption in electrolysis. Where pre-baked anodes are used, either separate mass balances for production and consumption may be applied, or one common mass balance taking into account both production and consumption of electrodes. In the case of Søderberg cells, the operator shall use one common mass balance.

For emissions from combustion processes the operator may choose to include them in the mass balance or to use the standard methodology in accordance with Article 24 and section 1 of this Annex at least for a part of the source streams, avoiding any gaps or double counting of emissions.

8. **PFC emissions from production or processing of primary aluminium as listed in Annex I to Directive 2003/87/EC**

A. *Scope*

The operator shall apply the following for emissions of perfluorocarbons (PFCs) resulting from anode effects including fugitive emissions of PFCs. For associated CO_2 emissions, including emissions from electrode production, the operator shall apply section 7 of this Annex.

B. *Determination of PFC emissions*

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 emissions (total) = PFC emissions (duct)/collection efficiency

The collection efficiency shall be measured when the installation-specific emission factors are determined. For its determination the most recent version of the guidance mentioned under Tier 3 of section 4.4.2.4 of the 2006 IPCC Guidelines shall be used.

The operator shall calculate emissions of CF_4 and C_2F_6 emitted through a duct or stack using one of the following methods:

(a) Method A where the anode effect minutes per cell-day are recorded;

(b) Method B where the anode effect overvoltage is recorded.

Calculation Method Method A — *Slope Method*

The operator shall use the following equations for determining PFC emissions:

CF_4 emissions [t] = AEM × (SEF_{CF4}/1 000) × Pr_{Al}

C_2F_6 emissions [t] = CF_4 emissions * F_{C2F6}

Where:

AEM	=	Anode effect minutes/cell-day;
SEF_{CF4}	=	Slope emission factor [(kg CF_4/t Al produced)/(anode effect minutes/cell-day)]. Where different cell-types are used, different SEF may be applied as appropriate;
Pr_{Al}	=	Annual production of primary Aluminium [t];
F_{C2F6}	=	Weight fraction of C_2F_6 (t C_2F_6/t CF_4).

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

AEM = frequency × average duration

Emission factor	:	The emission factor for CF_4 (slope emission factor, SEF_{CF4}) expresses the amount [kg] of CF_4 emitted per tonne of aluminium produced per anode effect minute/cell-day. The emission factor (weight fraction F_{C2F6}) of C_2F_6 expresses the amount [t] of C_2F_6 emitted proportionate to the amount [t] of CF_4 emitted.
Tier 1	:	The operator shall use technology-specific emission factors from Table 1 of this section of Annex IV.
Tier 2	:	The operator shall use installation-specific emission factors for CF_4 and C_2F_6 established through continuous or intermittent field measurements. For the determination of those emission factors the operator shall use the most recent version of the guidance mentioned under tier 3 of section 4.4.2.4 of the 2006 IPCC Guidelines[1]. The operator shall determine each emission factor with a maximum uncertainty of ± 15 %.

The operator shall determine the emission factors 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 1:

TECHNOLOGY-SPECIFIC EMISSION FACTORS RELATED
TO ACTIVITY DATA FOR THE SLOPE METHOD

Technology	Emission factor for CF_4 $(SEF_{CF4})[(kg\ CF_4/t\ Al)/(AE\text{-}Mins/cell\text{-}day)]$	Emission factor for C_2F_6 $(F_{C2F6})[t\ C_2F_6/t\ CF_4]$
Centre Worked Prebake (CWPB)	0,143	0,121
Vertical Stud Søderberg (VSS)	0,092	0,053

Calculation Overvoltage Method
Method
B —

Where the anode effect overvoltage is measured, the operator shall use the following equations for the determination of PFC emissions:

CF_4 emissions [t] = OVC × (AEO/CE) × Pr_{Al} × 0,001

C_2F_6 emissions [t] = CF_4 emissions × F_{C2F6}

Where:

OVC	=	Overvoltage coefficient ('emission factor') expressed as kg CF_4 per tonne of aluminium produced per mV overvoltage;

AEO	=	Anode effect overvoltage per cell [mV] determined as the integral of (time × voltage above the target voltage) divided by the time (duration) of data collection;
CE	=	Average current efficiency of aluminium production [%];
Pr_{Al}	=	Annual production of primary Aluminium [t];
F_{C2F6}	=	Weight fraction of C_2F_6 (t C_2F_6/t CF_4);

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

Emission factor	:	The emission factor for CF_4 ('overvoltage coefficient' OVC) shall express the amount [kg] of CF_4 emitted per tonne of aluminium produced per millivolt overvoltage [mV]. The emission factor of C_2F_6 (weight fraction F_{C2F6}) shall express the amount [t] of C_2F_6 emitted proportionate to the amount [t] of CF_4 emitted.
Tier 1	:	The operator shall apply technology-specific emission factors from Table 2 of this section of Annex IV.
Tier 2	:	The operator shall use installation-specific emission factors for CF_4 [(kg CF_4/t Al)/(mV)] and C_2F_6 [t C_2F_6/t CF_4] established through continuous or intermittent field measurements. For the determination of those emission factors, the operator shall use the most recent version of the guidance mentioned under tier 3 of section 4.4.2.4 of the 2006 IPCC Guidelines. The operator shall determine the emission factors with a maximum uncertainty of ± 15 % each.

The operator shall determine the emission factors 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 OVERVOLTAGE ACTIVITY DATA

Technology	Emission factor for CF_4[(kg CF_4/t Al)/mV]	Emission factor for C_2F_6[t C_2F_6/t CF_4]
Centre Worked Prebake (CWPB)	1,16	0,121
Vertical Stud Søderberg (VSS)	N.A.	0,053

C.   *Determination of CO$_{2(e)}$ emissions*

The operator shall calculate $CO_{2(e)}$ emissions from CF_4 and C_2F_6 emissions as follows, using the global warming potentials listed in Annex VI, section 3, Table 6:

PFC emissions [t $CO_{2(e)}$] = CF_4 emissions [t] * GWP_{CF4} + C_2F_6 emissions [t] * GWP_{C2F6}

9.   **Production of cement clinker as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: calcination of limestone in the raw materials, conventional fossil kiln fuels, alternative fossil-based kiln fuels and raw materials, biomass kiln fuels (biomass wastes), non-kiln fuels, organic carbon content of limestone and shales and raw materials used for waste gas scrubbing.

B.   *Specific monitoring rules*

Emissions from combustion shall be monitored in accordance with section 1 of this Annex. Process emissions from raw meal components shall be monitored in accordance with section 4 of Annex II based on the carbonate content of the process input (calculation Method A) or on the amount of clinker produced (calculation Method B). Carbonates to be taken into account shall at least include $CaCO_3$, $MgCO_3$ and $FeCO_3$.

CO_2 emissions related to dust removed from the process and organic carbon in the raw materials shall be added in accordance with subsections C and D of this section of Annex IV.

***Calculation Kiln Input Based
Method
A:***

Where cement kiln dust (CKD) and bypass dust leave the kiln system the operator shall not consider the related raw material as process input, but calculate emissions from CKD in accordance with subsection C.

Unless the raw meal is characterised, the operator shall apply the uncertainty requirements for activity data separately to each of the relevant carbon-bearing kiln inputs, 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.

***Calculation Clinker Output Based
Method
B:***

The operator shall determine activity data as the clinker production [t] over the reporting period in one of the following ways:

(a)   by direct weighing of clinker;

(b)   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:

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

The operator shall either derive the cement/clinker ratio for each of the different cement products based on the provisions of Articles 32 to 35 or calculate the 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.

By way of derogation from section 4 of Annex II, tier 1 for the emission factor shall be defined as follows:

Tier 1   :   The operator shall apply an emission factor of 0,525 t CO_2/t clinker.

C.   *Emissions related to discarded dust*

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The operator shall add CO_2 emissions, from bypass dust or cement kiln dust (CKD) leaving the kiln system, corrected for a partial calcination ratio of CKD calculated as process emissions in accordance with Article 24(2). By way of derogation from section 4 of Annex II, tiers 1 and 2 for the emission factor shall be defined as follows:

Tier 1   : The operator shall apply an emission factor of 0,525 t CO_2/t dust.

Tier 2   : The operator shall determine the emission factor (EF) at least once annually following Articles 32 to 35 and using the following formula:

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

Where:

EF_{CKD} = Emission factor of partially calcined cement kiln dust [t CO_2/t CKD];

EF_{Cli} = Installation-specific emission factor of clinker [t CO_2/ t clinker];

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

Tier 3 for the emission factor is not applicable.

D.   *Emissions from non-carbonate carbon in raw meal*

The operator shall determine the emissions from non-carbonate carbon at least from limestone, shale or alternative raw materials (for example, fly ash) used in the raw meal in the kiln in accordance with Article 24(2).

The following tier definitions for the emission factor shall apply:

Tier 1   : The content of non-carbonate carbon in the relevant raw material shall be estimated using industry best practice guidelines.

Tier 2   : The content of non-carbonate carbon in the relevant raw material shall be determined at least annually following the provisions of Article 32 to 35.

The following tier definitions for the conversion factor shall apply:

Tier 1   : A conversion factor of 1 shall be applied.

Tier 2   : The conversion factor shall be calculated applying best industry practice.

10.   **Production of lime or calcination of dolomite or magnesite as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: calcination of limestone, dolomite or magnesite in the raw materials, conventional fossil kiln fuels, alternative fossil-based kiln fuels and raw materials, biomass kiln fuels (biomass wastes) and other fuels.

Where the burnt lime and the CO_2 stemming from the limestone are used for purification processes, such that approximately the same amount of CO_2 is bound again, the decomposition of carbonates as well as the purification process shall not be required to be included separately in the monitoring plan of the installation.

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B.   *Specific monitoring rules*

Emissions from combustion shall be monitored in accordance with section 1 of this Annex. Process emissions from raw materials shall be monitored in accordance with section 4 of Annex II. Carbonates of calcium and magnesium shall be always taken into account. Other carbonates and organic carbon in the raw material shall be taken into account, where relevant.

For the input based methodology, carbonate content values shall be adjusted for the respective moisture and gangue content of the material. In the case of magnesia production, other magnesium bearing minerals than carbonates must be taken into account, as appropriate.

Double counting or omissions resulting from returned or by-pass material must be avoided. When applying Method B, lime kiln dust shall be considered a separate source stream where relevant.

[**F1**. . . . .]

Textual Amendments

F1   Deleted by 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 (Text with EEA relevance).

11.   **Manufacture of glass, glass fibre or mineral wool insulation material as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall apply the provisions in this section also to installations for the production of water glass and stone/rock wool.

The operator shall include at least the following potential sources of CO_2 emissions: decomposition of alkali- and alkali earth carbonates as the result of melting the raw material, conventional fossil fuels, alternative fossil-based fuels and raw materials, biomass fuels (biomass wastes), other fuels, carbon containing additives including coke, coal dust and graphite, post-combustion of flue gases and flue gas scrubbing.

B.   *Specific monitoring rules*

Emissions from combustion, including flue gas scrubbing, and from process materials including coke, graphite and coal dust shall be monitored in accordance with section 1 of this Annex. Process emissions from raw materials shall be monitored in accordance with section 4 of Annex II. Carbonates to be taken into account include at least $CaCO_3$, $MgCO_3$, Na_2CO_3, $NaHCO_3$, $BaCO_3$, Li_2CO_3, K_2CO_3, and $SrCO_3$. Only Method A shall be used.

The following tier definitions for the emission factor shall apply:

| Tier 1 | : | Stoichiometric ratios as listed in section 2 of Annex VI shall be used. The purity of relevant input materials shall be determined by means of industry best practice. |
| Tier 2 | : | The determination of the amount of relevant carbonates in each relevant input material shall be carried out in accordance with Articles 32 to 35. |

For the conversion factor, only tier 1 shall be applicable.

12.   Manufacture of ceramic products as listed in Annex I to Directive 2003/87/EC

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: kiln fuels, calcination of limestone/dolomite and other carbonates in the raw material, limestone and other carbonates for reducing air pollutants and other flue gas cleaning, fossil/biomass additives used to induce porosity including polystyrol, residues from paper production or sawdust, fossil organic material in the clay and other raw materials.

B.   *Specific monitoring rules*

Emissions from combustion including flue gas scrubbing shall be monitored in accordance with section 1 of this Annex. Process emissions from raw meal components shall be monitored in accordance with section 4 of Annex II. For ceramics based on purified or synthetic clays the operator may use either Method A or Method B. For ceramic products based on unprocessed clays and whenever clays or additives with significant organic content are used, the operator shall use Method A. Carbonates of calcium shall be always taken into account. Other carbonates and organic carbon in the raw material shall be taken into account, where relevant.

By way of derogation from section 4 of Annex II, the following tier definitions for emission factors for process emissions shall apply:

Method A (Input based)

Tier 1	:	A conservative value of 0,2 tonnes $CaCO_3$ (corresponding to 0,08794 tonnes of CO_2) per tonne of dry clay shall be applied for the calculation of the emission factor instead of results of analyses.
Tier 2	:	An emission factor for each source stream shall be derived and updated at least once per year using best industry practice reflecting site-specific conditions and the product mix of the installation.
Tier 3	:	The determination of the composition of the relevant raw materials shall be carried out in accordance with Articles 32 to 35.

Method B (Output based)

Tier 1	:	A conservative value of 0,123 tonnes of CaO (corresponding to 0,09642 tonnes of CO_2) per tonne of product shall be applied for the calculation of the emission factor instead of the results of analyses.
Tier 2	:	An emission factor shall be derived and updated at least once per year using best industry practice reflecting site-specific conditions and the product mix of the installation.
Tier 3	:	The determination of the composition of the products shall be carried out in accordance with Articles 32 to 35.

By way of derogation from section 1 of this Annex, for the scrubbing of flue gases the following tier for the emission factor shall apply:

Tier 1	:	The operator shall apply the stoichiometric ratio of $CaCO_3$ as shown in section 2 of Annex VI.

For scrubbing, no other tier and no conversion factor shall be used. Double counting from used limestone recycled as raw material in the same installation shall be avoided.

13.   Production of gypsum products and plaster boards as listed in Annex I to Directive 2003/87/EC

A.   *Scope*

The operator shall include at least CO_2 emissions from all types of combustion activities.

B.   *Specific monitoring rules*

Emissions from combustion shall be monitored in accordance with section 1 of this Annex.

14.   **Pulp and paper production as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least the following potential sources of CO_2 emissions: boilers, gas turbines, and other combustion devices producing steam or power, recovery boilers and other devices burning spent pulping liquors, incinerators, lime kilns and calciners, waste gas scrubbing and fuel-fired dryers (such as infrared dryers).

B.   *Specific monitoring rules*

The monitoring of emissions from combustion including flue gas scrubbing shall be carried out in accordance with section 1 of this Annex.

Process emissions from raw materials used as make-up chemicals, including at least limestone or soda ash, shall be monitored by Method A in accordance with section 4 of Annex II. CO_2 emissions from the recovery of limestone sludge in pulp production shall be assumed to be recycled biomass CO_2. Only the amount of CO_2 proportional to the input from make-up chemicals shall be assumed to give rise to fossil CO_2 emissions.

[**F1** . . . .]

For emissions from make-up chemicals, the following tier definitions for the emission factor shall apply:

Tier 1	:	Stoichiometric ratios as listed in section 2 of Annex VI shall be used. The purity of relevant input materials shall be determined by means of best industry practice. The derived values shall be adjusted in accordance with the moisture and gangue content of the applied carbonate materials.
Tier 2	:	The determination of the amount of relevant carbonates in each relevant input material shall be carried out in accordance with Articles 32 to 35.

For the conversion factor, only tier 1 shall be applicable.

15.   **Production of carbon black as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The operator shall include at least all fuels for combustion and all fuels used as process material as sources for CO_2 emissions.

B.   *Specific monitoring rules*

The monitoring of emissions from carbon black production may be monitored either as a combustion process, including flue gas scrubbing, in accordance with section 1 of this Annex or using a mass balance in accordance with Article 25 and section 3 of Annex II.

16.   **Determination of nitrous oxide (N_2O) emissions from nitric acid, adipic acid, caprolactam, glyoxal and glyoxylic acid production as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

Each operator shall consider for each activity from which N_2O emissions result, all sources emitting N_2O from production processes, including where N_2O emissions from production are channelled through any abatement equipment. This includes any of the following:

(a) nitric acid production — N_2O emissions from the catalytic oxidation of ammonia and/or from the NO_x/N_2O abatement units;

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

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

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

These provisions shall not apply to any N_2O emissions from the combustion of fuels.

B.   *Determination of N_2O emissions*

B.1.   Annual N_2O emissions

The operator shall monitor emissions of N_2O from nitric acid production using continuous emissions measurement. The operator shall monitor emissions of N_2O from adipic acid, caprolactam, glyoxal and glyoxylic acid production using a measurement-based methodology for abated emissions and a calculation-based method (based on a mass balance methodology) for temporary occurrences of unabated emissions.

For each emission source where continuous emissions measurement is applied, the operator shall consider the total annual emissions to be the sum of all hourly emissions using the following formula:

$$N_2O\ \text{emissions}_{annual}\ [t] = \Sigma\ [N_2O\ \text{conc}_{hourly}\ [mg/Nm^3] * \text{flue gas flow}_{hourly}\ [Nm^3/h]] * 10^{-9}$$

Where:

N_2O emissions$_{annual}$	=	total annual emissions of N_2O from the emission source in tonnes N_2O
N_2O conc$_{hourly}$	=	hourly concentrations of N_2O in mg/Nm^3 in the flue gas flow measured during operation
Flue gas flow	=	flue gas flow determined in Nm^3/h for each hourly concentration

B.2.   Hourly N_2O emissions

The operator shall calculate annual average hourly N_2O emissions for each source where continuous emission measurement is applied using the following equation:

$$N_2O\ \text{emissions}_{\text{av hourly}}\ [kg/h] = \frac{\Sigma\left(N_2O\ \text{conc}_{hourly}\left[mg/Nm^3\right] * \text{flue gas flow}\left[Nm^3/h\right] * 10^{-6}\right)}{\text{Hours of operation}[h]}$$

Where:

N_2O emissions$_{av\ hourly}$	=	annual average hourly N_2O emissions in kg/h from the source;
N_2O conc$_{hourly}$	=	hourly concentrations of N_2O in mg/Nm^3 in the flue gas flow measured during operation;
Flue gas flow	=	flue gas flow determined in Nm^3/h for each hourly concentration.

The operator shall determine hourly N_2O concentrations [mg/Nm^3] in the flue gas from each emission source using a measurement-based methodology at a representative point, after the NO_x/N_2O abatement equipment, where abatement is used. The operator shall apply techniques capable of measuring N_2O concentrations of all emission sources during both abated and unabated conditions. Where uncertainties increase during such periods, the operator shall take them into account in the uncertainty assessment.

The operator shall adjust all measurements to a dry gas basis where required and report them consistently.

B.3.   Determination of flue gas flow

The operator shall use the methods for monitoring flue gas flow set out in Article 43(5) of this Regulation for measuring the flue gas flow for N_2O emissions monitoring. For nitric acid production, the operator shall apply the method in accordance with point (a) of Article 43(5) unless it is technically not feasible. In that case and upon approval by the competent authority, the operator shall apply an alternative method, including by a mass balance methodology 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:

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

Where:

V_{air}	=	Total input air flow in Nm^3/h at standard conditions;
$O_{2,air}$	=	Volume fraction of O_2 in dry air [= 0,2095];
$O_{2,\text{flue gas}}$	=	Volume fraction of O_2 in the flue gas.

The V_{air} shall be calculated as the sum of all air flows entering the nitric acid production unit.

The operator shall apply the following formula, unless stated otherwise in its monitoring plan:

$$V_{air} = V_{prim} + V_{sec} + V_{seal}$$

Where:

V_{prim}	=	Primary input air flow in Nm^3/h at standard conditions;
V_{sec}	=	Secondary input air flow in Nm^3/h at standard conditions;
V_{seal}	=	Seal input air flow in Nm^3/h at standard conditions.

The operator shall determine V_{prim} by continuous flow measurement before the mixing with ammonia takes place. The operator shall determine V_{sec} by continuous flow measurement, including where the measurement is before the heat recovery unit. For V_{seal} the operator shall consider the purged airflow within the nitric acid production process.

For input air streams accounting for cumulatively less than 2,5 % of the total air flow, the competent authority may accept estimation methods for the determination of that air flow rate proposed by the operator based on industry best practices.

The operator shall provide evidence through measurements under normal operating conditions that the flue gas flow measured is sufficiently homogeneous to allow for the proposed measurement method. Where non-homogeneous flow is confirmed through these measurements, the operator shall take that into account when determining appropriate monitoring methods and when calculating the uncertainty in the N_2O emissions.

The operator shall adjust all measurements to a dry gas basis and report them consistently.

B.4.   Oxygen (O_2) concentrations

The operator shall measure the oxygen concentrations in the flue gas where necessary for calculating the flue gas flow in accordance with subsection B.3 of this section of Annex IV. In doing so, the operator shall comply with the requirements for concentration measurements within Article 41(1) and (2). In determining the uncertainty of N_2O emissions, the operator shall take the uncertainty of O_2 concentration measurements into account.

The operator shall adjust all measurements to a dry gas basis where required and report them consistently.

B.5.   Calculation of N_2O emissions

For specific periods of unabated emissions of N_2O from adipic acid, caprolactam, glyoxal and glyoxylic acid production, including unabated emissions from venting for safety reasons and when abatement plant fails, and where continuous emissions monitoring of N_2O is technically not feasible, the operator shall subject to the approval of the specific methodology by the competent authority calculate N_2O emissions using a mass balance methodology. For this purpose the overall uncertainty shall be similar to the result of applying the tier requirements of Article 41(1) and (2). The operator shall base the calculation method on the maximum potential emission rate of N_2O from the chemical reaction taking place at the time and the period of the emission.

The operator shall take the uncertainty in any calculated emissions for a specific emission source into account in determining the annual average hourly uncertainty for the emission source.

B.6.   Determination of activity production rates

Production rates shall be calculated using daily production reports and hours of operation.

B.7.   Sampling rates

Valid hourly averages or averages for shorter reference periods shall be calculated in accordance with Article 44 for:

(a)   concentration of N_2O in the flue gas;

(b)   total flue gas flow where this is measured directly and where required;

(c)   all gas flows and oxygen concentrations necessary to determine the total flue gas flow indirectly.

C.   *Determination of annual CO_2 equivalent — $CO_{2(e)}$*

The operator shall convert the total annual N_2O emissions from all emissions sources, measured in tonnes to three decimal places, to annual $CO_{2(e)}$ in rounded tonnes, using the following formula and the GWP values in Annex VI, section 3:

$$CO_{2(e)} [t] = N_2O_{annual}[t] * GWP_{N2O}$$

The total annual $CO_{2(e)}$ generated by all emission sources and any direct CO_2 emissions from other emission sources included under the greenhouse gas permit shall be added to the total annual CO_2 emissions generated by the installation and shall be used for reporting and surrendering allowances.

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Total annual emissions of N_2O shall be reported in tonnes to three decimal places and as $CO_{2(e)}$ in rounded tonnes.

17. **Production of ammonia as listed in Annex I to Directive 2003/87/EC**

A. *Scope*

The operator shall include at least the following potential emission sources for CO_2 emissions: combustion of fuels supplying the heat for reforming or partial oxidation, fuels used as process input in the ammonia production process (reforming or partial oxidation), fuels used for other combustion processes including for the purpose of producing hot water or steam.

B. *Specific monitoring rules*

For monitoring of emissions from combustion processes and from fuels used as process inputs, the standard methodology in accordance with Article 24 and section 1 of this Annex shall be applied.

Where CO_2 from ammonia production is used as feedstock for the production of urea or other chemicals, or transferred out of the installation for any use not covered by Article 49(1), the related amount of CO_2 shall be considered as emitted by the installation producing the CO_2.

18. **Production of bulk organic chemicals as listed in Annex I to Directive 2003/87/EC**

A. *Scope*

The operator shall take into account at least the following sources of CO_2 emissions: cracking (catalytic and non-catalytic), reforming, partial or full oxidation, similar processes which lead to CO_2 emissions from carbon contained in hydrocarbon based feedstock, combustion of waste gases and flaring, and the burning of fuel in other combustion processes.

B. *Specific monitoring rules*

Where the production of bulk organic chemicals is technically integrated in a mineral oil refinery, the operator of that installation shall apply the relevant provisions of section 2 of this Annex.

Notwithstanding the first subparagraph, the operator shall monitor emissions from combustion processes where the fuels used do not take part in or stem from chemical reactions for the production of bulk organic chemicals using the standard methodology in accordance with Article 24 and section 1 of this Annex. In all other cases, the operator may choose to monitor the emissions from bulk organic chemicals production by mass balance methodology in accordance with Article 25 or the standard methodology in accordance with Article 24. Where using the standard methodology, the operator shall provide evidence to the competent authority that the chosen methodology covers all relevant emissions that would also be covered by a mass-balance methodology.

For the determination of the carbon content under Tier 1, the reference emission factors as listed in Table 5 in Annex VI shall be applied. For substances not listed in Table 5 of Annex VI or other provisions of this Regulation, the operator shall calculate the carbon content from the stoichiometric carbon content in the pure substance and the concentration of the substance in the input or output stream.

19. **Production of hydrogen and synthesis gas as listed in Annex I to Directive 2003/87/EC**

A. *Scope*

The operator shall include at least the following potential emission sources for CO_2 emissions: fuels used in the hydrogen or synthesis gas production process (reforming or partial oxidation), and fuels used for other combustion processes including for the purpose of producing hot water or steam. Synthesis gas produced shall be considered as source stream under the mass balance methodology.

B.   *Specific monitoring rules*

For monitoring of emissions from combustion processes and from fuels used as process inputs in hydrogen production, the standard methodology in accordance with Article 24 and section 1 of this Annex shall be used.

For the monitoring of emissions from the production of synthesis gas, a mass balance in accordance with Article 25 shall be used. For emissions from separate combustion processes, the operator may choose to include them in the mass balance or to use the standard methodology in accordance with Article 24 at least for a part of the source streams, avoiding any gaps or double counting of emissions.

Where hydrogen and synthesis gas are produced at the same installation, the operator shall calculate CO_2 emissions using either separate methodologies for hydrogen and for synthesis gas as outlined in the first two paragraphs of this subsection, or using one common mass balance.

20.   **Production of soda ash and sodium bicarbonate as listed in Annex I to Directive 2003/87/EC**

A.   *Scope*

The emission sources and source streams for CO_2 emissions from installations for the production of soda ash and sodium bicarbonate shall include:

(a)   fuels used for combustion processes, including fuels used for the purpose of producing hot water or steam;

(b)   raw materials, including vent gas from calcination of limestone, to the extent it is not used for carbonation;

(c)   waste gases from washing or filtration steps after carbonation, to the extent it is not used for carbonation.

B.   *Specific monitoring rules*

For the monitoring of emissions from the production of soda ash and sodium bicarbonate, the operator shall use a mass balance in accordance with Article 25. For emissions from combustion processes, the operator may choose to include them in the mass balance or to use the standard methodology in accordance with Article 24 at least for a part of the source streams, avoiding any gaps or double counting of emissions.

Where CO_2 from the production of soda ash is used for the production of sodium bicarbonate, the amount of CO_2 used for producing sodium bicarbonate from soda ash shall be considered as emitted by the installation producing the CO_2.

21.   **Determination of greenhouse gas emissions from CO_2 capture activities for the purposes of transport and geological storage in a storage site permitted under Directive 2009/31/EC**

A.   *Scope*

CO_2 capture shall be performed either by a dedicated installation receiving CO_2 by transfer from one or more other installations, or by the same installation carrying out the activities producing the captured CO_2 under the same greenhouse gas emissions permit. All parts of the installation related to CO_2 capture, intermediate storage, transfer to a CO_2 transport network or to a site for geological storage of CO_2 greenhouse gas emissions shall be included in the greenhouse gas emissions permit and accounted for in the associated monitoring plan. In the case of the installation carrying out other activities covered by Directive 2003/87/EC, the emissions of those activities shall be monitored in accordance with the other relevant sections of this Annex.

The operator of a CO_2 capture activity shall at least include the following potential sources of CO_2 emission:

(a) CO_2 transferred to the capture installation;

(b)   combustion and other associated activities at the installation that are related to the capture activity, including fuel and input material use.

B.   *Quantification of transferred and emitted CO_2 amounts*

B.1.   Installation level quantification

Each operator shall calculate the emissions by taking into account the potential CO_2 emissions from all emission relevant processes at the installation, as well as the amount of CO_2 captured and transferred to the transport network, using the following formula:

$$E_{capture\ installation} = T_{input} + E_{without\ capture} - T_{for\ storage}$$

Where:

$E_{capture\ installation}$	=	Total greenhouse gas emissions of the capture installation;
T_{input}	=	Amount of CO_2 transferred to the capture installation, determined in accordance with Article 40 to 46 and Article 49.
$E_{without\ capture}$	=	Emissions of the installation assuming the CO_2 were not captured, meaning the sum of the emissions from all other activities at the installation, monitored in accordance with relevant sections of Annex IV;
$T_{for\ storage}$	=	Amount of CO_2 transferred to a transport network or a storage site, determined in accordance with Article 40 to 46 and Article 49.

In cases where CO_2 capture is carried out by the same installation as the one from which the captured CO_2 originates, the operator shall use zero for T_{input}.

In cases of stand-alone capture installations, the operator shall consider $E_{without\ capture}$ to represent the amount of emissions that occur from other sources than the CO_2 transferred to the installation for capture. The operator shall determine those emissions in accordance with this Regulation.

In the case of stand-alone capture installations, the operator of the installation transferring CO_2 to the capture installation shall deduct the amount T_{input} from the emissions of its installation in accordance with Article 49.

B.2.   Determination of transferred CO_2

Each operator shall determine the amount of CO_2 transferred from and to the capture installation in accordance with Article 49 by means of measurement methodologies carried out in accordance with Articles 40 to 46.

Only where the operator of the installation transferring CO_2 to the capture installation demonstrates to the satisfaction of the competent authority that CO_2 transferred to the capture installation is transferred in total and to at least equivalent accuracy, may the competent authority allow that operator to use a calculation-based methodology in accordance with Article 24 or 25 to determine the amount T_{input} instead of a measurement-based methodology in accordance with Article 40 to 46 and Article 49.

22.   **Determination of greenhouse gas emissions from the transport of CO_2 by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC**

A.   *Scope*

The boundaries for monitoring and reporting emissions from CO_2 transport by pipeline shall be laid down in the transport network's greenhouse gas emissions permit, including all ancillary plant functionally connected to the transport network, including booster stations and heaters. Each transport network shall have a minimum of one start point and one end point, each connected to other installations carrying out one or more of the activities: capture, transport or geological storage of CO_2. Start and end points may include bifurcations of the transport network and cross national borders. Start and end points as well as the installations they are connecting to, shall be laid down in the greenhouse gas emissions permit.

Each operator shall consider at least the following potential emission sources for CO_2 emissions: combustion and other processes at installations functionally connected to the transport network including booster stations; fugitive emissions from the transport network; vented emissions from the transport network; and emissions from leakage incidents in the transport network.

B.   *Quantification methodologies for CO_2*

The operator of transport networks shall determine emissions using one of the following methods:

(a)   Method A (overall mass balance of all input and output streams) set out in subsection B.1;

(b)   Method B (monitoring of emission sources individually) set out in subsection B.2.

In choosing either Method A or Method B, each operator shall demonstrate to the competent authority that the chosen methodology will lead to more reliable results with lower uncertainty of the overall emissions, using best available technology and knowledge at the time of the application for the greenhouse gas emissions permit and approval of the monitoring plan, without incurring unreasonable costs. Where Method B is chosen each operator shall demonstrate to the satisfaction of the competent authority that the overall uncertainty for the annual level of greenhouse gas emissions for the operator's transport network does not exceed 7,5 %.

The operator of a transport network using Method B shall not add CO_2 received from another installation permitted in accordance with Directive 2003/87/EC to its calculated level of emissions, and shall not subtract from its calculated level of emissions any CO_2 transferred to another installation permitted in accordance with Directive 2003/87/EC.

Each operator of a transport network shall use Method A for the validation of the results of Method B at least once annually. For that validation, the operator may use lower tiers for the application of Method A.

B.1.   Method A

Each operator shall determine emissions in accordance with the following formula:

$$\text{Emissions [t CO}_2] = E_{\text{own activity}} + \sum_i T_{\text{IN}, i} - \sum_j T_{\text{OUT}, j}$$

Where:

Emissions	=	Total CO_2 emissions of the transport network [t CO_2];
$E_{\text{own activity}}$	=	Emissions from the transport network's own activity, meaning not emissions stemming from the CO_2 transported, but including emissions from fuel used in booster stations, monitored in accordance with the relevant sections of Annex IV;
$T_{\text{IN},i}$	=	Amount of CO_2 transferred to the transport network at entry point i, determined in accordance with Articles 40 to 46 and Article 49.
$T_{\text{OUT},j}$	=	Amount of CO_2 transferred out of the transport network at exit point j, determined in accordance with Articles 40 to 46 and Article 49.

B.2.   Method B

Each operator shall determine emissions considering all processes relevant to emissions at the installation as well as the amount of CO_2 captured and transferred to the transport facility using the following formula:

Emissions [t CO_2] = CO_2 fugitive + CO_2 vented + CO_2 leakage events + CO_2 installations

Where:

Emissions	=	Total CO_2 emissions of the transport network [t CO_2];
CO_2 fugitive	=	Amount of fugitive emissions [t CO_2] from CO_2 transported in the transport network, including from seals, valves, intermediate compressor stations and intermediate storage facilities;
CO_2 vented	=	Amount of vented emissions [t CO_2] from CO_2 transported in the transport network;
CO_2 leakage events	=	Amount of CO_2 [t CO_2] transported in the transport network, which is emitted as the result of the failure of one or more components of the transport network;
CO_2 installations	=	Amount of CO_2 [t CO_2] being emitted from combustion or other processes functionally connected to the pipeline transport in the transport network, monitored in accordance with the relevant sections of Annex IV.

B.2.1.   Fugitive emissions from the transport network

The operator shall consider fugitive emissions from any of the following types of equipment:

(a)   seals;

(b)   measurement devices;

(c)   valves;

(d)   intermediate compressor stations;

(e)   intermediate storage facilities.

The operator shall determine average emission factors *EF* (expressed in g CO_2/unit time) per piece of equipment per occurrence where fugitive emissions can be anticipated at the beginning of operation, and by the end of the first reporting year in which the transport network is in

operation at the latest. The operator shall review those factors at least every 5 years in the light of the best available techniques and knowledge.

The operator shall calculate fugitive emissions by multiplying the number of pieces of equipment in each category by the emission factor and adding up the results for the single categories as shown in the following equation:

$$\text{Fugitive emissions [tCO}_2] = \left(\sum\nolimits_{\text{Category}} \text{EF [gCO}_2 \text{ / occurence]}* \text{number of occurences} \right) \Big/ 1000000$$

The number of occurrences shall be the number of pieces of the given equipment per category, multiplied by the number of time units per year.

B.2.2. Emissions from leakage events

The operator of a transport network shall provide evidence of the network integrity by using representative (spatial and time-related) temperature and pressure data. Where the data indicates that a leakage has occurred, the operator shall calculate the amount of CO_2 leaked with a suitable methodology documented in the monitoring plan, based on industry best practice guidelines, including by use of the differences in temperature and pressure data compared to integrity related average pressure and temperature values.

B.2.3. Vented emissions

Each operator shall provide in the monitoring plan an analysis regarding potential situations of venting emissions, including for maintenance or emergency reasons, and provide a suitable documented methodology for calculating the amount of CO_2 vented, based on industry best practice guidelines.

23. **Geological storage of CO_2 in a storage site permitted under Directive 2009/31/EC**

A. *Scope*

The competent authority shall base the boundaries for monitoring and reporting of emissions from geological storage of CO_2 on the delimitation of the storage site and storage complex as specified in the permit pursuant Directive 2009/31/EC. Where leakages from the storage complex are identified and lead to emissions or release of CO_2 into the water column, the operator shall immediately carry out all of the following:

(a) notify the competent authority;

(b) include the leakage as an emission source for the respective installation;

(c) monitor and report the emissions.

Only when corrective measures in accordance with Article 16 of Directive 2009/31/EC have been taken and emissions or release into the water column from that leakage can no longer be detected shall the operator delete the respective leakage as emission source from the monitoring plan and no longer monitor and report those emissions.

Each operator of a geological storage activity shall consider at least the following potential emission sources for CO_2 overall: fuel use by associated booster stations and other combustion activities including on-site power plants; venting from injection or enhanced hydrocarbon recovery operations; fugitive emissions from injection; breakthrough CO_2 from enhanced hydrocarbon recovery operations; and leakages.

B. *Quantification of CO_2 emissions*

The operator of the geological storage activity shall not add CO_2 received from another installation to its calculated level of emissions, and shall not subtract from its calculated level of emissions any CO_2 which is geologically stored in the storage site or which is transferred to another installation.

B.1.   Vented and fugitive emissions from injection

The operator shall determine emissions from venting and fugitive emissions as follows:

CO_2 emitted [t CO_2] = V CO_2 [t CO_2] + F CO_2 [t CO_2]

Where:

V CO_2 = amount of CO_2 vented;
F CO_2 = amount of CO_2 from fugitive emissions.

Each operator shall determine V CO_2 using measurement-based methodologies in accordance with Articles 41 to 46 of this Regulation. By way of derogation from the first sentence and upon approval by the competent authority, the operator may include in the monitoring plan an appropriate methodology for determining V CO_2 based on industry best practice, where the application of measurement-based methodologies would incur unreasonable costs.

The operator shall consider F CO_2 as one source, meaning that the uncertainty requirements associated with the tiers in accordance with section 1 of Annex VIII are applied to the total value instead of the individual emission points. Each operator shall provide in the monitoring plan an analysis regarding potential sources of fugitive emissions, and provide a suitable documented methodology to calculate or measure the amount of F CO_2, based on industry best practice guidelines. For the determination of F CO_2 the operator may use data collected in accordance with Article 32 to 35 and Annex II(1.1)(e) to (h) of Directive 2009/31/EC for the injection facility, where they comply with the requirements of this Regulation.

B.2.   Vented and fugitive emissions from enhanced hydrocarbon recovery operations

Each operator shall consider the following potential additional emission sources from enhanced hydrocarbon recovery (EHR):

(a)   the oil-gas separation units and gas recycling plant, where fugitive emissions of CO_2 could occur;

(b)   the flare stack, where emissions might occur due to the application of continuous positive purge systems and during depressurisation of the hydrocarbon production installation;

(c)   the CO_2 purge system, to avoid high concentrations of CO_2 extinguishing the flare.

Each operator shall determine fugitive emissions or vented CO_2 in accordance with subsection B.1 of this section of Annex IV.

Each operator shall determine emissions from the flare stack in accordance with subsection D of section 1 of this Annex, taking into account potential inherent CO_2 in the flare gas in accordance with Article 48.

B.3.   Leakage from the storage complex

Emissions and release to the water column shall be quantified as follows:

$$CO_2 \text{ emitted [t } CO_2] = \sum_{T_{Start}}^{T_{End}} L\ CO_2 \text{ [t } CO_2 / d]$$

Where:

$L\,CO_2$	=	the mass of CO_2 emitted or released per calendar day due to the leakage in accordance with all of the following:

    (a)   for each calendar day for which leakage is monitored, each operator shall calculate $L\,CO_2$ as the average of the mass leaked per hour [t CO_2/h] multiplied by 24;

    (b)   each operator shall determine the mass leaked per hour in accordance with the provisions in the approved monitoring plan for the storage site and the leakage;

    (c)   for each calendar day prior to commencement of monitoring, the operator shall take the mass leaked per day to equal the mass leaked per day for the first day of monitoring ensuring no under-estimation occurs;

T_{start}	=	the latest of:

    (a)   the last date when no emissions or release of CO_2 into the water column from the source under consideration were reported;

    (b)   the date the CO_2 injection started;

    (c)   another date such that there is evidence demonstrating to the satisfaction of the competent authority that the emission or release into the water column cannot have started before that date.

T_{end}	=	the date by which corrective measures in accordance with Article 16 of Directive 2009/31/EC have been taken and emissions or release of CO_2 into the water column can no longer be detected.

The competent authority shall approve and allow the use of other methods for the quantification of emissions or release of CO_2 into the water column from leakages where the operator can show to the satisfaction of the competent authority that such methods lead to a higher accuracy than the methodology set out in this subsection.

The operator shall quantify the amount of emissions leaked from the storage complex for each of the leakage events with a maximum overall uncertainty over the reporting period of 7,5 %. Where the overall uncertainty of the applied quantification methodology exceeds 7,5 %, each operator shall apply an adjustment, as follows:

$$CO_{2,Reported}\,[t\,CO_2] = CO_{2,Quantified}\,[t\,CO_2] * (1 + (Uncertainty_{System}\,[\%]/100) - 0,075)$$

Where:

$CO_{2,Reported}$	=	the amount of CO_2 to be included in the annual emission report with regards to the leakage event in question;
$CO_{2,Quantified}$	=	the amount of CO_2 determined through the used quantification methodology for the leakage event in question;
$Uncertainty_{System}$	=	the level of uncertainty associated with the quantification methodology used for the leakage event in question.

(**1**)   International Aluminium Institute; The Aluminium Sector Greenhouse Gas Protocol; October 2006; US Environmental Protection Agency and International Aluminium Institute; Protocol for Measurement of Tetrafluoromethane (CF4) and Hexafluoroethane (C2F6) Emissions from Primary Aluminum Production; April 2008.

Changes to legislation:
There are currently no known outstanding effects for the Commission Regulation (EU) No 601/2012 (repealed), ANNEX IV.