Regulation to amend the Safety Code

Building Act
(chapter B-1.1, ss. 175, 178 and 192)

1. The Safety Code (chapter B-1.1, r. 3) is amended by inserting the following after section 7:

"**7.1.** The water outlet temperature of valves supplying shower heads or bathtubs of a care occupancy or private seniors' residence within the meaning of the Act respecting health services and social services (chapter S-4.2) must be controlled with the devices provided for in section 7.3 and be verified and adjusted so that the temperature does not exceed 43°C.

The verification referred to in the first paragraph must be made at least once a year.

For the purposes of this section,

"care occupancy" means a building or part of a building housing persons who, because of their physical or mental state, need medical care or treatment.

7.2. Information relating to the verification and setting of the water outlet temperature supplying bathtubs and shower heads of a care occupancy or private seniors' residence must be kept in a register for at least 5 years. The register must indicate the date, time, initial temperature, temperature after adjustment, if any, the identification of the valve and the name of the person who made the verification and adjustment. It must be kept in the occupancy or residence and made available to the Board.

7.3. The valves referred to in section 7.1 must be of the thermostatic or combination pressure-balanced/thermostatic type. They must be certified according to the edition of the plumbing supply fitting standard that, under a regulation, was in force at the time of their installation.

Valves supplying only bathtubs need not be of one of the types referred to in the first paragraph if the hot water supply is controlled by a thermostatic-mixing valve or an automatic temperature-limiting device installed within the limits of a bathroom and certified according to the edition of the standard relating to plumbing fittings that, under a regulation, was in force at the time of their installation.

Despite the first paragraph, pressure-balanced valves installed before the coming into force of this section and certified according to the edition of the plumbing supply fitting standard that, under a regulation, was in force at the time of their installation, are permitted in private seniors' residences, except in the parts of those residences that are used as care occupancies.".

2. Subject to the second and third paragraphs of this section, this Regulation comes into force on 27 December 2013.

This Regulation applies as of 11 February 2013 to care occupancies and private seniors' residences with respect to their plumbing systems equipped with one of the devices covered by section 7.3.

Section 7.2 and the requirement covered by section 7.1 to verify and adjust the water outlet temperature of valves supplying shower heads and bathtubs apply as of 11 February 2013 to care occupancies and private seniors' residences with respect to their plumbing systems equipped with devices other than those covered by section 7.3 but that can nonetheless limit the temperature.

2394

M.O., 2012

Order of the Minister of Sustainable Development, Environment, Wildlife and Parks dated 11 December 2012

Environment Quality Act
(chapter Q-2)

MAKING the Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere

THE MINISTER OF SUSTAINABLE DEVELOPMENT, ENVIRONMENT, WILDLIFE AND PARKS

CONSIDERING section 2.2 of the Environment Quality Act (chapter Q-2), which provides that the Minister of Sustainable Development, Environment, Wildlife and Parks may make regulations determining what information a person or a municipality is required to provide regarding an enterprise, a facility or an establishment that the person or municipality operates;

CONSIDERING section 46.2 of the Act, which provides that the Minister may determine by regulation the emitters that must report greenhouse gas emissions and associated information and documents that must be provided to the Minister;

CONSIDERING the publication in Part 2 of the *Gazette officielle du Québec* of 15 October 2012, in accordance with sections 10, 11 and 13 of the Regulations Act (chapter R-18.1) as well as the fifth paragraph of section 2.2 and the second paragraph of section 46.2 of the Environment Quality Act, of the draft of the Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere with a notice that it could be made by the Minister of Sustainable Development, Environment, Wildlife and Parks on the expiry of 45 days following that publication;

CONSIDERING section 18 of the Regulations Act, which provides that a regulation may come into force on the date of its publication in the *Gazette officielle du Québec* where the authority making it is of the opinion that the urgency of the situation requires it and the reason justifying such coming into force must be published with the regulation;

CONSIDERING that the Minister of Sustainable Development, Environment, Wildlife and Parks is of the opinion that the urgency due to the following circumstances justifies the coming into force on the date of publication of the Regulation in the *Gazette officielle du Québec*:

—the amendments made to the draft Regulation, in particular concerning the methods for calculating greenhouse gas emissions, must apply as early as 1 January 2013 so that emissions of contaminants for 2013 are reported in accordance with the new requirements;

CONSIDERING that it is expedient to make the Regulation with amendments;

ORDERS AS FOLLOWS:

The Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere, attached to this Order, is hereby made.

Québec, 11 December 2012

YVES-FRANÇOIS BLANCHET,
Minister of Sustainable Development,
Environment, Wildlife and Parks

Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere

Environment Quality Act
(chapter Q-2, ss. 2.2, 46.2, 115.27 and 115.34)

1. The Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere (chapter Q-2, r. 15) is amended by adding the following paragraph at the end of section 3:

"Last, for the application of this Regulation to a closed landfill site, a person or municipality is considered to operate the site until such time as it is released from its environmental monitoring and maintenance obligations under section 85 of the Regulation respecting the landfilling and incineration of residual materials (chapter Q-2, r. 19)."

2. Section 4 is amended

(1) by inserting "reaches or" after "quantity that";

(2) by inserting ", using the form available on-line on the website of the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs," after "electronic means" in the first paragraph;

(3) by adding "along with their source and, if they originate in published documents, the applicable reference" at the end of the second paragraph;

(4) by striking out the third paragraph;

(5) by inserting "the emissions attributable to them," after "for each of them," in the fifth paragraph.

3. Section 5 is amended

(1) by replacing the first paragraph by the following paragraph:

"**5.** If the operator of the facility or establishment is required, under a public notice given pursuant to section 46 of the Canadian Environmental Protection Act (1999) (S.C. 1999, c. 33), to report to the Minister of the Environment of Canada for a contaminant listed in Part II of Schedule A, the operator must, not later than 1 June each year, transmit to the Minister by electronic means, using the form available on-line on the website of the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, the quantity of any of those contaminants that the facility or establishment emitted into the atmosphere in the preceding calendar year.";

(2) in the second paragraph,

(a) by inserting “, their source and, if they originate in published documents, the applicable reference” after “used for the calculation” in the second paragraph;

(b) by inserting, after “for each of them”, “emissions attributable to them”;

(c) by striking out “That information must be provided in the form in Parts I and III of Schedule B.”;

(3) by striking out the third paragraph.

4. The following sections are inserted after section 5:

“**5.1.** The operator referred to in section 4 or 5 must include the following information with the information referred to in those sections:

(1) the name of and contact information for the enterprise, facility or establishment as well as the name of and contact information for its representative;

(2) the business number assigned to the operator when registered under the Act respecting the legal publicity of enterprises (chapter P-44.1) as well as the ID number assigned under the National Pollutant Release Inventory of the Government of Canada;

(3) the type of enterprise, facility or establishment operated, the activities pursued and processes and equipment used as well as, where applicable, the 6-digit code under the North American Industry Classification System (NAICS Canada);

(4) the name of and contact information for the person responsible for the contaminants emissions report for the enterprise, facility or establishment.

5.2. When the emissions of contaminants from an establishment reported in accordance with section 4 or 5 fall below the reporting threshold the following year, the operator of the establishment must, not later than 1 June following the first year in which the emissions are below the threshold, send a notice to the Minister including the following information and documents:

(1) the information referred to in section 5.1;

(2) an attestation that the emissions of contaminants referred to in Schedule A are below the reporting threshold;

(3) the reason for the reduction in emissions of contaminants;

(4) the signature of the person responsible for the declaration at the establishment.”.

5. Section 6 is amended

(1) by replacing “emission factor” in subparagraph 4 of the first paragraph by “emission rate“;

(2) by replacing the third paragraph by the following paragraphs:

“In addition, unless otherwise indicated, the data required under this Regulation must be in metric units.

An emissions report made under section 4 or 5 must be signed by the person responsible for the report at the enterprise, facility or establishment, who must also attest to the veracity of the information communicated.”.

6. Section 6.1 of the Regulation is amended by inserting “permanently” before “closes” in the last paragraph.

7. Section 6.2 is amended

(1) by replacing “electronically to the Minister” in the part of the first paragraph preceding subparagraph 1 by “to the Minister by electronic means, using the form available on-line on the website of the Ministère du Développement durable, de l’Environnement, de la Faune et des Parcs,”;

(2) by replacing the part of subparagraph 1 of the first paragraph preceding the equation by the following:

“(1) the total quantity of the emitter’s greenhouse gas emissions in metric tons CO_2 equivalent, excluding greenhouse gas emissions captured, stored, re-used, eliminated or transferred out of the establishment and emissions reported in accordance with protocols QC.17 and QC.30, calculated using the following equation:”;

(3) by inserting “Total” before “Annual” in the definitions of the factors “CO_2e” and “GHG_i” in the equation of subparagraph 1 of the first paragraph;

(4) by replacing subparagraph 2 of the first paragraph by the following subparagraph:

“(2) the total quantity of emissions of each type of greenhouse gas referred to in Schedule A.1, in metric tons, excluding greenhouse gas emissions captured, stored, re-used, eliminated or transferred out of the establishment, and emissions reported in accordance with protocols QC.17 and QC.30;”;

(5) by adding "in metric tons CO_2 equivalent" at the end of subparagraph 2.1 of the first paragraph;

(6) by inserting the following after subparagraph 2.1 of the first paragraph:

"(2.2) in the case of a person or municipality operating an enterprise that purchases electricity produced outside Québec for its own consumption or for sale in Québec, the quantity of greenhouse gas emissions attributable to the production of that electricity, in metric tons CO_2 equivalent;

(2.3) the total quantity of the emitter's greenhouse gas emissions, in metric tons CO_2 equivalent, excluding greenhouse gas emissions captured, stored, re-used, eliminated or transferred out of the establishment, and emissions referred to in the second paragraph of section 6.6;";

(7) by adding "in metric tons" at the end of subparagraph 4 of the first paragraph;

(8) by replacing subparagraphs 4.1 and 4.2 of the first paragraph by the following:

"(4.1) the total quantity of CO_2 emissions attributable to the use of biomass and biomass fuels for purposes other than combustion, in metric tons;

(4.2) the quantity and description of biomass used, for each of the following categories:

(*a*) forest biomass, specifying the quantity and description of each of the following types of waste:

i. primary forest waste, namely waste from forest management activities such as parts of trees, residual trees, commercial and non-commercial tree sections, branches and foliage;

ii. secondary forest waste, namely waste from industrial process and related products such as woodchips, sawdust, shavings and bark;

iii. tertiary forest waste, namely waste from construction, demolition and packing processes;

(*b*) agricultural biomass, specifying the quantity and description of each of the following types of waste:

i. animal waste;

ii. plant waste;

iii. municipal biomass;

iv. any other type of biomass not referred to in subparagraphs *a* to *c*;

(9) by replacing subparagraph 5 of the first paragraph by the following:

"(5) the total quantity of emissions of each greenhouse gas that is captured, stored, re-used, eliminated or transferred out of the establishment and the quantity of emissions generated by each operation, in metric tons, along with the contact information of each operating or transfer site;";

(10) by replacing subparagraphs 6 to 8 of the first paragraph by the following:

"(6) the calculation methods used in accordance with section 6.3;

(7) in the case of types of enterprise, facility or establishment or types of activity, process or equipment not covered by a specific protocol in Schedule A.2 or for which greenhouse gas emissions have been calculated in accordance with the second paragraph of section 6.3:

(a) the quantity of emissions of each type of greenhouse gas referred to in Schedule A.1 attributable to each type of activity or the use or each type of process or equipment in metric tons, excluding greenhouse gas emissions captured, stored, re-used, eliminated or transferred out of the establishment;

(b) the CO_2 emissions attributable to the combustion or use of biomass or biomass fuels, in metric tons;

(c) the emission factors or rates used and their origin, reference or method of determination;

(8) in the case of an emitter referred to in section 6.6:

(a) the total annual quantity of benchmark units relating to the emitter's activities;

(b) for each benchmark unit, the total greenhouse gas emissions for each type of emission, excluding emissions referred to in the second paragraph of section 6.6, namely:

i. the fixed process CO_2 emissions, in metric tons;

ii. the annual greenhouse gas combustion emissions, in metric tons CO_2 equivalent;

iii. the annual other category greenhouse gas emissions, in metric tons CO_2 equivalent;”;

(11) by striking out subparagraph 9 of the first paragraph;

(12) by inserting the following paragraph after the first paragraph:

“When the facility or establishment is equipped with a continuous CO_2 monitoring system and when the emitter must, in accordance with this Regulation, indicate emissions by type, whether combustion, fixed process or “other”, the emitter must, for each type of emission,

(1) estimate the greenhouse gas combustion emissions and the “other” category emissions using the emission factors in tables 1-1 to 1-8 in QC.1.7. If no factor is indicated in the tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA), the Intergovernmental Panel on Climate Change (IPCC), the National Council for Air and Stream Improvement (NCASI) or the World Business Council for Sustainable Development (WBCSD);

(2) determine the annual fixed process greenhouse gas emissions by subtracting from the data measured by the continuous CO_2 monitoring system the greenhouse gas combustion emissions and the “other” category emissions estimated in accordance with subparagraph 1.”.

8. Section 6.3 is amended by replacing “the emitter’s total emissions” in subparagraph 1 of the first paragraph by “total emissions from the establishment”.

9. Section 6.4 is amended:

(1) by replacing paragraph 1 by the following:

“(1) the name of and contact information for the enterprise, facility or establishment as well as the name of and contact information for its representative;”;

(2) by striking out paragraph 2;

(3) by replacing paragraph 3 by the following:

“(3) the business number assigned to the emitter when registered under the Act respecting the legal publicity of enterprises (chapter P-44.1) as well as the ID number assigned under the National Pollutant Release Inventory of the Government of Canada;”.

10. Section 6.5 is replaced by the following:

“**6.5.** An emitter whose annual greenhouse gas emissions report includes one or more errors or omissions must, as soon as possible, communicate a notice of correction to the Minister containing the following information:

(1) a description of the corrections to be made to the initial report;

(2) the circumstances that led to the errors or omissions and, where application, the corrections made;

(3) where applicable, an estimate of the quantity of greenhouse gas emissions represented by the errors or omissions.”.

11. Section 6.6 is amended

(1) by replacing the part of the second paragraph preceding subparagraph 1 by the following:

“For the purposes of the verification threshold referred to in the first paragraph, the following emissions are excluded and do not need to be verified:”;

(2) by replacing “fermentation” in subparagraph 1 of the second paragraph by “use”;

(3) by inserting “, including those” after “anaerobic treatment of wastewater” in subparagraph 5 of the second paragraph;

(4) by replacing “and QC.29.3.9” in subparagraph 6 of the second paragraph by “, QC.29.3.9 and QC.29.3.11”;

(5) by adding the following after subparagraph 6 of the second paragraph:

“(7) until 31 December 2014, CO_2, CH_4 and N_2O emissions attributable to oil and gas exploration and production and natural gas processing, as referred to in QC.33.3.1, QC.33.3.2, QC.33.3.8, QC.33.3.16, QC.33.3.17 and QC.33.3.20 in Schedule A.2.”;

(6) by inserting “and a verifier designated by that organization” after “organization” in the part of the third paragraph preceding subparagraph 1;

(7) by replacing subparagraph 1 of the third paragraph by the following:

"(1) this organization and this verifier have not acted as consultants for the emitter for the quantification or greenhouse gas emissions report or have not provided a service referred to in subparagraph 3 of the first paragraph of section 6.10 during the 3 preceding years;";

(8) by replacing "has not" in subparagraph 2 of the third paragraph by "this organization and this verifier have not";

(9) by replacing subparagraph 3 of the third paragraph by the following:

"(3) where the emitter wishes to have the verification of the annual report done by a verifying organization or verifier other than the organization or verifier that verified the report the preceding year, the verifying organization or verifier must not have verified the emissions report for that establishment during the 3 previous years.".

(10) by adding the following paragraphs at the end:

"Despite the first paragraph, the verification report on the emissions report for 2012 or 2013 may be made by a verification organization in the process of being accredited so long as this organization receives its accreditation not later than 31 December of the year in which the emitter's verification report is sent.

If the organization fails to receive its accreditation within the time period specified in the fourth paragraph, the emitter must, not later than 1 April following the end of that period, send to the Minister a new verification report of its emissions report made by an organization accredited in accordance with the first paragraph.".

12. Section 6.7 is replaced by the following:

"**6.7.** An emitter referred to in section 6.6 who communicates a notice of correction for the emitter's emissions report in accordance with section 6.5 must include a verification report in cases where errors or omissions, calculated using the equation below, represent 5% or more of the total emissions of the establishment or correspond to emissions equal to or greater than 25,000 metric tons CO_2 equivalent:

$$PE = \left(\frac{SEO}{TER} \times 100\right)$$

Where:

PE = Percentage of error;

SEO = Sum of CO_2 equivalent greenhouse gas emissions erroneously calculated or omitted, in metric tons;

TER = Total CO_2 equivalent greenhouse gas emissions initially reported.

When the errors or omissions calculated using the equation in the first paragraph represent less than 5% of total emissions from the establishment and correspond to emissions under 25,000 metric tons CO_2 equivalent, the emitter must provide an attestation to that effect.”.

13. Section 6.8 is amended by striking out “or revised” in the part of the first paragraph preceding subparagraph 1.

14. Section 6.9 is amended

(1) by replacing paragraph 1 by the following:

“(1) the name of and contact information for the verification organization and its representative, as well as the name of and contact information for the chief verifier, the person assigned to the internal review of the verification process and the other members of the verification team designated by the organization to carry out the verification;”;

(2) by striking out paragraph 5;

(3) by replacing paragraph 7 by the following:

“(7) the total quantity of greenhouse gas emissions referred to in Schedule A.1, in metric tons, excluding greenhouse gas emissions that have been captured, stored, re-used, eliminated or transferred out of the establishment and emissions reported using protocols QC.17 and QC.30;”;

(4) by inserting the following after subparagraph 7.1:

“(7.2) the total quantity of CO_2 emissions attributable to the combustion of biomass and biomass fuels;”;

(5) by replacing subparagraph 8 by the following:

“(8) the conclusions of the verification and an attestation that the emissions report is exact and reliable;

(9) a conflict of interest declaration, including

(a) the name, contact information and sector and sub-sector of activity falling under the scope of the accreditation of the verification organization, as well as the name and contact information of the chief verifier, the person assigned to the internal review of the verification process and the other members of the verification team designated by the organization to carry out the verification;

(b) a copy of the organization chart for the verification organization, as well as the names of and contact information for any subcontractors who took part in the verification;

(c) an attestation signed by the representative of the verification organization that the requirements of section 6.10 have been met and that the risk of conflict of interest is acceptable.".

15. The following is inserted after section 6.9:

"**6.10.** In addition to the requirements of the standards ISO 14064-3 and ISO 14065 concerning conflicts of interest, the emitter must ensure that none of the following situations exists between the emitter, its officers, the verification organization and the members of the verification team:

(1) during the 3 years preceding the year of the declaration, one of the members of the verification team was employed by the emitter;

(2) a member of the verification team or a close relative of that member has personal ties with the emitter or one of its officers;

(3) during the 3 years preceding the year of the declaration, one of the members of the verification team or one of the subcontractors who took part in the verification provided the emitter with one of the following services:

(a) the design, development, commissioning or maintenance of a data inventory or data management system for greenhouse gas emissions from the establishment or facility of the emitter or, where applicable, for data on electricity or fuel transactions;

(b) the development of greenhouse gas emission factors or other data that were used for the quantification or the greenhouse gas emissions report and required under this Regulation;

(c) consultation concerning greenhouse gas emissions reductions, and in particular the design of an energy efficiency or renewable energy project and the assessment of assets relating to greenhouse gas sources;

(d) the preparation of manuals, guides or procedures connected with the emitter's greenhouse gas emissions reports;

(e) consultation in connection with a greenhouse gas emission allowances market, including

i. brokerage, with or without registration, while acting as a promoter or subscriber on behalf of the emitter;

ii. advice concerning the suitability of a greenhouse gas emissions transaction;

iii. the holding, purchase, sale, negotiation or withdrawal of emission allowances referred to in the second paragraph of section 46.6 of the Environment Quality Act (chapter Q-2);

(f) a consultation in the field of health and safety and environmental management, including the consultation leading to ISO 14001 certification;

(g) actuarial consulting, bookkeeping or other consulting services relating to accounting documents or financial statements;

(h) a service connected with the process data management systems covered by the greenhouse gas emissions verification process;

(i) an internal audit of greenhouse gas emissions;

(j) a service provided in connection with litigation or an inquiry into greenhouse gas emissions;

(k) a consultation for a greenhouse gas emissions reduction project or an offset credit project in accordance with the Regulation respecting a cap-and-trade system for greenhouse gas emission allowances (chapter Q-2, r. 46.1);

(4) the person at the verification organization responsible for carrying out an internal review of the verification process, in accordance with the standards ISO 14065 and ISO 14064-3, has previously provided a verification or other service referred to in subparagraph 3 to the emitter during the report year or the current year.

The existence of one of the situations described in the first paragraph is considered to be a conflict of interest that invalidates the verification report.

For the purposes of this section, a close relative of a member of the verification team is that person’s spouse, child, spouse’s child, mother or father, mother’s or father’s spouse, child’s spouse or spouse’s child’s spouse.”.

16. Section 7 is amended by adding “and submit them to the Minister on request” at the end of the first paragraph.

17. Division III is replaced by the following divisions:

“DIVISION III
MONETARY ADMINISTRATIVE PENALTIES

8. A monetary administrative penalty of $250 in the case of a natural person or $1,000 in all other cases may be imposed on any person who

(1) contravenes the third paragraph of section 6.2;

(2) fails to keep any information, calculation, assessment, measurement or data for the time prescribed in section 7;

(3) in contravention of this Regulation, refuses or neglects to provide any other notice or other information, any study, research or expert report, or any information, report, calculation, plan or other document, or fails to comply with the time limit for providing them, if no monetary administrative penalty is otherwise provided for.

9. A monetary administrative penalty of $350 in the case of a natural person or $1,500 in all other cases may be imposed on any person who fails to communicate, in the prescribed conditions, any information, notice, attestation or report, as prescribed in one of sections 4, 5, 5.1 or 5.2, the fourth paragraph of section 6, section 6.1, the first or second paragraph of section 6.2 or section 6.4 or 6.5.

9.1. A monetary administrative penalty of $500 in the case of a natural person or $2,500 in all other cases may be imposed on any person who fails

(1) to base any information communicated on the best data and best information, in accordance with the first or second paragraph of section 6;

(2) to calculate the quantities of greenhouse gas emissions reported using once of the methods in section 6.3;

(3) to carry out a verification referred to in section 6.8 in accordance with the standard prescribed by that section or to include in the verification report the information prescribed by section 6.9.

9.2. A monetary administrative penalty of $750 in the case of a natural person or $3,500 in all other cases may be imposed on any person who fails

(1) to send to the Minister, within the prescribed time, the verification report referred to in section 6.6 or 6.7, in accordance with those sections;

(2) to ensure that none of the situations described in section 6.10 exist, in accordance with that section;

(3) to maintain any device, system or equipment referred to in section 7.1 in good working order, or to ensure that it operates optimally during operating hours.

DIVISION III.1
PENAL PENALTIES

9.3. Any person who contravenes the third paragraph of section 6 or 6.2 or section 7 is guilty of an offence and liable to a fine of

(1) $1,000 to $100,000, in the case of a natural person;

(2) $3,000 to $600,000, in all other cases.

Any person who, in contravention of this Regulation, refuses or neglects to provide any other notice or other information, any study, research or expert report, or any information, report, calculation, plan or other document, or fails to comply with the time limit for providing them, is guilty of an offence and liable to the same fines, if no monetary administrative penalty is otherwise provided for.

9.4. Any person who contravenes section 4, 5, 5.1 or 5.2, the fourth paragraph of section 6, section 6.1, the first or second paragraph of section 6.2, or section 6.4 or 6.5 is guilty of an offence and liable to a fine of

(1) $2,000 to $100,000, in the case of a natural person;

(2) $5,000 to $600,000, in all other cases.

9.5. Any person who contravenes the first or second paragraph of section 6, or section 6.3, 6.8 or 6.9, is guilty of an offence and liable to a fine of

(1) $2,500 to $250,000, in the case of a natural person;

(2) $7,500 to $1,500,000, in all other cases.

9.6. Any person who contravenes section 6.6, 6.7, 6.10 or 7.1 is guilty of an offence and liable to a fine of

(1) $4,000 to $250,000, in the case of a natural person;

(2) $12,000 to $1,500,000, in all other cases.

9.7. Whoever communicates false or inaccurate information to the Minister for the purposes of this Regulation is guilty of an offence and liable to a fine of

(1) $5,000 to 500,000, in the case of a natural person or, notwithstanding section 231 of the Code of penal procedure (chapter C-25.1), a term of imprisonment not exceeding 18 months, or both;

(2) $15,000 to $3,000,000, in all other cases.”.

18. Schedule A is amended by replacing the last two lines of contaminants in Part I by the following:

“ – dimethyl sulphide ($(CH_3)_2)S$)	75-18-3
- dimethyl disulphide ($S_2(CH_3)_2$)	624-92-0”.

19. Schedule A.1 is amended by replacing “677-565” by “677-56-5” in line “· HFC-236cb ($C_3H_2F_6$)” of the CAS column.

20. Schedule A.2 is amended:

(1) in QC.1:

(a) by inserting “portable equipment,” after “equipment,” in the first paragraph of QC.1.1;

(b) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.1.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(c) by inserting the following after paragraph 1 of QC.1.2:

“(1.1) in the case of emitters referred to in section 6.6, for each benchmark unit, the annual greenhouse gas emissions attributable to each type of fuel, excluding CO_2 emissions attributable to the combustion of biomass, in metric tons CO_2 equivalent;”;

(d) by replacing subparagraphs *a* to *d* of paragraph 2 of QC.1.2 by the following:

“*(a)* in bone dry metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;

(d) in metric tons collected, in the case of municipal solid waste;”;

(e) by replacing paragraphs 3 and 4 of QC.1.2 by the following:

"(3) where carbon content is used to calculate CO_2 emissions, the average annual carbon content of each type of fuel;

(3.1) where the molecular weight is used to calculate CO_2 emissions, the annual average molecular weight of each type of fuel;

(4) where high heat value is used to calculate CO_2 emissions, the average annual high heat value of each type of fuel, expressed

(a) in gigajoules per bone dry metric ton, when the quantity is expressed as a mass;

(b) in gigajoules per thousand cubic metres, when the quantity is expressed as a volume of gas;

(c) in gigajoules per kilolitre, when the quantity is expressed as a volume of liquid;

(d) in gigajoules per metric ton collected, in the case of municipal solid waste;";

(f) by replacing "kilograms" in paragraph 5 of QC.1.2 by "metric tons";

(*g*) by inserting "for fluidized bed boilers" after "acid gas scrubbing equipment" in paragraph 6 of QC.1.2;

(*h*) by adding the following after paragraph 6 of QC.1.2:

"(7) the annual CO_2 emissions attributable to acid gas scrubbing equipment for fluidized bed boilers, in metric tons;

(8) the number of times that the methods for estimating missing data provided for in QC.1.6 were used.";

(i) by inserting "for fluidized bed boilers" after "equipment" in the first paragraph of QC.1.3;

(j) by replacing QC.1.3.1 and QC.1.3.2 by the following:

"QC.1.3.1. Calculation method using the fuel-specific default CO_2 emission factor, the default high heat value and the annual fuel consumption

The annual CO_2 emissions attributable to the combustion of fuels in stationary units may be calculated using equation 1-1 or 1-1.1

(1) in the case of an emitter not referred to in section 6.6 who uses any type of fuel for which an emission factor is specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6 in QC.1.7 and a high heat value is specified in Table 1-1 or 1-2;

(2) in the case of an emitter referred to in section 6.6 who uses

(a) natural gas with a high heat value that is equal to or greater than 36.3 GJ per thousand cubic metres but less than or equal to 40.98 GJ per thousand cubic metres, with the exception of an emitter using a stationary unit with a design rated heat input capacity that is greater than 264 GJ/h and that has operated for more than 1,000 hours during at least one of the 3 preceding years;

(b) a fuel in Table 1-2;

(c) municipal solid waste when no steam is generated;

(d) a biomass fuel specified in Table 1-3 except if it is targeted by another protocol specified in this Schedule.

However, this method cannot be used by an emitter who determines the high heat value of the fuels used using measurements carried out by the emitter in accordance with QC.1.5.4 or using data indicated by the fuel supplier, obtained at the frequency prescribed by QC.1.5.1.

Equation 1-1

$$CO_2 = Fuel \times HHV \times EF \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of each type of fuel, in metric tons;

Fuel = Mass or volume of the fuel combusted during the year, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

- in kilolitres, when the quantity is expressed as a volume of liquid;

- in metric tons collected, in the case of municipal solid waste;

HHV = High heat value of the fuel specified in Tables 1-1 and 1-2, expressed

- in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;

- in gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;

- in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

- in gigajoules per metric ton collected, in the case of municipal solid waste;

EF = CO_2 emission factor for the fuel specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6, in kilograms of CO_2 per gigajoule;

0.001 = Conversion factor, kilograms to metric tons;

Equation 1-1.1

$$CO_2 \times Fuel \times OEF$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of each type of fuel, in metric tons;

Fuel = Mass or volume of the fuel combusted during the year, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

- in kilolitres, when the quantity is expressed as a volume of liquid;

- in metric tons collected, in the case of municipal solid waste;

OEF = Overall CO_2 emission factor for the fuel, as specified in Table 1-3, 1-4 or 1-5, expressed

- in kilograms of CO_2 per bone dry kilogram, in the case of a fuel whose quantity is expressed as a mass;

- in kilograms of CO_2 per cubic metres at standard conditions, in the case of a fuel whose quantity is expressed as a volume of gas;

- in kilograms of CO_2 per litre, in the case of a fuel whose quantity is expressed as a volume of liquid;

- in kilograms of CO_2 per kilogram collected, in the case of municipal solid waste.

QC.1.3.2. Calculation method using the fuel-specific default CO_2 emission factor and the high heat value indicated by the fuel supplier or determined by the emitter

The annual CO_2 emissions attributable to the combustion of fuels in stationary units may be calculated

(1) in the case of an emitter not referred to in section 6.6 who uses

(a) any type of fuel other than municipal solid waste, for which an emission factor is specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6 in QC.1.7, using equation 1-2;

(b) municipal solid waste and any biomass solid fuel specified in Table 1-3 in QC.1.7, when the combustion of the fuel produces steam, using equation 1-3;

(2) in the case of an emitter referred to in section 6.6 who uses natural gas with a high heat value that is equal to or greater than 36.3 GJ per thousand cubic metres but less than or equal to 40.98 GJ per thousand cubic metres or who uses a fuel in Table 1-2 or a biomass fuel, using equation 1-2.

Equation 1-2

$$CO_2 = \sum_{i=1}^{n} Fuel_i \times HHV_i \times EF \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of each type of fuel, in metric tons;

n = Number of measurements of high heat value required annually, as specified in QC.1.5.1;

i = Measurement period;

$Fuel_i$ = Mass or volume of fuel combusted during measurement period *i*, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

- in kilolitres, when the quantity is expressed as a volume of liquid;

HHV_i = High heat value of the fuel for measurement period *i*, expressed

- in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;

- in gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;

- in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

EF = CO_2 emission factor for the fuel as specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6, in kilograms of CO_2 per gigajoule;

0.001 = Conversion factor, kilograms to metric tons;

Equation 1-3

$$CO_2 = Steam \times B \times EF \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of each type of biomass solid fuel or municipal solid waste, in metric tons;

Steam = Total quantity of steam produced during the year by the combustion of biomass solid fuel or municipal solid waste, in metric tons;

B = Ratio of the boiler's design rated heat input capacity to its design rated steam output capacity, in gigajoules per metric ton of steam;

EF = CO_2 emission factor for biomass solid fuel or municipal solid waste specified in Table 1-3 or 1-6, or an establishment-specific factor determined in accordance with QC.1.5.3, in kilograms of CO_2 per gigajoule;

0.001 = Conversion factor, kilograms to metric tons.”;

(k) by replacing the part of QC.1.3.3 preceding paragraph 1 by “The annual CO_2 emissions may be calculated using the following methods:”;

(l) by replacing “solid fuels” in the part of paragraph 1 of QC.1.3.3 preceding equation 1-4 by “fuels whose quantity is expressed as a mass”;

(m) by replacing “Mass” in the definition of the factor “$Fuel_i$” in equation 1-4 of QC.1.3.3 by “Bone dry mass”;

(n) in equation 1-4 of paragraph 1 of QC.1.3.3:

i. by replacing the definition of the “i” factor by the following:

“i = Measurement period;”;

ii. by replacing the definition of “CC_i” by the following:

“CC_i = Average carbon content of the fuel whose quantity is expressed as a mass, from the fuel analysis results for the measurement period i indicated by the fuel supplier or measured by the emitter in accordance with QC.1.5.5, in kilograms of carbon per kilogram of fuel;”;

(o) by replacing “liquid fuels” in the part of paragraph 3 of QC.1.3.3 preceding equation 1-6 by “fuels whose quantity is expressed as a volume of liquid”;

(p) in equation 1-6 of subparagraph 3 of QC.1.3.3:

i. by replacing “liquid fuel” by “fuel whose quantity is expressed as a volume of liquid”;

ii. by replacing the definition of the “i” factor by the following:

“i = Measurement period;”;

iii. by striking out “liquid” in the definition of the factor “$Fuel_i$”;

(q) by replacing paragraph 4 of QC.1.3.3 by the following:

“(4) for fuels whose quantity is expressed as a volume of gas, the emitter must use equation 1-7:

Equation 1-7

$$CO_2 = \sum_{i=1}^{n} Fuel_i \times CC_i \times \frac{MW}{MVC} \times 3.664 \times 1$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of each type of fuel whose quantity is expressed as a volume of gas, in metric tons;

n = Number of measurements of carbon content and molecular weight required annually, as specified in QC.1.5.1;

i = Measurement period;

$Fuel_i$ = Volume of gaseous fuel combusted during measurement period *i*, in thousands of cubic metres at standard conditions;

CC_i = Average carbon content of the gaseous fuel, from the fuel analysis results for the measurement period *i* indicated by the fuel supplier or measured by the emitter in accordance with QC.1.5.5, in kilograms of carbon per kilogram of fuel;

MW = Molecular weight of the gaseous fuel, established in accordance with QC.1.5.5 from the fuel analysis results, in kilograms per kilomole or, when a mass flowmeter is used to measure the flow in kilograms per unit of time, replace

$\frac{MW}{MVC}$ by 1;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres.”;

(r) by adding “, or, in the case of an emitter not referred to in section 6.6, in accordance with the manufacturer’s specifications” at the end of the first paragraph of QC.1.3.4;

(s) by adding the following after subparagraph 2 of the fourth paragraph of QC.1.3.4:

"(3) when the facility or establishment is equipped with a continuous CO_2 monitoring system and when the emitter must, in accordance with this Regulation, report emissions by type, namely combustion, fixed process or "other" category, the emitter must, for each type of emission,

(a) estimate the greenhouse gas emissions attributable to combustion and the "other" category emissions using the emission factors in tables 1-1 to 1-8 in QC.1.7. If no factor is indicated in the tables, the emitter may use a factor published by Environment Canada, the U.S. Environmental Protection Agency (USEPA), the Intergovernmental Panel on Climate Change (IPCC), the National Council for Air and Stream Improvement (NCASI) or the World Business Council for Sustainable Development (WBCSD);

(b) determine the annual greenhouse gas emissions attributable to the fixed process by subtracting from the data measured by the continuous CO_2 monitoring system the greenhouse gas emissions attributable to combustion and the "other" category emissions estimated in accordance with subparagraph *a*.";

(t) by replacing subparagraphs *b* and *c* of paragraph 2 of QC.1.3.5 by the following:

"*(b)* if the fuels contain over 5% of biomass by weight or if waste-derived fuels make up over 30% by weight of the fuels combusted during the year, calculate the emissions in accordance with the most recent version of ASTM D6866 "Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis", or using any other analysis method published by an organization listed in QC.1.5;

(c) conduct, at least every 3 months, an analysis on a representative fuel or exhaust gas sample in accordance with the most recent version of ASTM D6866 or using any other analysis method published by an organization listed in QC.1.5, the analysis being conducted on the exhaust gas stream when waste-derived fuels are combusted;

*(c.*1*)* when the exhaust gas stream is sampled, collect samples over a period of at least 24 consecutive hours in accordance with the most recent version of ASTM D7459 "Standard Practice for Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil-Derived Carbon Dioxide Emitted from Stationary Emissions Sources", or using any other analysis method published by an organization listed in QC.1.5;";

(u) by replacing subparagraph *e* of paragraph 2 of QC.1.3.5 by the following:

"*(e)* make the measurements in accordance with the most recent version of ASTM D6866 on the stationary combustion unit of the emitter's choice if there is a common fuel source for multiple units or using any other analysis method published by an organization listed in QC.1.5;";

(v) by adding "for fluidized bed boilers" at the end of the heading of QC.1.3.6;

(w) by inserting "for fluidized bed boilers" after "equipment" in the part of QC.1.3.6 preceding equation 1-9, and after "equipment" in the definition of the factor "CO_2" in that equation;

(*x*) by replacing the definition of "MM_s" in equation 1-9 of QC.1.3.6 by the following:

"MM_s = Molecular weight of sorbent, in kilograms per kilomole or, in the case of calcium carbonate, a value of 100;";

(y) by replacing "QC.1.4.4" in the first paragraph of QC.1.4 by "QC.1.4.5";

(z) by replacing QC.1.4.1 by the following:

"QC.1.4.1. Calculation method using a default CH_4 and N_2O emission factor and the default high heat value for the fuel

The annual CH_4 and N_2O emissions attributable to the combustion of a fuel whose high heat value is not determined by the measurements made by the emitter or the data provided by the fuel supplier for the purpose of calculating CO_2 emissions may be calculated using equation 1-10 or 1-10.1

(1) in the case of an emitter not referred to in section 6.6 who uses any type of fuel for which an emission factor is specified in Table 1-3, 1-6 or 1-7 in QC.1.7 and a high heat value is specified in Table 1-1 or 1-2;

(2) in the case of an emitter referred to in section 6.6 who uses either

(a) natural gas with a high heat value that is equal to or greater than 36.3 GJ per thousand cubic metres but less than or equal to 40.98 GJ per thousand cubic metres; or

(b) a fuel in Table 1-2 or a biomass fuel.

In the case of any emitter, the emissions attributable to the combustion of coal must be calculated using equation 1-11.

Equation 1-10

$$CH_4 \ or \ N_2O = Fuel \times HHV \times EF \times 0.000001$$

Where:

CH_4 or N_20 = Annual CH_4 or N_2O emissions attributable to the combustion of each type of fuel, in metric tons;

Fuel = Mass or volume of the fuel combusted during the year, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;
- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;
- in kilolitres, when the quantity is expressed as a volume of liquid;
- in metric tons collected, in the case of municipal solid waste;

HHV = High heat value of the fuel specified in Tables 1-1 and 1-2, expressed

- in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;
- in gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;
- in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;
- in gigajoules per metric ton collected, in the case of municipal solid waste;

EF = CH_4 or N_2O emission factor for the fuel established by the emitter in accordance with QC.1.5.3, emission factor for the fuel as specified in Table 1-3, 1-6 or 1-7, or emission factor from the document “AP-42, Compilation of Air Pollutant Emission Factors” published by the U.S. Environmental Protection Agency (USEPA), in grams of CH_4 or N_2O per gigajoule;

0.000001 = Conversion factor, grams to metric tons;

Equation 1-10.1

$$CH_4 \ or \ N_2O = Fuel \times OEF \times 0.001$$

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions attributable to the combustion of each type of fuel, in metric tons;

Fuel = Mass or volume of the fuel combusted during the year, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;
- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;
- in kilolitres, when the quantity is expressed as a volume of liquid;
- in metric tons collected, in the case of municipal solid waste;

OEF = Overall CH_4 or N_2O emission factor for the fuel, as specified in Table 1-3, 1-7 or 1-8, expressed

- in grams of CH_4 or N_2O per kilogram, in the case of a fuel whose quantity is expressed as a mass;
- in grams of CH_4 or N_2O per cubic metre at standard conditions, in the case of a fuel whose quantity is expressed as a volume of gas;
- in grams of CH_4 or N_2O per litre in the case of a fuel whose quantity is expressed as a volume of liquid;

0.001 = Conversion factor, kilograms to metric tons;

Equation 1-11

$$CH_4 \ or \ N_2O = Fuel \times EF_c \times 0.001$$

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions attributable to the combustion of coal, in metric tons;

Fuel = Mass of coal combusted during the year, in metric tons;

EF_c = CH_4 or N_2O emission factor for the coal established by the emitter in accordance with QC.1.5.3 or emission factor for the coal specified in Table 1-8, in grams of CH_4 or N_2O per kilogram of coal;

0.001 = Conversion factor, kilograms to metric tons.";

(aa) by replacing equations 1-12 and 1-13 of QC.1.4.2 by the following:

"**Equation 1-12**

$$CH_4 \ or \ N_2O = \sum_{i=1}^{n} Fuel_i \times HHV_i \times EF \times 0.000001$$

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions attributable to each type of fuel, in metric tons;

n = Number of measurements of high heat value required annually, as specified in QC.1.5.1;

i = Measurement period;

$Fuel_i$ = Mass or volume of fuel combusted during measurement period *i*, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

- in kilolitres, when the quantity is expressed as a volume of liquid;

- in metric tons collected, in the case of municipal solid waste;

HHV_i = High heat value determined from data provided by the fuel supplier or measurements made by the emitter for the measurement period *i* in accordance with QC.1.5.4, for each type of fuel, expressed

- in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;

- gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;

- in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

- in gigajoules per metric ton collected, in the case of municipal solid waste;

EF = CH_4 or N_2O emission factor for the fuel established by the emitter in accordance with QC.1.5.3, emission factor for the fuel as specified in Table 1-3 or 1-7 in QC.1.7, or emission factor from the document "AP-42, Compilation of Air Pollutant Emission Factors" published by the U.S. Environmental Protection Agency (USEPA), in grams of CH_4 or N_2O per gigajoule;

0.000001 = Conversion factor, grams to metric tons;

Equation 1-13

$$CH_4 \ or \ N_2O = \sum_{i=1}^{n} Fuel_i \times EF_c \times 0.001$$

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions attributable to the combustion of coal, in metric tons;

n = Number of measurements required annually, as specified in QC.1.5.1;

i = Measurement period;

$Fuel_i$ = Mass of coal combusted during measurement period *i*, in metric tons;

EF_c = CH_4 or N_2O emission factor for the coal indicated by the fuel supplier or established by the emitter in accordance with QC.1.5.3, in grams of CH_4 or N_2O per kilogram of coal;

0.001 = Conversion factor, kilograms to metric tons.";

(bb) by adding the following after QC.1.4.4:

"QC.1.4.5. Calculation method using data from a continuous emission monitoring and recording system

The annual CH_4 or N_2O emissions attributable to the combustion of any type of fuel used in stationary combustion units may be calculated using data from a continuous emission monitoring and recording system including a gas volumetric flow rate monitor and a CH_4 or N_2O concentration monitor, in accordance with the EPS 1/PG/7 protocol entitled “Protocols and performance specifications for continuous monitoring of gaseous emissions from thermal power generation” published in November 2005 by Environment Canada or, in the case of an emitter not referred to in section 6.6, in accordance with the manufacturer’s specifications.”;

(cc) by inserting the following after the heading of QC.1.5:

“In the cases provided for in this protocol, the emitter may use the analysis methods published by the following organizations:

(1) American Society for Testing and Materials (ASTM);

(2) Centre d'Expertise en Analyse Environnementale du Québec (CEAEQ);

(3) Environment Canada;

(4) U.S. Environmental Protection Agency (USEPA);

(5) International Organization for Standardization (ISO);

(6) Technical Association of the Pulp and Paper Industry: Industry Standards & Regulations (TAPPI);

(7) Canadian Standards Association;

(8) Measurement Canada;

(9) American Association of State Highway and Transportation Officials (AASHTO);

(10) Association française de normalisation (AFNOR);

(11) Association of Fertilizer and Phosphate Chemists (AFPC);

(12) American Petroleum Institute (API);

(13) ASM International (ASM);

(14) British Standard Institution (BS);

(15) Gas Processors Association (GPA).”;

(dd) by inserting “when no purchase took place during the year” after “fuel oil” in subparagraph *c* of subparagraph 1 of the first paragraph of QC.1.5.2;

(*ee*) by replacing the second paragraph of QC.1.5.2 by the following:

“Fuel flow meters that measure mass flow rates may be used for liquid fuels, provided that the fuel density is used to convert the readings to volumetric flow rates. The density must in such cases be measured at the same frequency as the carbon content using the most recent version of method ASTM D1298, “Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method”, or any other analysis method published by an organization listed in QC.1.5. An emitter using one of the methods specified in QC.1.3.1 or QC.1.3.2 may, however, use the mass flow specified in Table 1-10 in QC.1.7.”;

(ff) by replacing equation 1-16 in the first paragraph of QC.1.5.4 by the following:

“**Equation 1-16**

$$HHV_a = \frac{\sum_{i=1}^{n}\left[HHV_i \times Fuel_i\right]}{\sum_{i=1}^{n} Fuel_i}$$

Where:

HHV_a = Average annual high heat value, expressed

- in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;

- in gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;

- in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

- in gigajoules per metric ton collected, in the case of municipal solid waste;

n = Number of measurements of high heat value;

i = Measurement period;

HHV_i = High heat value for the measurement period *i*, expressed

- in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;

- in gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;

- in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

- in gigajoules per metric ton collected, in the case of municipal solid waste;

$Fuel_i$ = Mass or volume of fuel combusted during measurement period *i*, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

- in kilolitres, when the quantity is expressed as a volume of liquid;

- in metric tons collected, in the case of municipal solid waste.";

(gg) by replacing subparagraph *a* of subparagraph 1 of the second paragraph of QC.1.5.4 by the following:

"*(a)* in accordance with the most recent version of ASTM D1826 "Standard Test Method for Calorific (Heating) Value of Gases in Natural Gas Range by Continuous Recording Calorimeter", ASTM D3588 "Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels", and ASTM D4891 "Standard Test Method for Heating Value of Gases in Natural Gas Range by Stoichiometric Combustion", and GPA 2261 "Analysis for natural gas and similar gaseous mixtures by gas chromatography" published by the Gas Processors Association (GPA), or using any other analysis method published by an organization listed in QC.1.5.";

(hh) by replacing "megajoules per cubic metre" in the definitions of the factors "HHV" and "LHV" in equation 1-17 of subparagraph *c* of subparagraph 1 of the second paragraph of QC.1.5.4 by "gigajoules per thousand cubic metres";

(ii) by replacing subparagraphs 2 to 4 of the second paragraph of QC.1.5.4 by the following:

"(2) for middle distillates, fuel oil and liquid waste-derived fuels, in accordance with the most recent version of ASTM D240 "Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter", or ASTM D4809 "Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method)", or using any other analysis method published by an organization listed in QC.1.5;

(3) for biomass solid fuel, in accordance with the most recent version of ASTM D5865 "Standard Test Method for Gross Calorific Value of Coal and Coke", or using any other analysis method published by an organization listed in QC.1.5;

(4) for waste-derived fuels, in accordance with the most recent version of ASTM D5865 or ASTM D5468 "Standard Test Method for Gross Calorific and Ash Value of Waste Materials", or using any other analysis method published by an organization listed in QC.1.5 and, when the waste-derived fuels are not pure biomass fuels, by calculating the biomass fuel portion of CO_2 emissions in accordance with subparagraph 2 of the fifth paragraph of QC.1.3.4.";

(jj) by replacing QC.1.5.5 by the following:

"QC.1.5.5. Carbon content, molecular weight and molar fraction of fuel

The emitter must determine the average annual carbon content using equation 1-18:

Equation 1-18

$$CC_a = \frac{\sum_{i=1}^{n}\left[CC_i \times Fuel_i\right]}{\sum_{i=1}^{n} Fuel_i}$$

Where:

CC_a = Average annual carbon content, expressed

- in kilograms of carbon per bone dry kilogram, in the case of a fuel whose quantity is expressed as a mass;

- in kilograms of carbon per kilogram, in the case of a fuel whose quantity is expressed as a volume of gas;

- in kilograms of carbon par kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

n = Number of measurements of carbon content;

i = Measurement period;

CC_i = Carbon content of the fuel for the measurement period *i*, expressed

- in kilograms of carbon per bone dry kilogram, in the case of a fuel whose quantity is expressed as a mass;

- in kilograms of carbon per kilogram, in the case of a fuel whose quantity is expressed as a volume of gas;

- in kilograms of carbon par kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

$Fuel_i$ = Mass or volume of fuel combusted during measurement period *i*, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

- in kilolitres, when the quantity is expressed as a volume of liquid.

The carbon content and molecular weight or molar fraction must be determined using the sampling and analysis results indicated by the fuel supplier or the results of the sampling conducted by the emitter using one of the following methods:

(1) for solid fuels, namely coal, coke, biomass solid fuels and waste-derived fuels, in accordance with the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal", or using any other analysis method published by an organization listed in QC.1.5;

(2) for petroleum-based liquid fuels and liquid waste-derived fuels, using one of the following methods:

(a) in accordance with the most recent version of ASTM D5291 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants";

(b) by applying the elementary analysis method;

(c) in accordance with the most recent version of ASTM D3238 “Standard Test Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by n-d-M Method” and the most recent version of either ASTM D2502 “Standard Test Method for Estimation of Molecular Weight (Relative Molecular Mas(s) of Petroleum Oils From Viscosity Measurements” or ASTM D2503 “Standard Test Method for Relative Molecular Mass (Molecular Weight) of Hydrocarbons by Thermoelectric Measurements of Vapor Pressure”;

(d) using any other analysis method published by an organization listed in QC.1.5;

(3) for gaseous fuels, in accordance with the most recent version of ASTM D1945 “Standard Test Method for Analysis of Natural Gas by Gas Chromatography”, ASTM D1946 “Standard Practice for Analysis of Reformed Gas by Gas Chromatography”, or ASTM D2163 “Standard Test Method for Determination of Hydrocarbons in Liquefied Petroleum (L(P) Gases and Propane/Propene Mixtures by Gas Chromatography”, in accordance with any other analysis method published by an organization listed in QC.1.5, or by measuring the carbon content of the fuel to within ± 5% using data from a continuous emission monitoring and recording system, at the following frequency:

(a) weekly, for natural gas and biogas;

(b) daily, for all other types of gaseous fuel.”;

(*kk)* by replacing “and QC.1.4.4 must determine the replacement data for the CO_2 concentration” in the part of QC.1.6 preceding subparagraph *a* of paragraph 2, as amended by the Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere (M.O., 2012, G.O.2, 2759), by “, QC.1.4.4 and QC.1.4.5 must determine the replacement data for the CO_2, CH_4, and N_2O concentration”;

(ll) by replacing Table 1-1 in QC.1.7 by the following:

“**Table 1-1. High heat value by fuel type**

(QC.1.3.1, (1), QC.1.4.1, (1), QC.1.5.2, (2), QC.17.3.1, (2))

Liquid fuels	**High heat value (GJ/kl)**
Asphalt & Road Oil	44.46
Aviation Gasoline	33.52
Diesel	38.30
Aviation Turbo Fuel	37.40
Kerosene	37.68
Propane	25.31
Ethane	17.22

Butane	28.44
Lubricants	39.16
Motor Gasoline	34.87
Light Fuel Oil No.1	38.78
Light Fuel Oil No. 2	38.50
Residual Fuel Oil (#5 & 6)	42.50
Crude Oil	39.16
Naphtha	35.17
Petrochemical Feedstocks	35.17
Petroleum Coke - Refinery Use	46.35
Petroleum Coke - Upgrader Use	40.57
Ethanol (100%)	23.41
Biodiesel (100%)	35.67
Rendered animal fat	34.84
Vegetable oil	33.44
Solid fuels	**High heat value (GJ/t)**
Anthracite Coal	27.70
Bituminous Coal	26.33
Foreign Bituminous Coal	29.82
Sub-Bituminous Coal	19.15
Lignite	15.00
Coal coke	28.83
Wood Waste (dry basis)	19.2
Spent Puling Liquor (dry basis)	14.2
Municipal solid waste	11.57
Peat	9.30
Tires	31.18
Agricultural By-products[1]	9.59
Biomass By-products[2]	30.03
Gaseous fuels	**High heat value (GJ/10^3 m^3)**
Natural Gas	38.32
Coke Oven Gas	19.14
Still Gas – Refineries	36.08
Still Gas – Upgraders	43.24
Landfill Gas (methane portion)	39.82
Biogas (methane portion)	31.50

1. By-products not destined for consumption.

2. Animal and vegetable waste, excluding wood waste and spent pulping liquor.";

(mm) by replacing Table 1-3 in QC.1.7 by the following:

“Table 1-3. Emission factors by fuel type

(QC.1.3.1, (1), QC.1.3.2, QC.1.4.1, (1), QC.1.4.4, QC.17.3.1, (2))

Liquid fuels and biofuels	**CO_2 (kg/l)**	**CO_2 (kg/ GJ)**	**CH_4 (g/l)**	**CH_4 (g/GJ)**	**N_2O (g/l)**	**N_2O (g/GJ)**
Aviation Gasoline	2.342	69.87	2.200	65.630	0.230	6.862
Diesel	2.663	69.53	0.133	3.473	0.400	10.44
Aviation Turbo Fuel	2.534	67.75	0.080	2.139	0.230	6.150
Kerosene						
- Electric Utilities	2.534	67.25	0.006	0.159	0.031	0.823
- Industrial	2.534	67.25	0.006	0.159	0.031	0.823
- Producer Consumption	2.534	67.25	0.006	0.159	0.031	0.823
- Forestry, Construction, and Commercial/ - Institutional	2.534	67.25	0.026	0.690	0.031	0.823
Propane						
- Residential	1.510	59.66	0.027	1.067	0.108	4.267
- All other uses	1.510	59.66	0.024	0.948	0.108	4.267
Ethane	0.976	56.68	S. O.	S. O.	S. O.	S. O.
Butane	1.730	60.83	0.024	0.844	0.108	3.797
Lubricants	1.410	36.01	S. O.	S. O.	S. O.	S. O.
Motor Gasoline	2.289	65.40	2.700	77.140	0.050	1.429
Light Fuel Oil						
- Electric Utilities	2.725	70.23	0.180	4.639	0.031	0.799
- Industrial	2.725	70.23	0.006	0.155	0.031	0.799
- Producer Consumption	2.643	68.12	0.006	0.155	0.031	0.799
- Forestry, Construction, and Commercial/ - Institutional	2.725	70.23	0.026	0.670	0.031	0.799
Residual Fuel Oil (#5 & 6)						
- Electric Utilities	3.124	73.51	0.034	0.800	0.064	1.506
- Industrial	3.124	73.51	0.12	2.824	0.064	1.506
- Producer Consumption	3.158	74.31	0.12	2.824	0.064	1.506
- Forestry, Construction, and Commercial/ - Institutional	3.124	73.51	0.057	1.341	0.064	1.820
Naphtha	0.625	17.77	S. O.	S. O.	S. O.	S. O.
Petrochemical Feedstocks	0.556	14.22	S. O.	S. O.	S. O.	S. O.
Petroleum Coke -	3.826	82.55	0.12	2.589	0.0265	0.572

Refinery Use						
Petroleum Coke - Upgrader Use	3.494	86.12	0.12	2.958	0.0231	0.569
Ethanol (100%)	1.519	64.9	N/A	N/A	N/A	N/A
Biodiesel (100%)	2.497	70	N/A	N/A	N/A	N/A
Rendered Animal Fat	2.348	67.4	N/A	N/A	N/A	N/A
Vegetable Oil	2.585	77.3	N/A	N/A	N/A	N/A
Biomass and other solid fuels	**CO_2 (kg/kg)**	**CO_2 (kg/GJ)**	**CH_4 (g/kg)**	**CH_4 (g/GJ)**	**N_2O (g/kg)**	**N_2O (g/GJ)**
Wood Waste (dry basis)	1.799	93.7	0.576	30	0.077	4
Spent Puling Liquor (dry basis)	1.304	91.8	0.041	2.9	0.027	1.9
Agricultural By-products [1]	1.074	112	N/A	N/A	N/A	N/A
Biomass By-products[2]	3.000	100	N/A	N/A	N/A	N/A
Coal Coke	2.480	86.02	0.03	1.041	0.02	0.694
Tires	2.650	85.0	S. O.	S. O	S. O.	S. O.
Gaseous fuels and biofuels	**CO_2 (kg/m^3)**	**CO_2 (kg/GJ)**	**CH_4 (g/m^3)**	**CH_4 (g/GJ)**	**N_2O (g/m^3)**	**N_2O (g/GJ)**
Coke Oven Gas	0.879	45.92	0.037	1.933	0.0350	1.829
Still Gas – Refineries	1.75	48.50	S. O.	S. O.	0.0222	0.615
Still Gas – Upgraders	2.14	49.49	S. O.	S. O.	0.0222	0.513
Landfill Gas	2.175	54.63	0.040	1.0	0.004	0.1
Biogas (methane portion)	1.556	49.4	N/A	N/A	N/A	N/A

1. By-products not destined for consumption.
2. Animal and vegetable waste, excluding wood waste and spent pulping liquor.”;

(nn) by replacing the line beginning by “Peat” in Table 1-6 in QC.1.7 by the following line:

“

Peat	103.0	1.0	1.5

“;

(2) in QC.2:

(a) by replacing QC.2.1 by the following:

“QC.2.1. Covered sources

The covered sources are stationary combustion units that combust gaseous fuels such as refinery fuel gas, flexigas or associated gas.

Notwithstanding the first paragraph, emissions attributable to the combustion of gas fuels at a flare must be calculated in accordance with QC.9.3.5.”;

(b) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of the first paragraph of QC.2.2 preceding subparagraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(c) by inserting the following after subparagraph 1 of the first paragraph of QC.2.2:

“(1.1) the emissions attributable to the combustion of gas fuels at a flare, calculated in accordance with QC.9.3.5, in metric tons CO_2 equivalent;”;

(d) by replacing “millions” in subparagraph 2 of the first paragraph of QC.2.2 by “thousands”;

(e) by replacing “average carbon content” in subparagraph 3 of the first paragraph of QC.2.2 by “average annual carbon content”;

(f) by inserting “annual” after “average” in subparagraph 5 of the first paragraph of QC.2.2;

(g) by replacing “3 and 4” in the second paragraph of QC.2.2 by “3 and 5”;

(h) by replacing “stationary combustion units located at a petroleum refinery” in the first paragraph of QC.2.3 by “stationary units that combust gaseous fuels” and by replacing “stationary combustion units located at a petroleum refinery that uses refinery fuel gas, flexigas and associated gas” in the second paragraph of QC.2.3 by “stationary units that combust gaseous fuels”;

(i) by replacing equation 2-1 in QC.2.3.2 by the following:

“Equation 2-1

$$CO_2 = \sum_{i=1}^{n}\sum_{j=1}^{m}\left(RFG_{ij} \times CC_{ij} \times \frac{MW_{ij}}{MVC}\right) \times 3.664 \times 1$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of refinery gas or flexigas, in metric tons;

n = Number of days of operation in the year;

m = Number of supply systems;

i = Day;

j = Supply system;

RFG_{ij} = Consumption of refinery gas or flexigas in supply system *j* for day *i*, in thousands of cubic metres at standard conditions;

CC_{ij} = Carbon content of the sample of refinery gas or flexigas in supply system *j* for day *i*, measured in accordance with QC.2.4.2, in kilograms of carbon per kilogram of fuel;

MW_{ij} = Molecular weight of the sample of refinery gas or flexigas in supply system *j* for day *i*, in kilograms per kilomole;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres.”;

(j) by replacing “pourvoir” in the French text of subparagraph *b* of paragraph 3 of QC.2.3.4 by “pouvoir”;

(k) by replacing the part of QC.2.4.2 preceding paragraph 1 by the following:

“When the calculation method in QC.2.3.2 is used, the emitter must measure the carbon content and molecular weight of the gaseous fuels daily, using one of the following methods:”;

(3) in QC.3:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of the first paragraph of QC.3.2 preceding subparagraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by inserting “and reported” after “calculated’ in subparagraph 6 of the first paragraph of QC.3.2;

(c) by replacing “monthly and annual” in subparagraph 7 of the first paragraph of QC.3.2 by “annual”;

(d) by replacing subparagraphs 8 to 11 of the first paragraph of QC.3.2 by the following:

“(8) for the use of the prebaked anodes process, the annual net prebaked anode consumption for liquid aluminum production, in metric tons of anodes per metric ton of liquid aluminum;

(9) for the use of the Søderberg anodes process, the annual anode paste consumption, in metric tons of paste per metric ton of liquid aluminum;

(10) for the use of the baking process for prebaked anodes or cathodes, the annual quantity of baked anodes or cathodes removed from furnace, in metric tons;

(11) for the use of the coke calcination process:

(a) the annual consumption of green coke, in metric tons;

(b) the annual quantity of calcinated coke produced, in metric tons;

(c) the annual quantity of under-calcinated coke produced, in metric tons;”;

(e) by striking out subparagraphs *b*, *c*, *d*, *e*, *g* and *h* of subparagraph 12 of the first paragraph of QC.3.2;

(f) by striking out subparagraph 13 of the first paragraph of QC.3.2;

(g) by striking out subparagraph 15 of the first paragraph of QC.3.2;

(*h*) by replacing subparagraph 16 of the first paragraph of QC.3.2 by the following:

“(16) the annual quantity of aluminum hydrate produced, calculated at the precipitation stage, in metric tons of aluminum hydrate (Al_2O_3) equivalent.”;

(i) by inserting “*f* of subparagraph” after “Subparagraph” in the second paragraph of QC.3.2;

(*j*) by adding the following at the end of QC.3.2:

“For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 1, 2 and 4 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 6 of the first paragraph are emissions attributable to combustion;

(3) the emissions referred to in subparagraphs 3 and 5 of the first paragraph are other emissions.”;

(k) by replacing equation 3-1 in QC.3.3.1 by the following:

“**Equation 3-1**

$$CO_2 = \sum_{i=1}^{12} \left[NAC \times MP \times (1 - S_a - Ash_a) \times 3.664 \right]_i$$

Where:

CO_2 = Annual CO_2 emissions attributable to the consumption of prebaked anodes, in metric tons;

i = Month;

NAC = Net anode consumption for liquid aluminum production for month *i*, in metric tons of anodes per metric ton of liquid aluminum;

MP = Production of liquid aluminum for month *i*, in metric tons;

S_a = Sulphur content in the prebaked anodes for month *i*, in kilograms of sulphur per kilogram of prebaked anodes;

Ash_a = Ash content in the prebaked anodes for month *i*, in kilograms of ash per kilogram of prebaked anodes;

3.664 = Ratio of molecular weights, CO_2 to carbon.”;

(l) by replacing equation 3-2 in QC.3.3.2 by the following:

“**Equation 3-2**

$$CO_2 = \sum_{i=1}^{12} \left[\begin{array}{l} (PC \times MP) - \left(CSM \times \dfrac{MP}{1000} \right) - \left(BC \times PC \times MP \times (S_p + Ash_p + H_p) \right) \\ - \left((1 - BC) \times PC \times MP \times (S_c + Ash_c) \right) - (MP \times CP) \end{array} \right]_i \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to anode consumption from Søderberg electrolysis cells, in metric tons;

i = Month;

PC = Anode paste consumption for month *i*, in metric tons of paste per metric ton of liquid aluminum;

MP = Production of liquid aluminum for month *i*, in metric tons;

CSM = Emissions of cyclohexane-soluble matter (CSM) or the International Aluminium Institute factor used, in kilograms of CSM per metric ton of liquid aluminum;

BC = Average content of pitch or other binding agent in paste for month *i*, in kilograms of pitch or other binding agent per kilogram of paste;

S_p = Sulphur content in pitch or other binding agent for month *i*, in kilograms of sulphur per kilogram of pitch or other binding agent;

Ash_p = Ash content in pitch or other binding agent, in kilograms of ash per kilogram of pitch or other binding agent;

H_p = Hydrogen content in pitch or other binding agent, in kilograms of hydrogen per kilogram of pitch or other binding agent or the International Aluminium Institute factor used;

S_c = Sulphur content in calcinated coke, in kilograms of sulphur per kilogram of calcinated coke;

Ash_c = Ash content in calcinated coke, in kilograms of ash per kilogram of calcinated coke;

CP = Monthly reported carbon present in the dust from Søderberg electrolysis cells, in kilograms of carbon per kilogram of liquid aluminum produced, or a value of 0;

3.664 = Ratio of molecular weights, CO_2 to carbon.”;

(m) by replacing paragraphs 1 to 3 of QC.3.3.3 by the following:

“(1) for annual CO_2 emissions, using equation 3-3:

Equation 3-3

$$CO_2 = CO_{2\,PM} + CO_{2\,P}$$

Where:

CO_2 = Annual CO_2 emissions attributable to anode and cathode baking, in metric tons;

$CO_{2\,PM}$ = Annual CO_2 emissions attributable to packing material calculated in accordance with equation 3-4, in metric tons;

$CO_{2\,P}$ = Annual CO_2 emissions attributable to the coking of pitch or another binding agent, calculated in accordance with equation 3-5, in metric tons;

(2) for emissions of CO_2 attributable to packing material, using equation 3-4:

Equation 3-4

$$CO_{2\,PM} = \sum_{i=1}^{12} \left(CPM \times BAC \times \left(1 - Ash_{pm} - S_{pm} \right) \right)_i \times 3.664$$

Where:

$CO_{2\,PM}$ = Annual CO_2 emissions attributable to packing material, in metric tons;

i = Month;

CPM = Consumption of packing material for month *i*, in metric tons of packing material per metric ton of baked anodes or cathodes;

BAC = Quantity of baked anodes or cathodes removed from furnace for month *i*, in metric tons;

Ash_{pm} = Ash content of packing material for month *i*, in kilograms of ash per kilogram of packing material;

S_{pm} = Sulphur content of packing material for month *i*, in kilograms of sulphur per kilogram of packing material;

3.664 = Ratio of molecular weights, CO_2 to carbon;

(3) for emissions of CO_2 attributable to the coking of pitch or another binding agent, using equation 3-5:

Equation 3-5

$$CO_{2P} = \sum_{i=1}^{12} \left(GAC - BAC - \left(H_b \times PC \times GAC\right) - RT\right)_i \times 3.664$$

Where:

$CO_{2\,P}$ = Annual CO_2 emissions attributable to the coking of pitch or another binding agent, in metric tons;

i = Month;

GAC = Quantity of green anodes or cathodes put into furnace for month *i*, in metric tons;

BAC = Quantity of baked anodes or cathodes removed from furnace for month *i*, in metric tons;

H_b = Hydrogen content in pitch or other binding agent for month *i* or the International Aluminium Institute factor used, in kilograms of hydrogen per kilogram of pitch or other binding agent;

PC = Pitch or other binding agent content of green anodes or cathodes for month *i*, in kilograms of pitch or other binding agent per kilogram of green anodes or cathodes;

RT = Recovered tar for month *i*, in metric tons;

3.664 = Ratio of molecular weights, CO_2 to carbon.”;

(n) by replacing equation 3-6 of QC.3.3.4 by the following:

“**Equation 3-6**

$$CO_2 = \sum_{i=1}^{12} \left[\left(GC \times \left(1 - H_2O_{gc} - V_{gc} - S_{gc}\right) - \left(CC + UCC + ED\right) \times \left(1 - S_{cc}\right)\right) \times 3.664 + \left(GC \times 0.035 \times 2.75\right)\right]_i$$

Where:

CO_2 = Annual CO_2 emissions attributable to green coke calcination, in metric tons;

i = Month;

GC = Consumption of green coke for month *i*, in metric tons;

H_2O_{gc} = Humidity content of green coke for month *i*, in kilograms of water per kilogram of green coke;

V_{gc} = Volatiles content of green coke for month *i*, in kilograms of volatiles per kilogram of green coke;

S_{gc} = Sulphur content of green coke for month *i*, in kilograms of sulphur per kilogram of green coke;

CC = Calcinated coke produced for month *i*, in metric tons;

UCC = Under-calcinated coke produced for month *i*, in metric tons;

ED = Emissions of coke dust for month *i*, in metric tons;

S_{cc} = Sulphur in calcinated coke, in kilograms of sulphur per kilogram of calcinated coke;

3.664 = Ratio of molecular weights, CO_2 to carbon;

0.035 = CH_4 and tar content in coke volatiles contributing to CO_2 emissions;

2.75 = Conversion factor, CH_4 to CO_2.";

(o) by replacing equations 3-7 and 3-8 of subparagraph 1 of QC.3.4.2 by the following:

"**Equation 3-7**

$$CF_4 = \sum_{i=1}^{12} \left[slope_{CF4} \times AED \times MP \right]_i$$

Where:

CF_4 = Annual CF_4 emissions, in metric tons;

i = Month;

$slope_{CF4}$ = Slope for series of pots *j*, determined in accordance with the method in QC.3.6.1, in metric tons of CF_4 per metric ton of liquid aluminum, per anode effect minute, per pot-day, for month *i*;

AED = Anode effect duration, in anode effect minutes per pot-day, calculated for month *i* and obtained by multiplying the anode effects frequency, in number of anode effects per pot-day, by the average duration of anode effects, in minutes;

MP = Monthly production of liquid aluminum, in metric tons;

Equation 3-8

$$CF_4 = \sum_{j=1}^{m}\left[\sum_{i=1}^{12}\left[OVC_{CF4} \times \frac{AEO}{CE} \times MP\right]_i\right]_j$$

Where:

CF_4 = Annual CF_4 emissions attributable to anode effects, in metric tons;

m = Number of series of pots;

j = Series of pots;

i = Month;

OVC_{CF4} = Overvoltage coefficient determined in accordance with the method in QC.3.6.1, in metric tons of CF_4 per metric ton of liquid aluminum per millivolt;

AEO = Monthly anode effect overvoltages, in millivolts per pot;

CE = Current efficiency of the aluminum production process, expressed as a fraction;

MP = Monthly production of liquid aluminum, in metric tons;";

(p) by replacing the equation in paragraph 2 of QC.3.4.2 by the following:

Equation 3-8.1

$$C_2F_6 = \sum_{i=1}^{12}\left[CF_4 \times F\right]_i$$

Where:

C_2F_6 = Annual C_2F_6, emissions in metric tons;

i = Month;

CF_4 = CF_4 emissions for month *i*, in metric tons;

F = C_2F_6/CF_4 weight fraction, determined by the emitter or selected from Table 3-1 in QC.3.8, in kilograms of C_2F_6 per kilogram of CF_4.";

(q) in equation 3-10 of QC.3.5.2:

i. by adding "of SF_6 per metric ton of input gas" at the end of the definition of the "C_{input}" factor;

ii. by adding "of SF_6 per metric ton of gas collected and shipped out of the establishment" at the end of the definition of the "C_{output}" factor;

(r) by replacing "benzene" in subparagraph 1 of QC.3.6 by "cyclohexane";

(s) by inserting "technology used in a" after "each" in the part of the second paragraph of QC.3.6.1 that precedes subparagraph 1;

(*t*) by replacing "BSM" in subparagraph *a* of subparagraph 1 of QC.3.7, as modified by the *Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere* (A.M., 2012, G.O.2, 4450), by "CSM";

(4) in QC.4:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.4.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by striking out paragraph 1 of QC.4.2;

(c) by replacing "the monthly quantity" in subparagraph *b* of paragraph 3 of QC.4.2 by "the annual quantity";

(d) by striking out subparagraphs *c* to *g* of paragraph 3 of QC.4.2;

(e) by replacing "discarded" in subparagraph *h* of paragraph 3 of QC.4.2 by "collected";

(f) by striking out subparagraphs *h.1* and *h.2* of paragraph 3 of QC.4.2;

(g) by replacing "quarterly quantity of the dust discarded" in subparagraph *i* of paragraph 3 of QC.4.2 by "annual quantity of dust collected";

(h) by replacing "raw material" in paragraph 6 of QC.4.2 by "carbon-containing raw material that contributes 0.5% or more of the total carbon in the process";

(i) by replacing "matières premières utilisées" in the French text of subparagraph *a* of paragraph 6 of QC.4.2 by "matière première utilisée";

(j) by replacing subparagraph *b* of paragraph 6 of QC.4.2 by the following:

"*(b)* the total organic carbon content of the raw material, in metric tons of organic carbon per metric ton of raw material;";

(k) by replacing paragraph 7 of QC.4.2 by the following:

"(7) the annual CO_2, CH_4 and N_2O emissions attributable to fuel combustion in all cement kilns, in metric tons;";

(l) by replacing paragraph 8 of QC.4.2 by the following;

"(8) annual CO_2, CH_4 and N_2O emissions attributable to the use of all fixed combustion equipment, calculated and reported in accordance with QC.1 in metric tons;";

(m) by striking out paragraph 10 of QC.4.2;

(n) by adding the following paragraphs at the end of QC.4.2:

"Subparagraphs *a* and *h* of subparagraph 3 and subparagraph *b* of subparagraph 6 of the first paragraph do not apply to the emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 2 and 5 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 8 of the first paragraph are emissions attributable to combustion";

(o) by inserting "**, CH_4 and N_2O**" after "**CO_2**" in the heading of QC.4.3;

(p) by replacing the paragraph of QC.4.3 preceding QC.4.3.1 by the following paragraphs:

"The annual CO_2 emissions attributable to the use of cement kilns, other than combustion emissions, must be calculated in accordance with one of the 2 calculation methods in QC.4.3.1 and QC.4.3.2.

The annual CO_2, CH_4 and N_2O emissions attributable to the combustion of fuels in all cement kilns must be calculated in accordance with QC.4.3.3.";

(q) by replacing "in accordance with paragraph 2 of QC.4.3.2" in QC.4.3.1 by "in accordance with QC.4.3.3";

(r) by replacing the part of QC.4.3.2 preceding equation 4-1 by the following:

"The CO_2 emissions attributable to the use of each cement kiln must be calculated by adding together the CO_2 emissions attributable to calcination and the CO_2 emissions attributable to the oxidation of the organic carbon present in the raw materials, calculated in accordance with the following methods:

(1) the CO_2 emissions attributable to calcination must be calculated, for each cement kiln, using equations 4-1 to 4-3:";

(*s*) in equation 4-1 of QC.4.3.2:

i. by inserting "Monthly" before "production" in the definition of the "Cli" factor;

ii. by replacing "discarded" in the definitions of the factors "Q_{CKD}" and "EF_{CKD}" by "collected";

(t) by inserting ", determined in accordance with paragraph 1 of QC.4.4" after "in the clinker" in the definition of the factor "CaO_{Cli}" in equation 4-2 of QC.4.3.2;

(u) by replacing the second paragraph of the definition of the factor "CaO_{NCC}" in equation 4-2 of QC.4.3.2 by the following paragraph:

"The non-calcined calcium oxide content in the clinker is the sum of the CaO content present as a non-carbonate species in the raw materials entering the kiln and the non-transformed $CaCO_3$ content remaining in the clinker after oxidation, expressed as CaO; these values must be determined, respectively, in accordance with paragraphs 4 and 5 of QC.4.4, or a value of 0 must be used;";

(v) by inserting ", determined in accordance with paragraph 1 of QC.4.4" after "in the clinker" in the definition of the factor "MgO_{Cli}" in equation 4-2 of QC.4.3.2;

(w) by replacing the second paragraph of the definition of the factor "MgO_{NCC}" in equation 4-2 of QC.4.3.2 by the following paragraph:

"The non-calcined magnesium oxide content in the clinker is the sum of the MgO content present as a non-carbonate species in the raw materials entering the kiln and the non-transformed $MgCO_3$ content remaining in the clinker after oxidation, expressed as MgO; these values must be determined, respectively, in accordance with paragraphs 4 and 5 of QC.4.4, or a value of 0 must be used;";

(x) by replacing "discarded" in the definition of the factor "EF_{CKD}" in equation 4-3 of QC.4.3.2 by "collected";

(y) by replacing the definition of the factor "CaO_{CKD}" in equation 4-3 of QC.4.3.2 by the following definition:

"CaO_{CKD} = Quarterly content of calcium oxide in the dust collected that is not recycled to the cement kiln, determined in accordance with paragraph 6 of QC.4.4, in metric tons of calcium oxide per metric ton of dust;";

(z) by replacing "discarded" in the first paragraph of the definition of the factor "CaO_{NCD}" in equation 4-3 of QC.4.3.2 by "collected";

(aa) by replacing the second paragraph of the definition of the factor "CaO_{NCD}" in equation 4-3 of QC.4.3.2 by the following paragraph:

"The non-calcined calcium oxide content in the dust is the sum of the CaO content present as a non-carbonate species in the raw materials entering the kiln and the non-transformed $CaCO_3$ content remaining in the kiln dust collected that is not recycled after oxidation, expressed as CaO; these values must be determined, respectively, in accordance with paragraphs 7 and 8 of QC.4.4, or a value of 0 must be used;";

(bb) by replacing the definition of the factor "MgO_{CKD}" in equation 4-3 of QC.4.3.2 by the following:

"MgO_{CKD} = Quarterly content of magnesium oxide in the kiln dust collected that is not recycled in the cement kiln, determined in accordance with paragraph 6 of QC.4.4, in metric tons of magnesium oxide per metric ton of dust;";

(cc) by replacing "discarded" in the first paragraph of the definition of the factor "MgO_{NCD}" in equation 4-3 of QC.4.3.2 by "collected";

(dd) by replacing the second paragraph of the definition of the factor "MgO_{NCD}" in equation 4-3 of QC.4.3.2 by the following paragraph:

“The non-calcined magnesium oxide content in the dust is the sum of the magnesium oxide that enters the kiln as a non-carbonate species and the non-transformed $MgCO_3$ content remaining in the kiln dust collected that is not recycled after oxidation, expressed as MgO; these values must be determined, respectively, in accordance with paragraphs 7 and 8 of QC.4.4, or a value of 0 must be used;”;

(ee) by replacing subparagraph *b* of paragraph 1 and equation 4-4 in QC.4.3.2 by the following:

“(2) the CO_2 emissions attributable to the oxidation of the organic carbon present in the raw material must be calculated using equation 4-4:

Equation 4-4

$$CO_{2,RMm} = \sum_{m=1}^{n} TOC_{RMm} \times RM_m \times 3.664$$

Where:

$CO_{2,RMm}$ = CO_2 emissions resulting from the oxidation of the raw material, in metric tons;

n = Number of raw materials;

m = Raw material;

TOC_{RMm} = Total organic carbon content in raw material, determined in accordance with paragraph 10 of QC.4.4 or using a default value of 0.2% metric tons of total organic carbon content per metric ton of raw material;

RM_m = Quantity of raw material, in metric tons;

3.664 = Ratio of molecular weights, CO_2 to carbon.”;

(ff) by replacing paragraph 2 of QC.4.3.2 by the following:

“4.3.3. Calculation of the emissions attributable to the combustion of the fuels used in cement kilns

The CO_2, CH_4 and N_2O emissions attributable to fuel combustion in each cement kiln must be calculated and reported using the calculation methods in QC.1. When pure biomass fuels, in other words fuels constituted of the same substance for at least 97% of their total weight, are combusted only during start-up, shut-down, or malfunction operating periods for the apparatus or units, the emitter may calculate CO_2 emissions using the calculation method in QC.1.3.1.”;

(gg) by replacing “An emitter” in the part of QC.4.4 preceding paragraph 1 by “When using the calculation method in QC.4.3.2, an emitter”;

(hh) by replacing paragraph 1 of QC.4.4 by the following:

“(1) determine monthly the calcium oxide and magnesium oxide content of the clinker, in accordance with the most recent version of ASTM C114 “Standard Test Methods for Chemical Analysis of Hydraulic Cement”, or using any other analysis method published by an organization listed in QC.1.5; the measurements being made daily from clinker drawn from the clinker cooler or monthly from clinker drawn from bulk storage;”;

(ii) by adding “, or using a material balance” at the end of paragraph 3 of QC.4.4;

(jj) by replacing paragraphs 4 to 10 of QC.4.4 by the following:

“(4) determine monthly the calcium oxide and magnesium oxide content of the raw material entering the kiln as a non-carbonate species, in accordance with the most recent version of ASTM C114 or in accordance with any other analysis method published by an organization listed in QC.1.5, or use the value of 0;

(5) determine monthly the non-transformed $CaCO_3$ content and the non-transformed $MgCO_3$, expressed an MgO, remaining in the clinker after oxidation in accordance with the most recent version of ASTM C114, or in accordance with any other analysis method published by an organization listed in QC.1.5, or use the value of 0;

(6) determine quarterly the calcium oxide and magnesium oxide content in the kiln dust collected that is not recycled to the cement kiln in accordance with the most recent version of ASTM C114, or using any other analysis method published by an organization listed in QC.1.5; the measurements being made daily at the exit of the kiln or quarterly if the dust is in bulk storage;

(7) determine quarterly the calcium oxide and magnesium oxide content in the kiln dust collected that is not recycled that enters the kiln as a non-carbonate species in accordance with the most recent version of ASTM C114 or in accordance with any other analysis method published by an organization listed in QC.1.5, or use the value of 0;

(8) determine quarterly the calcium oxide and magnesium oxide content remaining in the kiln dust collected that is not recycled after oxidation in accordance with the most recent version of ASTM C114 or in accordance with any other analysis method published by an organization listed in QC.1.5, or use the value of 0;

(9) determine quarterly the quantity of kiln dust collected that is not recycled to the cement kiln by direct weight measurement using the same plant instruments used for inventory purposes, such as weigh hoppers or belt weigh feeders, or using a material balance;

(10) take samples annually of each category of raw materials in bulk storage and determine the total organic carbon content of the raw materials in accordance with the most recent version of ASTM C114 or in accordance with any other analysis method published by an organization listed in QC.1.5, or use the value of 0.2%.";

(5) in QC.5:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.5.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(*b*) by striking out subparagraph 5 of QC.5.2;

(6) in QC.6:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of the first paragraph of QC.6.2 preceding subparagraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by replacing subparagraphs *a* to *c* of subparagraph 2 of the first paragraph of QC.6.2 by the following:

"*(a)* in bone dry metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;";

(c) by replacing "millions" in subparagraph 3 of the first paragraph of QC.6.2 by "thousands";

(d) by inserting "annual" after "average" in subparagraph 4 of the first paragraph of QC.6.2;

(e) by inserting "and reported" after "calculated" in subparagraph 5 of the first paragraph of QC.6.2;

(*f*) by striking out subparagraph 7 of the first paragraph of QC.6.2;

(*g*) by adding the following at the end of QC.6.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 1 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 5 of the first paragraph are emissions attributable to combustion.";

(h) by replacing QC.6.3.2 by the following:

"QC.6.3.2. Calculation by feedstock material balance

The annual CO_2 emissions attributable to the production of hydrogen may be calculated by feedstock material balance using equations 6-1 to 6-3, depending on the type of feedstock:

(1) in the case of feedstocks for which the quantity is expressed as a volume of gas, the emitter must use equation 6-1:

Equation 6-1

$$CO_2 = \sum_{j=1}^{12} Q_j \times CC_j \times \frac{MW}{MVC} \times 3.664 \times 1$$

Where:

CO_2 = Annual CO_2 emissions attributable to the production of hydrogen, in metric tons;

j = Month;

Q_j = Quantity of gaseous feedstock consumed in month *j*, in thousands of cubic metres at standard conditions, or in metric tons when a mass flowmeter is used;

CC_j = Average carbon content of the feedstock based on the analysis results for month *j* and measured by an emitter in accordance with QC.6.4, in kilograms of carbon per kilogram of feedstock;

MW = Molecular weight of the feedstock, in kilograms per kilomole or, when a mass flowmeter is used to measure the flow, in metric tons per unit of time, replace

$\frac{MW}{MVC}$ by 1;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres;

(2) in the case of feedstocks for which the quantity is expressed as a volume of liquid, the emitter must use equation 6-2:

Equation 6-2

$$CO_2 = \sum_{j=1}^{12} Q_j \times CF_j \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the production of hydrogen, in metric tons;

j = Month;

Q_j = Quantity of raw material consumed in month *j*, in kilolitres;

CF_j = Average carbon content of feedstock based on the analysis results for month *j* and measured by an emitter in accordance with QC.6.4, in metric tons of carbon per kilolitre of feedstock;

3.664 = Ratio of molecular weights, CO_2 to carbon;

(3) in the case of feedstocks for which the quantity is expressed as a mass, the emitter must use equation 6-3:

Equation 6-3

$$CO_2 = \sum_{j=1}^{12} Q_j \times CC_j \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the production of hydrogen, in metric tons;

j = Month;

Q_j = Quantity of raw material consumed in month *j*, in metric tons;

CC_j = Average carbon content of the feedstock based on the analysis results for month *j* and measured by an emitter in accordance with QC.6.4, in kilograms of carbon per kilogram of feedstock;

3.664 = Ratio of molecular weights, CO_2 to carbon.”;

(i) by replacing paragraph 5 of QC.6.4 by the following:

“(5) to measure the average carbon content of each type of feedstock, use an analysis method published by an organization listed in QC.1.5 or one of the following analysis methods:

(a) for solid feedstocks, the most recent version of ASTM D2013/D2013M “Standard Practice for Preparing Coal Samples for Analysis”, ASTM D2234/D2234M “Standard Practice for Collection of a Gross Sample of Coal”, ASTM D3176 “Standard Practice for Ultimate Analysis of Coal and Coke”, ASTM D6609 “Standard Guide for Part-Stream Sampling of Coal”, ASTM D6883 “Standard Practice for Manual Sampling of Stationary Coal from Railroad Cars, Barges, Trucks, or Stockpiles” or ASTM D7430 “Standard Practice for Mechanical Sampling of Coal”;

(b) for liquid feedstocks, the most recent version of ASTM D2597 “Standard Test Method for Analysis of Demethanized Hydrocarbon Liquid Mixtures Containing Nitrogen and Carbon Dioxide by Gas Chromatography”, ASTM D4057 “Standard Practice for Manual Sampling of Petroleum and Petroleum Products”, ASTM D4177 “Standard Practice for Automatic Sampling of Petroleum and Petroleum Products”, ISO 3170 “Petroleum Liquids—Manual sampling” or ISO 3171 “Petroleum liquids—Automatic pipeline sampling”;

(c) for gaseous feedstocks, the most recent version of UOP539 “Refinery Gas Analysis by Gas Chromatography” or GPA 2261 “Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography.”;

(7) in QC.7:

(a) by inserting “de” after “production de fer, les procédés” in the French text of QC.7.1;

(*b*) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of the first paragraph of QC.7.2 preceding subparagraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(*c*) by replacing “facility” by “process” in the part of subparagraph 1 of the first paragraph of QC.7.2 that precedes subparagraph *a*;

(d) by striking out subparagraph *a* of subparagraph 1 of the first paragraph of QC.7.2;

(e) by inserting “and reported” after “calculated” in subparagraph *b* of subparagraph 1 of the first paragraph of QC.7.2;

(*f*) by replacing “de coke utilisé” by “à coke utilisé” in the French text of subparagraph *b* of subparagraph 2 of the first paragraph of QC.7.2;

(g) by replacing subparagraphs *h* and *h.1* of subparagraph 2 of the first paragraph of QC.7.2 by the following:

> “*(h)* the average annual carbon content of the materials input for the production of metallurgical coke and of derivatives of those materials referred to in subparagraphs *b* to *g.1*, in metric tons of carbon per metric ton of material;”;
>
> (*h.1*) the CH_4 emission factors, as the case may be:
>
> i. determined by the emitter, including the methods that were used for estimating those factors;
>
> ii. indicated in Tables 1-1 to 1-8 of QC.1.7. If no factor is indicated in those tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC);”;

(h) by replacing subparagraphs *h* and *i* of subparagraph 3 of the first paragraph of QC.7.2 by the following:

> “*(h)* the average annual carbon content of the materials and products referred to in subparagraphs *b* to *g* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material and products;
>
> (*i*) the CH_4 emission factors, as the case may be:
>
> i. determined by the emitter, including the methods that were used for estimating those factors;
>
> ii. indicated in Tables 1-1 to 1-8 of QC.1.7. If no factor is indicated in those tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC);”;

(*i*) by replacing subparagraph *b* of subparagraph 4 of the first paragraph of QC.7.2 by the following:

"(*b*) the annual quantity of each carbonaceous material used in sinter production, in metric tons;";

(*j*) by replacing "carbonaceous materials" in subparagraph *c* of subparagraph 4 of the first paragraph of QC.7.2 by "carbonaceous materials that contribute 0.5% or more of the total carbon introduced in the process";

(k) by replacing subparagraphs *f* and *g* of paragraph 4 of the first paragraph of QC.7.2 by the following:

"*(f)* the average annual carbon content of the materials and products referred to in subparagraphs *b* to *e* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material and products;

(*g*) the CH_4 emission factors, as the case may be:

i. determined by the emitter, including the methods that were used for estimating those factors;

ii. indicated in Tables 1-1 to 1-8 of QC.1.7. If no factor is indicated in those tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC);";

(l) by replacing subparagraphs *j* and *k* of paragraph 5 of the first paragraph of QC.7.2 by the following:

"*(j)* the average annual carbon content of the materials and products referred to in subparagraphs *b* to *j* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material or product;

(*k*) the CH_4 emission factors, as the case may be:

i. determined by the emitter, including the methods that were used for estimating those factors;

ii. indicated in Tables 1-1 to 1-8 of QC.1.7. If no factor is indicated in those tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC);";

(*m*) by inserting "or the vacuum degassing process using argon" after "argon-oxygen decarburization" in subparagraph *a* of subparagraph 6 of the first paragraph of QC.7.2;

(n) by replacing "carbon content" in subparagraphs *c*, *d* and *f* of subparagraph 6 of the first paragraph of QC.7.2 by "average annual carbon content";

(o) by replacing subparagraph *g* and *h* of subparagraph 7 of the first paragraph of QC.7.2 by the following:

"*(g)* the average annual carbon content of the materials and products referred to in subparagraphs *b* to *f* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material or product;

(*h*) the CH_4 emission factors, as the case may be:

i. determined by the emitter, including the methods that were used for estimating those factors;

ii. indicated in Tables 1-1 to 1-8 of QC.1.7. If no factor is indicated in those tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC);";

(p) by replacing subparagraphs *h* and *i* of subparagraph 8 of the first paragraph of QC.7.2 by the following:

"*(h)* the average annual carbon content of the materials and products referred to in subparagraphs *b* to *g* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material and product;

(*i*) the CH_4 emission factors, as the case may be:

i. determined by the emitter, including the methods that were used for estimating those factors;

ii. indicated in Tables 1-1 to 1-8 of QC.1.7. If no factor is indicated in those tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC);";

(q) by inserting ", for each type of pellets" after "pellets" in subparagraph *a* of subparagraph 9 of the first paragraph of QC.7.2;

(r) by replacing subparagraph *e* of subparagraph 9 of the first paragraph of QC.7.2 by the following:

"*(e)* the average annual carbon content of the materials and products referred to in subparagraphs *b* to *d* and *f* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material and product;";

(*s*) by striking out subparagraph *g* of subparagraph 9 of the first paragraph of QC.7.2;

(*t*) by inserting the following after subparagraph 9 of the first paragraph of QC.7.2:

"(9.1) in case a ladle furnace is used:

(*a*) the annual CO_2 emissions attributable to the use of the ladle furnace, in metric tons;

(*b*) the annual quantity of liquid steel fed into the ladle furnace, in metric tons;

(*c*) the annual consumption of each additive that contributes 0.5% or more of the total carbon in the process, in metric tons;

(d) the annual consumption of carbon electrodes, in metric tons;

(e) the annual production of steel, in metric tons;

(f) the quantity of slag produced, in metric tons;

(g) the annual quantity of air pollution control residue, in metric tons;

(h) the annual quantity of residue other than those referred to in subparagraph *g*, in metric tons;

(i) the annual average carbon content of materials and products referred to in subparagraphs *b* to *h* that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of materials or products;";

(*u*) by striking out subparagraph 11 of the first paragraph of QC.7.2;

(*v*) by adding the following after subparagraph 13 of the first paragraph of QC.7.2:

"(14) the annual quantity of steel slabs, billets or ingots produced at the steel mill, in metric tons;";

(w) by adding the following paragraphs at the end of QC.7.2:

"Subparagraph *h.1* of subparagraph 2, subparagraph *i* of subparagraph 3, subparagraph *g* of subparagraph 4, subparagraph *k* of subparagraph 5, subparagraph *g* of subparagraph 6, subparagraph *h* of subparagraph 7, subparagraph *i* of subparagraph 8, subparagraph *e* of subparagraph 9 and subparagraph *i* of subparagraph 9.1 of the first paragraph do not apply to the CH_4 emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs *a* of subparagraphs 2 to 9 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph *b* of subparagraph 1 of the first paragraph are emissions attributable to combustion;

(3) the emissions referred to in subparagraphs *a* of subparagraphs 2 to 9 of the first paragraph are other emissions.";

(x) by replacing equation 7-1 in paragraph 2 of QC.7.3.2, in by the following:

"**Equation 7-1**

$$CO_2 = CO_{2,COKE} + CO_{2,BOF} + CO_{2,SINTER} + CO_{2,EAF} + CO_{2,AOD} + CO_{2,DR} + CO_{2,BF} + CO_{2,IP} + CO_{2,LF}$$

Where:

CO_2 = Annual CO_2 emissions attributable to primary processes to produce both iron and steel, secondary steelmaking processes, iron production processes, metallurgical coke production processes and iron ore pellet firing processes, in metric tons;

$CO_{2,\ COKE}$ = Annual CO_2 emissions attributable to the production of metallurgical coke, calculated in accordance with equation 7-2, in metric tons;

$CO_{2,\ BOF}$ = Annual CO_2 emissions attributable to steel production using a basic oxygen furnace, calculated in accordance with equation 7-3, in metric tons;

$CO_{2,\ SINTER}$ = Annual CO_2 emissions attributable to sinter production, calculated in accordance with equation 7-4, in metric tons;

$CO_{2,\ EAF}$ = Annual CO_2 emissions attributable to steel production using an electric arc furnace, calculated in accordance with equation 7-5, in metric tons;

$CO_{2,\ AOD}$ = Annual CO_2 emissions attributable to argon-oxygen decarburization or the vacuum degassing using argon, calculated in accordance with equation 7-6, in metric tons;

$CO_{2,\ DR}$ = Annual CO_2 emissions attributable to iron production using the direct reduction process, calculated in accordance with equation 7-7, in metric tons;

$CO_{2,\ BF}$ = Annual CO_2 emissions attributable to iron production using a blast furnace, calculated in accordance with equation 7-8, in metric tons;

$CO_{2,\ IP}$ = Annual CO_2 emissions attributable to the indurating of iron ore pellets, calculated in accordance with equation 7-9, in metric tons;

$CO_{2,\ LF}$ = Annual CO_2 emissions attributable to using a ladle furnace, calculated in accordance with equation 7-9.1, in metric tons;”;

(y) by replacing equation 7-2 in subparagraph 2 of QC.7.3.2 by the following:

“**Equation 7-2**

$$CO_{2,COKE} = \left[(CC \times C_{CC}) - (GOC \times C_{GOC}) - (MC \times C_{MC}) - (R \times C_R) - \sum_{i=1}^{n} (COB_i \times C_{COB,i}) \right] \times 3.664$$

Where:

$CO_{2,\ COKE}$ = Annual CO_2 emissions attributable to the production of metallurgical coke, in metric tons;

CC = Annual consumption of coking coal, in metric tons;

C_{CC} = Average annual carbon content of coking coal, in metric tons of carbon per metric ton of coking coal;

GOC = Quantity of coke oven gas transferred offsite during the year, in metric tons;

C_{GOC} = Average annual carbon content of the coke oven gas transferred offsite during the year, in metric tons of carbon per metric ton of coke oven gas;

MC = Annual production of metallurgical coke, in metric tons;

C_{MC} = Average annual carbon content of the metallurgical coke produced, in metric tons of carbon per metric ton of metallurgical coke;

R = Annual quantity of air pollution control residue collected, in metric tons;

C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;

COB_i = Quantity of coke oven by-product *i* transferred offsite during the year, in metric tons;

$C_{COB,\ i}$ = Average annual carbon content of coke oven by-product *i* transferred offsite during the year, in metric tons of carbon per metric ton of by-product *i*;

n = Number of coke oven by-products transferred offsite during the year;

i = Type of by-product;

3.664 = Ratio of molecular weights, CO_2 to carbon;";

(z) by replacing equation 7-3 in subparagraph 3 of QC.7.3.2 by the following:

"**Equation 7-3**

$$CO_{2,BOF} = \begin{bmatrix} (MI \times C_{MI}) + (SC \times C_{SC}) + \sum_{i=1}^{n}(FL_i \times C_{FL,i}) + \sum_{j=1}^{m}(CAR_j \times C_{CAR,j}) \\ -(ST \times C_{ST}) - (SL \times C_{SL}) - (BOG \times C_{BOG}) - (R \times TC_R) \end{bmatrix} \times 3.664$$

Where:

$CO_{2,\ BOF}$ = Annual CO_2 emissions attributable to steel production using a basic oxygen furnace, in metric tons;

MI = Annual consumption of molten iron, in metric tons;

C_{MI} = Average annual carbon content of molten iron, in metric tons of carbon per metric ton of molten iron;

SC = Annual consumption of ferrous scrap, in metric tons;

C_{SC} = Average annual carbon content of ferrous scrap, in metric tons of carbon per metric ton of ferrous scrap;

n = Number of flux materials;

i = Type of flux material;

FL_i = Annual quantity of flux material *i* used, in metric tons;

$C_{FL,i}$ = Average annual carbon content of flux material *i*, in metric tons of carbon per metric ton of flux material;

m = Number of carbonaceous materials that contribute 0.5% or more of the total carbon in the process;

j = Type of carbonaceous material;

CAR_j = Annual consumption of carbonaceous material *j* that contributes 0.5% or more of the total carbon in the process, in metric tons;

$C_{CAR,j}$ = Average annual carbon content of carbonaceous material *j*, in metric tons of carbon per metric ton of carbonaceous material;

ST = Annual production of molten steel, in metric tons;

C_{ST} = Average annual carbon content of molten steel, in metric tons of carbon per metric ton of molten steel;

SL = Annual production of slag, in metric tons;

C_{SL} = Average annual carbon content of slag or a default value of 0, in metric tons of carbon per metric ton of slag;

BOG = Annual quantity of basic oxygen furnace gas transferred off-site during the year, in metric tons;

C_{BOG} = Average annual carbon content of basic oxygen furnace gas transferred off-site during the year, in metric tons of carbon per metric ton of basic oxygen furnace gas;

R = Annual quantity of air pollution control residue collected, in metric tons;

C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;

3.664 = Ratio of molecular weights, CO_2 to carbon;";

(aa) in equation 7-4 in subparagraph 4 of QC.7.3.2:

i. by replacing the definition of the factor “CAR_i” by the following:

“CAR_i = Annual consumption of raw carbonaceous material *j* that contributes 0.5% or more of the total carbon in the process, in metric tons;”;

ii. by replacing the definition of the factor “C_{CAR}” by the following:

“$C_{CAR,\,i}$ = Average annual carbon content of raw carbonaceous material *i*, in metric tons of carbon per metric ton of raw carbonaceous material;”;

iii. by inserting “and that contributes 0.5% or more of the total carbon in the process,” after “oil” in the definition of the factor “RM_j”;

iv. by replacing the definition of the factor “C_{RMj}” by the following:

“C_{RMj} = Average annual carbon content of raw material *j*, other than raw carbonaceous materials, required for sinter production, and that contributes 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of raw material *j*;”;

v. by inserting “Average annual” before “carbon content” in the definition of the factor “C_{SINTER}”;

vi. by replacing the definition of the factor “C_R” by the following:

“C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;”;

(*bb*) by replacing equation 7-5 in subparagraph 5 of QC.7.3.2 by the following:

“**Equation 7-5**

$$CO_{2,EAF} = \begin{bmatrix} (I \times C_I) + (SC \times C_{SC}) + \sum_{j=1}^{m} (FL_j \times C_{FL,j}) + (EL \times C_{EL}) \\ + \sum_{i=1}^{n} (CAR_i \times C_{CAR,i}) - (ST \times C_{ST}) - (SL - C_{SL}) - (R \times C_R) \end{bmatrix} \times 3.664$$

Where:

$CO_{2,\,EAF}$ = Annual CO_2 emissions attributable to steel production using an electric arc furnace, in metric tons;

I = Annual consumption of direct reduced iron ore pellets, in metric tons;

C_I = Average annual carbon content of direct reduced iron ore pellets, in metric tons of carbon per metric ton of direct reduced iron ore pellets;

SC = Annual consumption of ferrous scrap, in metric tons;

C_{SC} = Average annual carbon content of ferrous scrap, in metric tons of carbon per metric ton of ferrous scrap;

m = Number of flux materials;

j = Type of flux material;

FL_i = Annual quantity of flux material *i* used, in metric tons;

$C_{FL,j}$ = Average annual carbon content of flux material *j* used, in metric tons of carbon per metric ton of flux material;

EL = Annual consumption of carbon electrodes, in metric tons;

C_{EL} = Average annual carbon content of carbon electrodes, in metric tons of carbon per metric ton of carbon electrodes;

n = Total number of carbonaceous materials;

i = Carbonaceous material;

CAR_i = Annual consumption of carbonaceous material *i* that contributes 0.5% or more of the total carbon in the process, in metric tons;

$C_{CAR,i}$ = Average annual carbon content of carbonaceous material *i*, in metric tons of carbon per metric ton of carbonaceous material;

ST = Annual production of molten steel, in metric tons;

C_{ST} = Average annual carbon content of molten steel, in metric tons of carbon per metric ton of molten steel;

SL = Annual production of slag, in metric tons;

C_{SL} = Average annual carbon content of slag or a default value of 0, in metric tons of carbon per metric ton of slag;

R = Annual quantity of air pollution control residue collected, in metric tons;

C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;

3.664 = Ratio of molecular weights, CO_2 to carbon;";

(cc) by inserting "or the argon vacuum degassing process," after "argon-oxygen decarburization process" in the part of subparagraph 6 of QC.7.3.2 preceding equation 7-6;

(dd) in equation 7-6 of subparagraph 6 of QC.7.3.2:

i. by inserting "or the argon vacuum degassing process" after "argon–oxygen decarburization process" in the definition of the factor "$CO_{2,\ AOD}$";

ii. by inserting "or the argon vacuum degassing process" after "argon-oxygen decarburization process" in the definition of the factor "Steel";

iii. by replacing the definitions of the factors "$C_{Steel,in}$" and "$C_{Steel,out}$" by the following:

"$C_{Steel,in}$ = Average annual carbon content of molten steel before decarburization or degassing, in metric tons of carbon per metric ton of molten steel;

$C_{Steel,out}$ = Average annual carbon content of molten steel after decarburization or degassing, in metric tons of carbon per metric ton of molten steel;";

iv. by replacing the definition of the factor "C_R" by the following:

"C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;";

(ee) in equation 7-7 of subparagraph 7 of QC.7.3.2:

i. by inserting "Average annual" before "carbon content" in the definitions of the factors "C_{Ore}", "$C_{RM,i}$", "$C_{CAR,j}$", "C_I" and "C_{NM}";

ii. by inserting "and that contributes 0.5% or more of the total carbon in the process" after "fuel oil" in the definition of the factor "RM_j";

iii. by replacing the definition of the factor "C_R" by the following:

"C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;";

(ff) in equation 7-8 of subparagraph 8 of QC.7.3.2:

i. by inserting “and that contributes 0.5% or more of the total carbon in the process” after “ore” in the definition of the factor “RM_j”;

ii. by replacing the definition of the factor “C_{RMi}” by the following:

“C_{RMi} = Average annual carbon content of raw material *i*, other than carbonaceous materials or ore, that contributes 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of raw material *i*;”;

iii. by inserting “Average annual” before “carbon content” in the definitions of the factors “$C_{CAR,j}$”, “$C_{F,k}$”, “C_{Ore}”, “C_I” and “C_{NM}”;

iv. by replacing the definition of the factor “C_R” by the following:

“C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;”;

(gg) in equation 7-9 of subparagraph 9 of QC.7.3.2:

i. by inserting “Average annual” before “carbon content” in the definitions of the factors “C_{GBP}” and “C_{FP}”;

ii. by replacing the definition of the factor “C_R” by the following:

“C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;”;

(hh) by adding the following after subparagraph 9 of QC.7.3.2:

“(10) where using a ladle furnace, in accordance with equation 7-9.1:

Equation 7-9.1

$$CO_{2,LF} = \begin{bmatrix} \left(MS_{\text{sup}} \times C_{MS\,\text{sup}}\right) + \sum_{j=1}^{m}\left(AD_j \times C_{AD,j}\right) + \left(EL \times C_{EL}\right) \\ -\left(MS_{prod} \times C_{MSprod}\right) - \left(SL - C_{SL}\right) - \left(R \times TC_R\right) - \left(Rp \times C_{Rp}\right) \end{bmatrix} \times 3.664$$

Where:

$CO_{2,\,LF}$ = Annual CO_2 emissions attributable to using a ladle furnace, in metric tons;

MS_{sup} = Annual quantity of molten steel supplied to the ladle furnace, in metric tons;

C_{MSsup} = Average annual carbon content of molten steel supplied to the ladle furnace, in metric tons of carbon per metric ton of molten steel;

AD_j = Annual consumption of additive *j* that contributes 0.5% or more of the total carbon in the process, in metric tons;

$C_{AD,j}$ = Average annual carbon content of additive *j* that contributes 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of additive *j*;

EL = Annual consumption of carbon electrodes, in metric tons;

C_{EL} = Average annual carbon content of carbon electrodes, in metric tons of carbon per metric ton of carbon electrodes;

MS_{prod} = Annual production of molten steel produced in a ladle furnace, in metric tons;

C_{MSprod} = Average annual carbon content of molten steel, in metric tons of carbon per metric ton of molten steel;

SL = Annual production of slag, in metric tons;

C_{SL} = Average annual carbon content of slag or a default value of 0, in metric tons of carbon per metric ton of slag;

R = Annual quantity of air pollution control residue collected, in metric tons;

C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;

Rp = Annual quantity of other residue produced, in metric tons;

C_{Rp} = Average annual carbon content of other residue produced or a default value of 0, in metric tons of carbon per metric ton of residue;

3.664 = Ratio of molecular weights, CO_2 to carbon;

j = Additive;

m = Number of additives.”.

(ii) by replacing “in accordance with QC.1.3.4” in QC.7.4.1 by “in accordance by QC.1.4.5”;

(jj) by adding the following after QC.7.4.2:

"QC.7.4.3. Calculation using published emission factors

Annual CH_4 emissions attributable to the primary processes to produce iron and steel, secondary steelmaking processes, iron production processes, metallurgical coke production processes and iron ore pellet firing processes can be calculated using the emission factors in Tables 1-1 to 1-8 in Q.C.1.7. If no factor is indicated in the tables, the emitter may use a factor determined by Environment Canada, the U.S. Environmental Protection Agency (USEPA) or the Intergovernmental Panel on Climate Change (IPCC).

(kk) by adding "for materials other than ferrous scrap" at the end of the heading of QC.7.5.1;

(ll) by replacing the part of QC.7.5.1 that precedes subparagraph 1 by the following:

"When the calculation method in QC.7.3.2 is used, an emitter who operates a facility or establishment that produces iron or steel or who operates the indurating of iron ore pellets must, for materials that contribute 0.5% or more of the total carbon in the process, use the data provided by the supplier or determine the carbon content by analyzing a minimum of 3 representative samples per year, using an analysis method published by an organization listed in QC.1.5 or the following methods:";

(mm) by replacing paragraphs 3 to 7 of QC.7.5.1 by the following:

"(3) for flux materials such as limestone or dolomite, using the most recent version of ASTM C25 "Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime";

(4) for coal, coke and the carbon electrodes used in electric arc furnaces, using the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal" or, for fuels, raw materials or liquid products, the most recent version of ASTM D7582 "Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis";

(5) for iron and ferrous scrap, using the most recent version of ASTM E1019 "Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques";

(6) for the steel produced, using one of the following methods:

(a) the most recent version of ASM CS-104 UNS G10460 “Carbon Steel of Medium Carbon Content” published by ASM International;

(b) the most recent version of ISO/TR 15349-1 “Unalloyed steel – Determination of low carbon content, Part 1: Infrared absorption method after combustion in an electric resistance furnace (by peak separation)”;

(c) the most recent version of ISO/TR 15349-3 “Unalloyed steel – Determination of low carbon content, Part 3: Infrared absorption method after combustion in an electric resistance furnace (with preheating)”;

(d) the most recent version of ASTM E415 “Standard Test Method for Atomic Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel”;

(7) for baked or greenball iron ore pellets, using the most recent version of ASTM E1915 “Standard Test Methods for Analysis of Metal Bearing Ores and Related Materials for Carbon, Sulfur, and Acid-Base Characteristics”;

(8) for slag and air pollution control residue collected, in accordance with an analysis method published by an organization listed in QC.1.5 or using a default value of 0.”;

(nn) by replacing the heading of QC.7.5.2 by the following:

“QC.7.5.2. Carbon content of ferrous scrap

When the calculation method in QC.7.5.2 is used, an emitter who operates a facility or establishment that produces iron or steel must use the data provided by the supplier or determine the carbon content by using the following method:

(1) separate the ferrous scrap into various classes according to carbon content;

(2) for each of the classes, determine the carbon content by analyzing a minimum of 5 representative samples in accordance with the most recent version of ASTM E1019 “Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques,” ASTM E415 “Standard Test Method for Atomic Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel” or in accordance with an analysis method published by an organization listed in QC.1.5;

(3) calculate the characteristic carbon content for each class of ferrous scrap by taking the average of the measured content values, removing the highest and lowest value;

(4) calculate the average carbon content for ferrous scrap using equation 7-9.2:

Equation 7-9.2

$$C_{FS} = \frac{\sum_{i=1}^{n} C_{CFS,i} \times CFS_i}{\sum_{i-1}^{n} CFS_i}$$

Where:

C_{FS} = Average annual carbon content of ferrous scrap, in metric tons of carbon per metric ton of ferrous scrap;

n = Number of classes of ferrous scrap;

i = Class of ferrous scrap;

$C_{CFS,i}$ = Carbon content of class *i* ferrous scrap, in metric tons of carbon per metric ton of ferrous scrap;

CFS_i = Annual consumption of class *i* ferrous scrap, in metric tons.

QC.7.3.3. Consumption of process materials”;

(8) in QC.8:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.8.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by striking out paragraph 1 of QC.8.2;

(c) by replacing “lime production process” in paragraph 2 of QC.8.2 by “production process for each type of lime”;

(d) by replacing subparagraph *b* of paragraph 3 of QC.8.2 by the following:

“*(b)* the annual production of each type of lime, in metric tons;”;

(e) by striking out subparagraphs *c* and *d* of paragraph 3 of QC.8.2;

(f) by replacing "quarterly" in subparagraph *b* of paragraph 4 of QC.8.2 by "annual";

(g) by striking out subparagraphs *c* and *d* of paragraph 4 of QC.8.2;

(h) by striking out subparagraph 5 of QC.8.2;

(i) by replacing subparagraph 6 of QC.8.2 by the following:

"(6) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion units, calculated and reported in accordance with QC.1, in metric tons;";

(j) by striking out subparagraph 8 of QC.8.2;

(k) by adding the following paragraphs at the end of QC.8.2:

"Subparagraphs *a* of paragraphs 3 and 4 of the first paragraph do not apply to the emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 6 of the first paragraph are emissions attributable to combustion.";

(l) by replacing "**emissions from kilns**" in the heading of QC.8.3 by inserting "**, CH_4 and N_2O emissions**";

(m) by replacing the paragraph of QC.8.3 preceding QC.8.3.1 by the following paragraphs:

"The annual CO_2 emissions, other than combustion emissions, attributable to the use of kilns must be calculated in accordance with one of the 2 calculation methods in QC.8.3.1 and QC.8.3.2.

The annual CO_2, CH_4 and N_2O attributable to the combustion of fuels in kilns must be calculated in accordance with QC.8.3.3.";

(n) by replacing the part of QC.8.3.2 preceding paragraph 1, and paragraph 1 preceding equation 8-1, by the following:

"The annual CO_2 emissions attributable to the use of kilns must be calculated, for each type of lime, using equations 8-1 to 8-3:";

(o) by replacing equation 8-1 of subparagraph 1 of QC.8.3.2 by the following:

"**Equation 8-1**

$$CO_2 = \sum_{i=1}^{12} \left[L \times EF_L \right]_i + \sum_{x=1}^{4} \sum_{y=1}^{z} \left[CBF \times EF_{CBF} \right]_{xy}$$

Where:

CO_2 = CO_2 emissions from kilns, in metric tons;

i = Month;

L = Production of lime *j* for the month *i*, in metric tons;

EF_L = CO_2 emission factor of lime *j* for the month *i*, calculated in accordance with equation 8-2, in metric tons of CO_2 per metric ton of lime;

x = Quarter;

z = Total number of types of calcined by-products and wastes;

y = Type of calcined by-product and waste;

CBF = Production of calcined by-products and wastes *y* in quarter *x*, including lime kiln dust, scrubber sludge and other calcined wastes, in metric tons;

EF_{CBF} = CO_2 emission factor for calcined by-products and wastes *y* for quarter *x,* calculated in accordance with equation 8-3, in metric tons of CO_2 per metric ton of calcined by-products and wastes;";

(p) by striking out the part of subparagraph *a* preceding equation 8-2 of QC.8.3.2;

(q) by striking out the part of subparagraph *b* preceding equation 8-3 of QC.8.3.2;

(r) by replacing paragraph 2 of QC.8.3.2 by the following:

"QC.8.3.3. Calculation of the emissions attributable to the combustion of fuels in kilns

The CO_2, CH_4 and N_2O emissions attributable to the combustion of fuels in kilns must be calculated and reported in accordance with the calculation methods in QC.1. When pure biomass fuels, in other words fuels constituted of the same substance for at least 97% of their total weight, are consumed only during start-up, shut-down, or malfunction operating periods for the apparatus or units, the emitter may calculate CO_2 emissions using the calculation method in QC.1.3.1.";

(s) by inserting "and who uses the method in QC.8.3.2" after "lime" in the part of QC.8.4 preceding paragraph 1;

(t) by replacing paragraph 1 of QC.8.4 by the following:

"(1) collect at least one sample each month for each type of lime produced during the month and determine the monthly content of calcium oxide and of magnesium oxide in each type of lime using the most recent version of ASTM C25 "Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime" or the most recent revision of the National Lime Association's "CO_2 Emissions Calculation Protocol for the Lime Industry", or using any other analysis method published by an organization listed in QC.1.5;";

(u) by replacing paragraph 6 of QC.8.4 by the following:

"(6) follow the quality assurance/quality control procedures in the most recent revision of the National Lime Association's "CO_2 Emissions Calculation Protocol for the Lime Industry" published by la National Lime Association.";

(9) in QC.9:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.9.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by inserting "and reported" after "calculated" in paragraph 1 of QC.9.2;

(c) by striking out ", CH_4 and N_2O" in paragraph 2 of QC.9.2;

(d) by inserting the following after paragraph 2 of QC.9.2:

"(2.1) the annual CH_4 and N_2O emissions attributable to catalyst regeneration, calculated in accordance with QC.9.3.1, in metric tons;";

(e) by replacing paragraph 6 of QC.9.2 by the following:

"(6) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion units that are not referred to in paragraphs 1 and 7, calculated and reported in accordance with QC.1, in metric tons;";

(f) by inserting "and reported" after "calculated" in paragraph 6.1 of QC.9.2;

(g) by replacing subparagraphs *a* to *d* of paragraph 12 of QC.9.2 by the following:

"*(a)* in bone dry metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;";

(h) by replacing subparagraphs *a* to *d* of paragraph 13 of QC.9.2 by the following:

"*(a)* in bone dry metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;";

(i) by replacing paragraph 14 of QC.9.2 by the following:

"(14) the annual CO_2 emissions from coke calcining, calculated in accordance with QC.9.3.10, in metric tons;

(14.1) the annual CH_4 and N_2O emissions from coke calcining, calculated in accordance with QC.9.3.10, in metric tons;";

(j) by inserting "calculated in accordance with QC.9.3.11," after "systems," in paragraph 15 of QC.9.2;

(k) by inserting "calculated in accordance with QC.9.3.12," after "operations," in paragraph 16 of QC.9.2;

(l) by inserting "calculated in accordance with QC.9.3.13," after "coking," in paragraph 17 of QC.9.2;

(m) by striking out subparagraph 19 of QC.9.2;

(n) by replacing “the total” in paragraph 21 of QC.9.2 by “the annual total”;

(o) by adding the following paragraph at the end of QC.9.2:

“For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 2, 6.1 and 14 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraphs 1 and 6 of the first paragraph are emissions attributable to combustion;

(3) the emissions referred to in subparagraphs 2.1, 3 to 5, 7 to 11, 14.1 and 15 to 17 of the first paragraph are other emissions.”;

(p) by replacing “to QC.9.3.9” in QC.9.3 by “to QC.9.3.13”;

(q) by replacing equations 9-1 and 9-2 in subparagraph *a* of paragraph 1 of QC.9.3.1 by the following:

“**Equation 9-1**

$$CO_2 = \sum_{j=1}^{n} \left(CB_j\right)_n \times CC \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the continuous regeneration of catalyst material in fluid catalytic cracking units and fluid cokers, in metric tons;

n = Number of hours of operation during the year;

j = Hour;

CB_j = Hourly coke burn for hour *j*, calculated in accordance with equation 9-2 or determined by the emitter, in metric tons;

CC = Carbon content of coke burned, in kilograms of carbon per kilogram of coke burned;

3.664 = Ratio of molecular weights, CO_2 to carbon;

Equation 9-2

$$CB_j = \left(K_1 Q_r \times (\%CO_2 + \%CO) + K_2 Q_a - K_3 Q_r \times \left(\frac{\%CO}{2} + \%CO_2 + \%O_2 \right) + K_3 Q_{oxy} \times \%O_{2,oxy} \right) \times 0.001$$

Where:

CB_j = Hourly coke burn, in metric tons;

K_1, K_2, K_3 = Material balance and conversion factors (K_1, K_2 and K_3) from Table 9-1 in QC.9.6;

Q_r = Volumetric flow of regeneration gas before entering the antipollution system, calculated in accordance with equation 9-3 or measured continuously, in cubic metres per minute, at standard conditions and on a dry basis;

$\%CO_2$ = CO_2 concentration in regenerator exhaust, in cubic metres of CO_2 per cubic metre of regeneration gas on a dry basis, expressed as a percentage;

%CO = Concentration of carbon monoxide in regenerator exhaust, in cubic metres of carbon monoxide per cubic metre of regeneration gas on a dry basis, expressed as a percentage;

Q_a = Volumetric flow of air to regenerator, in cubic metres per minute, at standard conditions and on a dry basis;

$\%O_2$ = Concentration of oxygen in regenerator exhaust, in cubic metres of oxygen per cubic metre of regeneration gas on a dry basis, expressed as a percentage;

Q_{oxy} = Volumetric flow of oxygen to regenerator, in cubic metres per minute, at standard conditions and on a dry basis;

$\%O_{2,oxy}$ = Concentration of oxygen in enriched air stream inlet to regenerator, expressed as a percentage par volume on a dry basis;

0.001 = Conversion factor, kilograms to metric tons;”;

(r) by replacing equation 9-4 of paragraph 2 of QC.9.3.1 by the following:

"**Equation 9-3.1**

$$CO_2 = \sum_{j=1}^{n} \left[Q_r \times \left(\frac{\%CO_2 + \%CO}{100\%} \right) \times 60 \right]_j \times \frac{44}{CVM} \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to the continuous regeneration of catalyst material in fluid catalytic cracking units and fluid cokers, in metric tons;

n = Number of hours of operation during the year;

j = Hour;

Q_r = Volumetric flow of regeneration gas from regenerator before entering the antipollution system, in cubic metres per minute, at standard conditions and on a dry basis;

$\%CO_2$ = CO_2 concentration in regenerator exhaust, in cubic metres of CO_2 per cubic metre of regeneration gas on a dry basis, expressed as a percentage;

%CO = Concentration of carbon monoxide in regenerator exhaust, in cubic metres of carbon monoxide per cubic metre of regeneration gas on a dry basis, expressed as a percentage or, if there is no post-combustion device, a percentage of 0;

60 = Conversion factor, minutes to hours;

44 = Molecular weight of CO_2 in kilograms per kilomole;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

0.001 = Conversion factor, kilograms to metric tons;";

(s) by replacing equation 9-4 of paragraph 2 of QC.9.3.1 by the following:

"**Equation 9-4**

$$CO_2 = \sum_{i=1}^{n} \left(CB_i \right)_n \times CC \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to periodic catalyst regeneration processes, in metric tons;

n = Number of regeneration cycles during the year;

i = Regeneration cycle;

CB_i = Quantity of coke burned, in metric tons per regeneration cycle *i*;

C = Carbon content of coke burned, measured or estimated by the emitter, or using a default value of 0.94 kg of carbon per kilogram of coke burned;

3.664 = Ratio of molecular weights, CO_2 to carbon;";

(t) by replacing equation 9-5.1 in paragraph 4 of QC.9.3.1 by the following:

"**Equation 9-5.1**

$$CH_4 = CO_2 \times \frac{EF_{CH4}}{EF_{CO2}}$$

Where:

CH_4 = Annual CH_4 emissions from catalyst regeneration, in metric tons;

CO_2 = Annual CO_2 emissions from catalyst regeneration, calculated using equations 9-1, 9-3.1 or 9-4, in metric tons;

EF_{CH4} = CH_4 emission factor, 2.8×10^{-3} kg per gigajoule;

EF_{CO2} = CO_2 emission factor, namely 97 kg per gigajoule;";

(u) by replacing equation 9-6 of QC.9.3.2 by the following:

"**Equation 9-6**

$$E_x = \sum_{j=1}^{m}\sum_{i=1}^{n}\left[VR_i \times F_{x,i} \times \frac{MW_x}{MVC} \times VT_i \times 0.001\right]_j$$

Where:

E_x = Annual emissions of gas *x* from process vents, in metric tons;

x = CO_2, CH_4 or N_2O;

m = Total number of vents;

j = Vent;

n = Number of venting events during the year;

i = Venting event;

VR_i = Vent rate *j* for venting event *i*, in cubic metres per unit of time at standard conditions;

F_{xi} = Molar fraction of *x* in vent gas stream during venting event *i*, in kilomoles of *x* per kilomole of gas;

MW_{xi} = Molecular weight of *x* in kilograms per kilomole or, when a mass flowmeter is used to measure the flow in kilograms per unit of time, replace

$\frac{MW_x}{MVC}$ by 1;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

VT_i = Duration of venting event *i* of vent *j*, using the same units of time as for VR_i;

0.001 = Conversion factor, kilograms to metric tons.”;

(v) by striking out “au cours” in the French definition of the factor “Q_{PB}” of equation 9-7 of subparagraph 1 of QC.9.3.3;

(w) by inserting “emitted” after “gas” in the definition of the factor “FR” of equation 9-9 of QC.9.3.4;

(x) by replacing equation 9-10 in subparagraph 1 of QC.9.3.5 by the following:

“**Equation 9-10**

$$CO_2 = \left[\sum_{p=1}^{n}\left(Flare_p \times \frac{MW_p}{MVC} \times CC_p \times 3.664\right)\right] \times 0.98 \times 1$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of hydrocarbons in flares, in metric tons;

n = Number of measurement periods; minimum of 52 for weekly measurements and maximum of 366 for daily measurements;

p = Measurement period;

$Flare_p$ = Volume of gas directed to flares during measurement period *p*, in thousands of cubic metres at standard conditions;

MW_p = Average molecular weight of flare gas combusted during measurement period *p*, in kilograms per kilomole or, when a mass flowmeter is used to measure flare gas flow in kilograms per measurement period, replace

$$\frac{MW_p}{MVC} \text{ by } 1.$$

If measurements are taken more frequently than daily, the arithmetic average of measurement values must be used;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

CC_p = Average carbon content of flare gas combusted during measurement period *p*, in kilograms of carbon per kilogram of flare gas.

If measurements are taken more frequently than daily, the arithmetic average of measurement values must be used;

3.664 = Ratio of molecular weights, CO_2 to carbon;

0.98 = Flare combustion efficiency;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres;”;

(y) by replacing the definition of the factor “$Flare_p$” in equation 9-11 of paragraph 2 of QC.9.3.5 by the following:

“$Flare_p$ = Volume of gas directed to flares during measurement period *p*, in thousands of cubic metres at standard conditions;”;

(z) by replacing “cubic metres” in the definition of the factor “HHV_p” in equation 9-11 of paragraph 2 of QC.9.3.5 by “thousand cubic metres”;

(aa) by replacing equation 9-12 of paragraph 2 of QC.9.3.5 by the following:

“**Equation 9-12**

$$Flare_p = Flare_p\left(kg\right) \times \frac{MVC}{MW_p} \times 0.001$$

Where:

Flare$_p$ = Volume of gas directed to flares during measurement period *p*, in thousands of cubic metres;

Flare$_p$ (kg) = Masse of flare gas combusted during measurement period *p*, in kilograms;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

MW$_p$ = Average molecular weight of flare gas combusted during measurement period *p*, in kilograms per kilomole;

0.001 = Conversion factor, cubic metres to thousands of cubic metres;”;

(bb) by replacing equation 9-13 in paragraph 3 of QC.9.3.5 by the following:

“**Equation 9-13**

$$CO_2 = \left[\sum_{p=1}^{n}\left(Flare_{SSM}\right)_p \times \frac{MW_p}{MVC} \times CC_p \times 3.664\right] \times 0.98 \times 1$$

Where:

CO$_2$ = Annual CO$_2$ emissions attributable to the combustion of hydrocarbons in flare during startup, shutdown or malfunctions, in metric tons;

n = Annual number of startups, shutdowns or malfunctions;

p = Startup, shutdown or malfunction period;

(Flare$_{SSM}$)$_p$ = Volume of gas directed to flare during startup, shutdown or malfunction period *p*, in thousands of cubic metres at standard conditions;

MW$_p$ = Average molecular weight of flare gas combusted during measurement period *p*, in kilograms per kilomole;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

CC_p = Average carbon content of flare gas combusted during measurement period *p*, in kilograms of carbon per kilogram of flare gas;

3.664 = Ratio of molecular weights, CO_2 to carbon;

0.98 = Flare combustion efficiency;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres;”;

(cc) by replacing equation 9-16 in paragraph 6 of QC.9.3.5 by the following:

“**Equation 9-16**

$$CO_2 = \sum_{p=1}^{n} \left(GV_p \times CC_p \times \frac{MW_p}{MVC} \right) \times 3.664 \times 1$$

Where:

CO_2 = Annual CO_2 emissions attributable to the combustion of low Btu gases, in metric tons;

n = Total number of low Btu gases;

p = Low Btu gas;

GV_p = Annual volume of gas *p*, in thousands of cubic metres at standard conditions or in kilograms for a mass balance;

CC_p = Carbon content of gas *p*, in kilograms of carbon per kilogram of gas;

MW_p = Molecular weight of gas *p* in kilograms per kilomole or, when a mass flowmeter is used to measure the flow of gas *p* in kilograms, replace

$\frac{MW_p}{MVC}$ *by 1;*

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres.";

(dd) by replacing equation 9-17 in subparagraph *b* of paragraph 1 of QC.9.3.6 by the following:

"**Equation 9-17**

$$CH_4 = Q_{pb} \times 6.29 \times 10^{-7}$$

Where:

CH_4 = Annual CH_4 emissions from storage tanks, in metric tons;

Q_{pb} = Annual quantity of crude oil and intermediate products received from off-site that are processed at the establishment, in kilolitres;

6.29×10^{-7} = Default emission factor for storage tanks, in metric tons of CH_4 per kilolitre;";

(ee) by replacing equation 9-18 in subparagraph *b* of paragraph 2 of QC.9.3.6 by the following:

"**Equation 9-18**

$$CH_4 = \left(2.57\, x 10^{-5}\right) \times Q_{un} \times \Delta P \times MF_{CH4} \times \frac{16}{MVC} \times 1$$

Where:

CH_4 = Annual CH_4 emissions from storage tanks, in metric tons;

2.57×10^{-5} = Equation correlation factor, in thousands of cubic metres at standard conditions, per kilolitre per kilopascal;

Q_{un} = Annual quantity of unstabilized crude oil, in kilolitres;

ΔP = Pressure differential from storage pressure to atmospheric pressure, in kilopascals;

MF_{CH4} = Mole fraction of CH_4 in vent gas from the unstabilized crude oil storage tank, measured by the emitter, in kilomoles of CH_4 per kilomole of gas, or a value of 0.27;

16 = Molecular weight of CH_4, in kilograms per kilomole;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres.";

(ff) by inserting the following heading in the French text before the heading of QC.9.4.1:

"**QC.9.4. Exigences d'échantillonnage, d'analyse et de mesure**";

(gg) by replacing "utilisée" in the French text of the part of paragraph 3 of QC.9.4.1 preceding subparagraph *a* by "utilisés";

(hh) by replacing subparagraphs 2 and 3 of the first paragraph of QC.9.4.5 by the following:

"(2) if using equation 9-10 or 9-13, measure the parameters used to determine the carbon content of the flare gas daily;

(3) if using equation 9-11, measure the parameters used to determine the high heat value of the flare gas daily.";

(ii) by replacing paragraphs 1 to 3 of QC.9.4.9 by the following:

"(1) the most recent version of ASTM D3176 "Standard Practice for Ultimate Analysis of Coal and Coke";

(2) the most recent version of ASTM D5291 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants";

(3) the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal";

(4) any other analysis method published by an organization listed in QC.1.5.";

(10) in QC.10:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.10.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by inserting "and reported" after "calculated" in paragraphs 1, 2, 3, 3.1, 4 and 7 of QC.10.2;

(c) by striking out paragraph 9 of QC.10.2;

(d) by adding the following paragraph at the end of QC.10.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 1 and 3 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraphs 3.1 and 4 of the first paragraph are emissions attributable to combustion;
(3) the emissions referred to in subparagraphs 2 and 7 of the first paragraph are other emissions.";

(e) by replacing QC.10.3 by the following:

"**QC.10.3. Calculation methods for CO_2, CH_4 and N_2O emissions**

To calculate the CO_2, CH_4 and N_2O emissions from biomass, the high heat value or carbon content of the biomass must be determined by the emitter in accordance with QC.10.4.";

(f) by striking out the second paragraph of QC.10.3.1;

(g) by inserting "the most recent version of" after "with" in subparagraph *a* of paragraph 1 of QC.10.4;

(h) by replacing subparagraph *b* of paragraph 1 of QC.10.4 by the following:

"(*b*) by measuring it using monthly data from a monitoring device installed on the process line;

(c) by determining it using equation 1-8;

(d) by using any other analysis method published by an organization listed in QC.1.5;";

(i) by replacing paragraphs 1.1 and 2 of QC.10.4 by the following:

"(1.1) determine the high heat value of the black liquor using the most recent version of TAPPI T 684 om-11 "Gross heating value of black liquor", or using any other analysis method published by an organization listed in QC.1.5;

(2) measure the monthly carbon content of the black liquor using the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal" or ASTM 5291 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricant", or using any other analysis method published by an organization listed in QC.1.5;";

(j) by striking out paragraphs 3 and 4 of QC.10.4;

(11) in QC.11:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.11.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by inserting "and reported" after "calculated" in paragraph 2 of QC.11.2;

(c) by replacing "monthly" in paragraph 3 of QC.11.2 by "annual";

(d) by striking out subparagraph 4.2 of QC.11.2;

(e) by adding the following paragraph at the end of QC.11.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 1 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion.";

(f) by replacing paragraph 1 of QC.11.4 by the following:

"(1) determine the monthly inorganic carbon content of the trona or sodium carbonate from a weekly composite sample for each production unit using the most recent version of ASTM E359 e1 "Standard Test Methods for Analysis of Soda Ash (Sodium Carbonate(e)", or using any other analysis method published by an organization listed in QC.1.5;";

(12) in QC.12:

(a) by inserting "and reported" after "calculated" wherever it occurs in the second paragraph of QC.12.1;

(b) by replacing “chloruration” in the French text of the third paragraph of QC.12.1 by “chloration”;

(c) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.12.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(d) by inserting “and reported” after “calculated” in paragraphs 1, 2 and 2.1 of QC.12.2;

(*e)* by replacing paragraph 3 of QC.12.2 by the following:

“(3) the annual CO_2 emissions attributable to each petrochemical process, in metric tons;”;

(f) by striking out “, calculated in accordance with QC.12.3.2” in paragraph 4 of QC.12.2;

(*g)* by inserting the following after paragraph 4 of QC.12.2:

“(4.1) the annual CH_4 and N_2O emissions attributable to catalyst regeneration, in metric tons;”;

(h) by striking out “, calculated in accordance with QC.12.3.3” in paragraph 5 of QC.12.2;

(i) by striking out “, calculated in accordance with QC.12.3.4” in paragraph 6 of QC.12.2;

(j) by striking out “, calculated in accordance with QC.12.3.5” in paragraph 7 of QC.12.2;

(k) by striking out “calculated in accordance with QC.12.3.6” in paragraph 8 of QC.12.2;

(l) by replacing paragraphs 9 to 11 of QC.12.2 by the following:

“(9) the annual CH_4 and N_2O emissions attributable to wastewater treatment, calculated and reported in accordance with QC.9.3.7, in metric tons;

(10) the annual CH_4 emissions attributable to oil-water separators, calculated and reported in accordance with QC.9.3.8, in metric tons;

(11) the annual consumption of each type of raw material that emits CO_2, CH_4 or N_2O, expressed

(a) in metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;

(d) in bone dry metric tons, for biomass-derived solid fuels, when the quantity is expressed as a mass;";

(*m)* by replacing "monthly" in paragraphs 12 and 13 of QC.12.2 by "annual";

(n) by striking out subparagraph 15 on QC.12.2;

(o) by adding the following paragraph at the end of QC.12.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 2.1, 3 and 4 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraphs 1 and 2 of the first paragraph are emissions attributable to combustion;

(3) the emissions referred to in subparagraphs 4.1 and 5 to 10 of the first paragraph are other emissions.";

(*p)* by inserting "4.1 and" after "paragraphs" in subparagraph *c* of paragraph 15 of QC.12.2;

(q) by replacing "QC.12.3.8" in QC.12.3 by "QC.12.3.6";

(r) by replacing QC.12.3.1 by the following:

"QC.12.3.1. Calculation of CO_2 emissions attributable to each petrochemical process

The annual CO_2 emissions attributable to each petrochemical process must be calculated in accordance with the following methods:

(1) where the quantity of feedstock and the quantity of product are expressed as volumes of gas, using equation 12-1:

Equation 12-1

$$CO_2 = \sum_{n=1}^{12}\left[\sum_{i=1}^{k}\left[(V_{GI})_{i,k} \times (C_{GI})_{i,k} \times \frac{(MM_{GI})_i}{MVC}\right] - \sum_{j=1}^{m}\left[(V_{GP})_{j,k} \times (C_{GP})_{j,k} \times \frac{(MM_{GP})_j}{MVC}\right]\right] \times 3.664 \times 1$$

Where:

CO_2 = Annual CO_2 emissions attributable to each petrochemical process, in metric tons;

k = Month;

n = Number of feedstock materials;

m = Number of products;

i = Type of feedstock the quantity of which is expressed as a volume of gas;

j = Type of product the quantity of which is expressed as a volume of gas;

$(V_{GI})_{i,k}$ = Quantity of feedstock *i* consumed in month *k*, in thousands of cubic metres at standard conditions;

$(C_{GI})_{i,k}$ = Average carbon content of feedstock *i* in for month *k*, in kilograms of carbon per kilogram of feedstock;

$(MM_{GI})_i$ = Monthly average molecular mass of feedstock *i*, in kilograms per kilomole or, when a mass flowmeter is used to measure the flow of gas input in metric tons for month *n*, replace

$$\frac{MM_{GI}}{MVC} \text{ by } 1;$$

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

$(V_{GP})_{j,k}$ = Volume of product *j* produced in month *k*, in thousands of cubic metres at standard conditions;

$(C_{GP})_{j,k}$ = Average carbon content of product *j* produced in month *k*, in kilograms of carbon per kilogram of product;

$(MM_{GP})_j$ = Monthly average molecular mass of gas *j*, in kilograms per kilomole;

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres;

(2) where the quantity of feedstock and the quantity of product are expressed as a mass, using equation 12-2:

Equation 12-2

$$CO_2 = \sum_{n=1}^{12}\left[\sum_{i=1}^{k}\left[(Q_F)_{i,n} \times (C_F)_{i,n}\right] - \sum_{j=1}^{m}\left[(Q_P)_{j,n} \times (C_P)_{j,n}\right]\right] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to each petrochemical process, in metric tons;

n = Month;

k = Number of feedstock materials;

m = Number of products;

i = Type of feedstock material the quantity of which is expressed as a mass;

j = Type of product the quantity of which is expressed as a mass;

$(Q_F)_{i,n}$ = Quantity of feedstock *i* consumed in month *n*, in metric tons;

$(C_F)_{i,n}$ = Average carbon content of feedstock *i* for month *n*, in kilograms of carbon per kilogram of feedstock;

$(Q_P)_{j,n}$ = Quantity of product *j* for month *n*, in metric tons;

$(C_P)_{j,n}$ = Average carbon content of product *j* for month *n*, in kilograms of carbon per kilogram of product;

3.664 = Ratio of molecular weights, CO_2 to carbon.”;

(s) by inserting “, CH_4 and N_2O” after “CO_2” in the heading of QC.12.3.2 and in the paragraph following;

(t) by striking out QC.12.3.7, QC.12.3.8 and QC.12.4.4;

(13) in QC.13:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.13.2 preceding subparagraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by inserting "and reported" after "calculated" in subparagraph 1.1 of QC.13.2;

(c) by striking out subparagraph 7 of QC.13.2;

(d) by adding the following paragraph at the end of QC.13.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 1.1 of the first paragraph are emissions attributable to combustion;

(2) the emissions referred to in subparagraph 1 of the first paragraph are other emissions.";

(e) by inserting "carried out in accordance with QC.13.4" after "performance test *i*" in the definition of the factor "C_{N2O}" in equation 13-2 of QC.13.3.1;

(f) by replacing "ASTM D6348-03 (2010)" in subparagraph *b* of paragraph 1 of the third paragraph of QC.13.4 by "the most recent version of ASTM D6348";

(g) by inserting the following after subparagraph *b* of paragraph 1 of the third paragraph of QC.13.4:

"*(b.1)* any other analysis method published by an organization listed in QC.1.5;";

(14) in QC.14:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.14.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by striking out paragraph 1 of QC.14.2;

(c) by replacing paragraph 2 of QC.14.2 by the following:

"(2) the annual CO_2 emissions attributable to the use in the furnace of each material that contributes 0.5% or more of the total carbon in the process, in metric tons;";

(d) by inserting "and reported" after "calculated" in paragraph 2.1 of QC.14.2;

(e) by replacing paragraphs 3 and 4 of QC.14.2 by the following:

"(3) the annual quantity of each material that contributes 0.5% or more of the total carbon in the process, in metric tons;

(4) the average annual carbon content of each material that contributes 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material;";

(f) by striking out subparagraph 6 of QC.14.2;

(g) by adding the following paragraphs at the end of QC.14.2:

"Subparagraph 4 of the first paragraph does not apply to the CO_2 emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 2.1 of the first paragraph are emissions attributable to combustion.";

(h) by replacing the definition of the factor "M_i" in equation 14-1 of QC.14.3.2 by the following:

"M_i = Annual quantity of each material *i* used that contributes 0.5% or more of the total carbon in the process, in metric tons;";

(i) by replacing "Carbon content" in the definition of the factor "CC_i" in equation 14-1 of QC.14.3.2 by "Average annual carbon content";

(j) by replacing "An emitter" in the part of QC.14.4 preceding paragraph 1 by "When the calculation method in QC.14.3.2 is used, an emitter";

(k) by replacing paragraph 1 of QC.14.4 by the following:

"(1) determine annually the carbon content of each material that contributes 0.5% or more of the total carbon in the process used in the furnace, either by using the data provided by the material supplier or by using the following methods, based on a minimum of 3 representative samples per year:

(a) for solid carbonaceous reducing agents and carbon electrodes, using the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal", or using any other analysis method published by an organization listed in QC.1.5;

(b) for liquid reducing agents, using the most recent version of ASTM D2502 “Standard Test Method for Estimation of Molecular Weight (Relative Molecular Mass) of Petroleum Oils From Viscosity Measurements”, ASTM D2503 “Standard Test Method for Relative Molecular Mass (Molecular Weight) of Hydrocarbons by Thermoelectric Measurement of Vapor Pressure”, ASTM D3238 “Standard Test Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the n-d-M Method” or ASTM D5291 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants”, or using any other analysis method published by an organization listed in QC.1.5;

(c) for gaseous reducing agents, using the most recent version of ASTM D1945 “Standard Test Method for Analysis of Natural Gas by Gas Chromatograph” or ASTM D1946 “Standard Practice for Analysis of Reformed Gas by Gas Chromatography”, or using any other analysis method published by an organization listed in QC.1.5;

(d) for waste-based materials and ores, by sampling and chemical analysis using an analysis method published by an organization listed in QC.1.5;”;

(15) in QC.15:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.15.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by striking out paragraph 1 of QC.15.2;

(c) by replacing paragraph 2 of QC.15.2 by the following:

“(2) the annual CO_2 emissions attributable to the use in the furnace of materials that contribute 0.5% or more of the total carbon in the process, in metric tons;”;

(d) by inserting “and reported” after “calculated” in paragraph 2.1 of QC.15.2;

(e) by replacing paragraphs 3 and 4 of QC.15.2 by the following:

“(3) the annual quantity of each material that contributes 0.5% or more of the total carbon in the process, in metric tons;

(4) the average annual carbon content of each material that contributes 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material;”;

(f) by striking out subparagraph 6 of QC.15.2;

(g) by adding the following paragraphs at the end of QC.15.2:

"Subparagraph 4 of the first paragraph does not apply to the CO_2 emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 2.1 of the first paragraph are emissions attributable to combustion.";

(h) by replacing the definition of the factor "M_i" in equation 15-1 of QC.15.3.2 by the following:

"M_i = Annual quantity of each material *i* used that contributes 0.5% or more of the total carbon in the process, in metric tons;";

(i) by replacing "Carbon content" in the definition of the factor "CC_i" in equation 15-1 of QC.15.3.2 by "Average monthly carbon content";

(j) by replacing "An emitter" in the part of QC.15.4 preceding paragraph 1 by "When the calculation method in QC.15.3.2 is used, an emitter";

(k) by replacing paragraph 1 of QC.15.4 by the following:

"(1) determine annually the carbon content of each material that contributes 0.5% or more of the total carbon in the process, either by using the data provided by the supplier, or by using the following methods:

(a) for ores containing zinc, using the most recent version of ASTM E1941 "Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys", or using any other analysis method published by an organization listed in QC.1.5;

(b) for carbonaceous reducing agents and carbon electrodes, using the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal", or using any other analysis method published by an organization listed in QC.1.5;

(c) for flux materials, using the most recent version of ASTM C25 "Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime", or using any other analysis method published by an organization listed in QC.1.5;

(d) for waste-based materials and ores, by sampling and chemical analysis using an analysis method published by an organization listed in QC.1.5;";

(16) in QC.16:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.16.2 preceding subparagraph 1 the first paragraph by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by replacing subparagraphs *a* to *d* of subparagraph 2 of the first paragraph of QC.16.2 by the following:

"*(a)* in bone dry metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;

(d) in bone dry metric tons, in the case of biomass fuels, when the quantity is expressed as a mass;

(e) in metric tons collected, in the case of municipal solid waste;";

(c) by inserting "annual" after "average" in subparagraph 3 of the first paragraph of QC.16.2;

(d) by inserting "annual" after "average" in subparagraph 4 of the first paragraph of QC.16.2;

(e) by replacing subparagraphs *a* to *c* of subparagraph 4 of the first paragraph of QC.16.2 by the following:

"*(a)* in gigajoules per bone dry metric ton, in the case of a fuel whose quantity is expressed as a mass;

(b) in gigajoules per thousand cubic metres, in the case of a fuel whose quantity is expressed as a volume of gas;

(c) in gigajoules per kilolitre, in the case of a fuel whose quantity is expressed as a volume of liquid;

(d) in gigajoules per metric ton collected, in the case of municipal solid waste;";

(f) by replacing “and acid gas reagent” in subparagraph 8 of the first paragraph of QC.16.2 by “for fluidized bed boilers”, and by inserting “for fluidized bed boilers” after “equipment” in subparagraph 12 of the first paragraph of QC.16.2;

(g) by replacing subparagraph 11 of the first paragraph of QC.16.2 by the following:

“(11) the annual fugitive emissions of CH_4 from coal storage calculated and reported in accordance with QC.5, in metric tons;”;

(h) by striking out subparagraph 18 of the first paragraph of QC.16.2;

(i) by adding the following paragraph at the end of QC.16.2:

“For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 8 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 1 of the first paragraph are emissions attributable to combustion, excluding CO_2 emissions attributable to the combustion of biomass;

(3) the emissions referred to in subparagraphs 9, 10 and 11 of the first paragraph are other emissions.”;

(j) by striking out “, CH_4 and N_2O” in the second paragraph of QC.16.3;

(k) by replacing “and QC.1.3.3” in subparagraph *a* of paragraph 7 of QC.16.3.2 by “or QC.1.3.3”;

(l) by replacing “and QC.1.3.4” in subparagraph 10 of QC.16.3.2 by “or QC.1.3.4”;

(m) by inserting “for fluidized bed boilers” after “scrubbing” in QC.16.3.3;

(n) by adding the following paragraphs at the end of QC.16.4:

“For a facility or establishment with natural gas, diesel or heavy oil-powered units that are not individually equipped with a flowmeter or a dedicated tank and for which data cannot be obtained using a continuous emission monitoring and recording system, an emitter may calculate CO_2, CH_4 and N_2O emissions using data from a measurement device common to all the units.

To calculate the emissions attributable to each stationary combustion unit, the estimate must be based on total emissions, the hours of operation and the combustion efficiency of each unit. For diesel-powered units, the estimate may be based on the total quantity of energy produced, the energy produced by each unit, and the total quantity of diesel fuel consumed.";

(o) by replacing equation 16-3 of QC.16.5.2 by the following:

"**Equation 16-3**

$$HFC = \left[\sum_{i=1}^{n}\left(Q\,NEW_i - NC\,NEW_i\right) + \sum_{j=1}^{m}\left(Q\,RECH_j - Q\,RECO_j\right) + \sum_{k=1}^{p}\left(NC\,RET_k - Q\,RET_k\right)\right] \times 0.001$$

Where:

HFC = Annual fugitive HFC emissions attributable to cooling units used in electricity production, in metric tons;

n = Number of new cooling units brought into operation during the year;

i = New cooling unit brought into operation;

$Q\,NEW_i$ = Quantity of HFC used to fill the new cooling unit brought into operation *i*, in kilograms;

$NC\,NEW_i$ = Nameplate capacity of the new cooling unit brought into operation *i*, in kilograms;

m = Number of maintenance operations, either to recharge or recover, completed during the year;

j = Cooling unit maintained;

$Q\,RECH_j$ = Quantity of HFC used to recharge the unit during maintenance of cooling unit *i*, in kilograms;

$Q\,RECO_j$ = Quantity of HFC recovered during maintenance of cooling unit *i*, in kilograms;

p = Number of cooling units retired during the year;

k = Cooling unit retired;

$NC\,RET_k$ = Nameplate capacity of cooling unit *k*, in kilograms;

$Q\ RET_k$ = Quantity of HFC recovered from cooling unit *k*, in kilograms;

0.001 = Conversion factor, kilograms to metric tons.";

(p) by adding "when the calculation method in QC.16.3.2 is used" at the end of QC.16.6.1 and QC.16.6.2;

(q) by inserting "who operates a fluid bed boiler equipped with a gas scrubber" after "emitter" in QC.16.6.3;

(17) in QC.17:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of the first paragraph of QC.17.2 preceding subparagraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by replacing subparagraph *b* of subparagraph 1 of the first paragraph of QC.17.2 by the following:

"*(b)* the annual total greenhouse gas emissions attributable to the production of electricity referred to in subparagraph *a*, calculated in accordance with QC.17.3.1, in metric tons CO_2 equivalent;";

(c) by replacing "CO_2 emissions" in subparagraph *c* of subparagraph 1 of the first paragraph of QC.17.2 by "greenhouse gas emissions";

(d) by replacing subparagraphs v and vi of subparagraph *c* of subparagraph 1 of the first paragraph of QC.17.2 by the following:

"v. the annual greenhouse gas emissions attributable to the production of the electricity acquired from the facility, in metric tons CO_2 equivalent;

vi. the annual greenhouse gas emissions of the facility, in metric tons CO_2 equivalent;";

(e) by replacing "CO_2" in subparagraphs *d* and *e* of subparagraph 1 of the first paragraph of QC.17.2 by "greenhouse gas";

(f) by replacing subparagraph ii of subparagraph *d* of subparagraph 1 of the first paragraph of QC.17.2 by the following:

"ii. each fuel type used for electricity production and its heat value, that is:

- in gigajoules per metric ton, when the quantity of fuel is expressed as a mass;

- in gigajoules per kilolitre, when the quantity of fuel is expressed as a volume of liquid;

- in gigajoules per cubic metre, when the quantity of fuel is expressed as a volume of gas;";

(g) by replacing subparagraph iii of subparagraph *e* of subparagraph 1 of the first paragraph of QC.17.2 by the following:

"iii. the annual greenhouse gas emissions attributable to the electricity acquired, in metric tons CO_2 equivalent, by province or state;";

(h) by replacing subparagraph *b* of subparagraph 2 of the first paragraph of QC.17.2 by the following:

"*(b)* the annual total greenhouse gas emissions caused or avoided by the exportation of the electricity, calculated in accordance with QC.17.3.2, in metric tons CO_2 equivalent;";

(i) by replacing "CO_2" in subparagraph *c* of subparagraph 2 of the first paragraph of QC.17.2 by "greenhouse gas";

(j) by replacing subparagraph i of subparagraph *c* of subparagraph 2 of the first paragraph of QC.17.2 by the following:

"i. the annual greenhouse gas emissions caused or avoided by the exportation of the electricity produced by the facility, in metric tons CO_2 equivalent;";

(k) by replacing "CO_2" in subparagraph *d* of subparagraph 2 of the first paragraph of QC.17.2 by "greenhouse gas";

(l) by replacing subparagraph ii of subparagraph *d* of subparagraph 2 of the first paragraph of QC.17.2 by the following:

"ii. the annual greenhouse gas emissions caused or avoided by the exportation of the electricity produced by the facility, in metric tons CO_2 equivalent;";

(m) by striking out the second paragraph of QC.17.2;

(n) by replacing "CO_2" and "$\mathbf{CO_2}$" in QC.17.3 and in the heading to QC.17.3 by "greenhouse gas" and "**greenhouse gas**", respectively;

(o) by replacing QC.17.3.1 and QC.17.3.2 by the following:

"QC.17.3.1. Calculation of greenhouse gas emissions attributable to the production of electricity acquired outside Québec and sold or consumed within Québec

The annual greenhouse gas emissions attributable to electricity produced outside Québec and sold or consumed within Québec must be calculated by adding the greenhouse gas emissions attributable to electricity acquired outside Québec and produced by identifiable and unidentifiable facilities which emissions are calculated in accordance with the following methods:

(1) for an identifiable facility covered by a greenhouse gas emissions report made to Environment Canada under section 71 of the Canadian Environmental Protection Act (1999) (1999, c. 33), the U.S. Environmental Protection Agency (USEPA) under Part 75 of Title 40 of the Code of Federal Regulations, or the organization The Climate Registry, using equation 17-1:

Equation 17-1

$$GHG = GHG_i \times \frac{MWh_{imp}}{MWh_n}$$

Where:

GHG = Annual greenhouse gas emissions attributable to the production of electricity acquired outside Québec and produced by the identifiable facility, in metric tons CO_2 equivalent;

GHG_i = Annual greenhouse gas emissions attributable to the identifiable facility, in metric tons CO_2 equivalent;

MWh_{imp} = Total quantity of electricity acquired from the identifiable facility and consumed or sold annually in Québec, including an estimate of transmission losses, from the facility's busbar, in megawatt-hours;

MWh_n = Net annual production of electricity at the identifiable facility, in megawatt-hours;

(2) for an identifiable facility not covered by a greenhouse gas emissions report made to one of the organizations referred to in paragraph 1, using equation 17-2:

Equation 17-2

$$GHG = \sum_{j=1}^{n} \left(Q_j \times HHV_j \times EF_j \right) \times \frac{MWh_{imp}}{MWh_n}$$

Where:

GHG = Annual greenhouse gas emissions attributable to the production of electricity acquired outside Québec and produced by the identifiable facility, in metric tons CO_2 equivalent;

n = Number of fuels used annually by the facility;

j = Type of fuel;

Q_j = Quantity of fuel *j*, expressed

- in bone dry metric tons, when the quantity is expressed as a mass;

- in kilolitres, when the quantity is expressed as a volume of liquid;

- in thousands of cubic metres, when the quantity is expressed as a volume of gas;

HHV_j = High heat value of fuel *j* consumed for electricity production, as specified in Table 1-1 or 1-2 in QC.1.7, expressed

- in gigajoules per bone dry metric ton, when the quantity is expressed as a mass;

- in gigajoules per kilolitre, when the quantity is expressed as a volume of liquid;

- in gigajoules per thousand cubic metres, when the quantity is expressed as a volume of gas;

EF_j = Greenhouse gas emission factor for fuel *j*, calculated using equation 17-2.1, in metric tons CO_2 equivalent per gigajoule;

MWh_{imp} = Quantity of electricity acquired from the identifiable facility and consumed or sold annually in Québec, including an estimate of transmission losses, from the facility's busbar, in megawatt-hours;

MWh_n = Net annual production of electricity at the identifiable facility, in megawatt-hours;

Equation 17-2.1

$$EF_j = \left[\left(EF_{CO2} \times 1000\right) + \left(EF_{CH4} \times 21\right) + \left(EF_{N2O} \times 310\right)\right] \times 0.000001$$

Where:

EF_j = Greenhouse gas emission factor for fuel *j*, in metric tons CO_2 equivalent per gigajoule;

EF_{CO2} = CO_2 emission factor for fuel *j* as specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6 in QC.1.7, in kilograms of CO_2 per gigajoule;

1000 = Conversion factor, kilograms to grams;

EF_{CH4} = CH_4 emission factor for fuel *j* as specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6 in QC.1.7, in grams of CH_4 per gigajoule;

21 = Global warming potential of CH_4;

EF_{N2O} = N_2O emission factor for fuel *j* as specified in Table 1-2, 1-3, 1-4, 1-5 or 1-6 in QC.1.7, in grams of N_2O per gigajoule;

310 = Global warming potential of N_2O;

0.000001 = Conversion factor, grams to metric tons;

(3) for an identifiable facility for which the information needed to calculate greenhouse gas emissions using equation 17-1 or 17-2 is not available, and for an unidentifiable facility, using equation 17-3:

Equation 17-3

$$GHG = MWh_{imp} \times EF_D$$

Where:

GHG = Annual greenhouse gas emissions attributable to the production of electricity acquired outside Québec and produced by the identifiable or unidentifiable facility, in metric tons CO_2 equivalent;

MWh_{imp} = Quantity of electricity acquired from the identifiable or unidentifiable facility and consumed or sold annually in Québec, in megawatt-hours;

EF_D = Greenhouse gas emission factor for the province or North American market from which the electricity comes, in metric tons of CO_2 per megawatt-hour, which is either

- indicated in Table 17-1 in QC.17.4;

- when the electricity comes from an identifiable nuclear, hydroelectric, sea current, wind, solar or tidal power facility, a factor of 0;

- when the electricity comes from a non-identifiable facility, a factor of 0.999.

QC.17.3.2. Calculation of greenhouse gas emissions caused or avoided by the exportation of the electricity

The annual greenhouse gas emissions caused or avoided by the exportation of the electricity must be calculated by adding the greenhouse gas emissions attributable to the exportation of electricity produced by identifiable facilities to the greenhouse gas emissions attributable to the exportation of electricity produced by unidentifiable facilities, using one of the following methods:

(1) for an identifiable facility covered by a greenhouse gas emissions report in accordance with QC.16, using equation 17-4:

Equation 17-4

$$GHG = GHG_t \times \frac{MWh_{\exp}}{MWh_n} - \left(MWh_{\exp} \times EF_D\right)$$

Where:

GHG = Annual greenhouse gas emissions caused or avoided by the exportation of the electricity produced by the identifiable facility, in metric tons CO_2 equivalent;

GHG_t = Total annual greenhouse gas emissions attributable to the identifiable facility, in metric tons CO_2 equivalent;

MWh_{exp} = Total quantity of electricity produced by the identifiable facility and exported annually, including an estimate of transmission losses, from the facility's busbar, in megawatt-hours;

MWh_n = Net annual production of electricity at the identifiable facility, in megawatt-hours;

EF_D = Greenhouse gas emission factor for the province or North American market where the electricity is delivered, as specified in Table 17-1 in QC.17.4, in metric tons CO_2 equivalent per megawatt-hour;

(2) for an identifiable facility not covered by a greenhouse gas emissions report in accordance with QC.16 and for an unidentifiable facility, using equation 17-5:

Equation 17-5

$$GHG = MWh_{\exp} \times \left(EF_{QC} - EF_{D}\right)$$

Where:

GHG = Annual greenhouse gas emissions caused or avoided by the exportation of the electricity produced by the identifiable or unidentifiable facility, in metric tons CO_2 equivalent;

MWh_{exp} = Quantity of electricity produced by the identifiable or unidentifiable facility and exported annually, in megawatt-hours;

EF_{QC} = Greenhouse gas emission factor for Québec, as specified in Table 17-1 in QC.17.4, in metric tons CO_2 equivalent per megawatt-hour;

EF_D = Greenhouse gas emission factor for the province or North American market where the electricity is delivered, in metric tons CO_2 equivalent per megawatt-hour, which is either

- indicated in Table 17-1 in QC.17.4;
- when the electricity comes from an identifiable nuclear, hydroelectric, sea current, wind, solar or tidal power facility, a factor of 0;
- when the electricity comes from a non-identifiable facility, a factor of 0.”;

(p) by replacing the heading of Table 17-1 in QC.17.4 by the following:

“**Table 17-1. Default greenhouse gas emission factors for Canadian provinces and certain North American markets, in metric tons CO_2 equivalent per megawatt-hour**”;

(q) by replacing the heading of Table 17-1 in QC.17.4 and the first 5 lines of the Table by the following:

"

Canadian province or North American market	**Default emission factor (metric tons GHG/MWh)**
Newfoundland and Labrador	0.017
Nova Scotia	0.810
New Brunswick	0.510
Québec	0.002
Ontario	0.130

";

(18) in QC.18:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of the first paragraph of QC.18.2 preceding subparagraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by striking out subparagraph 1 of the first paragraph of QC.18.2;

(c) by inserting "and reported" after "calculated" in subparagraph 2 of the first paragraph of QC.18.2;

(d) by replacing "carbon content" in subparagraphs 9, 11, 13 and 15 of the first paragraph of QC.18.2 by "average annual carbon content";

(e) by replacing subparagraphs 16 and 17 of the first paragraph of QC.18.2 by the following:

"(16) the annual consumption of each other raw material that contributes 0.5% or more of the total carbon in the process, in metric tons;

(17) the average annual carbon content of the other raw materials that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of feedstock;";

(f) by striking out subparagraph 19 of the first paragraph of QC.18.2;

(g) by adding "When the emissions referred to in subparagraphs 3 to 7 of the first paragraph are measured by the same continuous emission monitoring and recording system, the emissions may be declared as a whole." at the end of the second paragraph of QC.18.2;

(h) by adding the following paragraph at the end of QC.18.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 3 to 7 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion.";

(i) by replacing "carbon-containing raw materials" in the definition of the factor "$CO_{2,\ RM}$" in equation 18-1 of paragraph 1 of QC.18.3.2 by "raw materials that contribute 0.5% or more of the total carbon in the process";

(j) by replacing "Calcium carbonate content" in the definition of the factor "C_{LS}" in equation 18-2 of paragraph 2 of QC.18.3.2 by "Average annual calcium carbonate content";

(k) by replacing the definition of the factor "C_D" in equation 18-2 of paragraph 2 of QC.18.3.2 by the following:

"C_D = Average annual calcium carbonate and magnesium carbonate content, in metric tons of carbonates per metric ton of dolomite;";

(l) by replacing "Carbon content" in the definition of the factor "C_{RA}" in equation 18-3 in paragraph 3, the definition of the factor "C_{ORE}" in equation 18-4 in paragraph 4 and the definition of the factor "C_{CE}" in equation 18-5 in paragraph 5 of QC.18.3.2 by "Average annual carbon content";

(m) by replacing definition of the factor "$CO_{2,\ RM}$" in equation 18-6 of paragraph 6 of QC.18.3.2 by the following:

"$CO_{2,\ RM}$ = Annual CO_2 emissions attributable to raw materials that contribute 0.5% or more of the total carbon in the process, in metric tons;";

(n) by adding "that contribute 0.5% or more of the total carbon in the process" at the end of the definition of the factor "n" in equation 18-6 in paragraph 6 of QC.18.3.2;

(o) by replacing ", that contributes to 0.5%" in the definition of the factor "RM_i" in equation 18-6 in paragraph 6 of QC.18.3.2 by "that contributes 0.5%";

(p) by replacing "Carbon content" in the definition of the factor "$C_{RM,\ i}$" in equation 18-6 in paragraph 6 of QC.18.3.2 by "Average annual carbon content";

(q) by replacing "An emitter" in the part of QC.18.4 preceding paragraph 1 by "When the calculation method in QC.18.3.2 is used, an emitter";

(r) by replacing paragraph 1 of QC.18.4 by the following:

“(1) when a calculation method in QC.18.3 is used, determine annually the carbon or carbonate content of each material used, either by using data from the material supplier or by using the following methods:

(a) for coal and coke, the most recent version of ASTM D5373 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal and Coke”, or any other analysis method published by an organization listed in QC.1.5;

(b) for petroleum-based liquid fuels and liquid waste-derived fuels, the most recent version of ASTM D5291 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants”, the elementary analysis method or calculations specified in the most recent version of ASTM D3238 “Standard Test Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the n-d-M Method”, and the most recent version of either ASTM D2502 “Standard Test Method for Estimation of Molecular Weight (Relative Molecular Mass) of Petroleum Oils From Viscosity Measurements” or ASTM D2503 “Standard Test Method for Relative Molecular Mass (Molecular Weight) of Hydrocarbons by Thermoelectric Measurement of Vapor Pressure”, or any other analysis method published by an organization listed in QC.1.5;

(c) for gaseous fuels, the most recent version of ASTM D1945 “Standard Test Method for Analysis of Natural Gas by Gas Chromatography” or ASTM D1946 “Standard Practice for Analysis of Reformed Gas by Gas Chromatography”, or any other analysis method published by an organization listed in QC.1.5;

(d) for limestone and dolomite, the most recent version of ASTM C25 “Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime”, or any other analysis method published by an organization listed in QC.1.5;

(e) for other raw materials, any other analysis method published by an organization listed in QC.1.5;”;

(19) in QC.19:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of the first paragraph of QC.19.2 preceding subparagraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by striking out subparagraph 1 of the first paragraph of QC.19.2;

(c) by replacing "carbon-containing material" in subparagraph *d* of subparagraph 2 of the first paragraph of QC.19.2 by "material that contributes 0.5% or more of the total carbon in the process";

(d) by replacing subparagraph *e* of subparagraph 2 of the first paragraph of QC.19.2 by the following:

"*(e)* the average annual carbon content of each material or product that contributes 1% or more of the total carbon in the process, in metric tons of carbon per metric ton of material or product;

(f) the annual production of material other than alloys, in metric tons;";

(e) by inserting "and reported" after "calculated" in subparagraphs 3 and 4 of the first paragraph of QC.19.2;

(f) by striking out subparagraph 6 of the first paragraph of QC.19.2;

(g) by adding the following paragraph at the end of QC.19.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph *a* of subparagraph 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 3 and CH_4 and N_2O emissions referred to in subparagraph 4 of the first paragraph are emissions attributable to combustion;

(3) the emissions referred to in subparagraph *b* of subparagraph 2 of the first paragraph are other emissions.";

(h) by replacing "Carbon content" in the definitions of the factors "C_{RA}", "C_{CE}", "C_{ORE}", "C_{MF}", "C_{FEA}" and "C_{NAM}" in equation 19-1 of QC.19.3.2 by "Average annual carbon content";

(i) by replacing "An emitter" in the part of QC.19.5 preceding paragraph 1 by "When the calculation method in QC.19.3.2 is used, an emitter";

(j) by replacing paragraph 1 of QC.19.5 by the following:

"(1) determine annually the carbon content of each material that contributes at least 1% of the total carbon in the process, based on either the data indicated by the supplier or the analysis of a minimum of 3 representative samples per year using any analysis method published by an organization listed in QC.1.5, or the following methods:

(a) for metal ores and ferroalloy products, the most recent version of ASTM E1941 “Standard Test Method for Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis”;

(b) for carbonaceous reducing agents and carbon electrodes, the most recent version of ASTM D5373 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal”;

(c) for flux materials, the most recent version of ASTM C25 “Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime”;”;

(k) by adding “**, in metric tons of CH_4 per metric ton of ferroalloy product**” at the end of the heading of Table 19-1 in QC.19.7;

(20) in QC.20:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.20.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by inserting “and reported” after “calculated” in paragraph 2 of QC.20.2;

(c) by striking out subparagraph 7 of QC.20.2;

(d) by adding the following paragraph at the end of QC.20.2:

“For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion;

(2) the emissions referred to in subparagraph 1 of the first paragraph are other emissions.”;

(21) in QC.21:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.21.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by inserting “and reported” after “calculated” in paragraph 2 of QC.21.2;

(c) by striking out subparagraph 5 of QC.21.2;

(d) by adding the following paragraphs at the end of QC.21.2:

"Subparagraph *c* of subparagraph 3 of the first paragraph does not apply to the N_2O emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion;

(2) the emissions referred to in subparagraph 1 of the first paragraph are other emissions.";

(e) by replacing "An emitter" in the part of QC.21.4 preceding paragraph 1 by "When the method in QC.21.3.2 is used, an emitter";

(f) by replacing subparagraph ii of subparagraph *b* of paragraph 1 of QC.21.4 by the following:

"ii. the most recent version of ASTM D6348 "Standard Test Method for Determination of Gaseous Compounds by Extractive Direct Interface Fourier Transform Infrared (FTIR) Spectroscopy", or any other analysis method published by an organization listed in QC.1.5;";

(g) by replacing "subparagraph *b*" in paragraph 2 of QC.21.4 by "subparagraph *c*";

(h) by striking out "the carbon content" from subparagraph *b* of subparagraph 1 of the second paragraph of QC.21.5, as replaced by subparagraph 25 of section 8 of the *Regulation to amend the Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere* (M.O., 2012, G.O.2, 4450);

(22) in QC.22:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of the first paragraph of QC.22.2 preceding subparagraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by inserting "and reported" after "calculated" in subparagraph 2 of the first paragraph of QC.22.2;

(c) by replacing "monthly inorganic carbon" in subparagraph 4 of the first paragraph of QC.22.2 by "annual average inorganic carbon content";

(d) by striking out "monthly and" in subparagraph 5 of the first paragraph of QC.22.2;

(e) by striking out subparagraph 7 of the first subparagraph of QC.22.2;

(f) by adding the following paragraph at the end of QC.22.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 1 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion.";

(g) by replacing "Carbon content" in the definition of the factor "C_i" in equation 22-1 in QC.22.3.2 by "Monthly carbon content";

(h) by replacing "An emitter" in the part of QC.22.4 preceding paragraph 1 by "When the calculation method in QC.22.3.2 is used, an emitter";

(i) by adding "or any other analysis method published by an organization listed in QC.1.5" at the end of paragraph 2 of QC.22.4;

(23) in QC.23:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.23.2 preceding subparagraph 1 the first paragraph by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by inserting "and reported" after "calculated" in subparagraph 2 of the first paragraph of QC.23.2;

(c) by replacing subparagraph 3 of the first paragraph of QC.23.2 by the following:

"(3) the annual consumption of each raw material used in ammonia production, expressed

(a) in bone dry metric tons, when the quantity is expressed as a mass;

(b) in thousands of cubic metres at standard conditions, when the quantity is expressed as a volume of gas;

(c) in kilolitres, when the quantity is expressed as a volume of liquid;";

(d) by replacing "monthly" in subparagraphs 4 and 7 of the first paragraph of QC.23.2 by "average annual";

(e) by striking out subparagraph 11 of the first subparagraph of QC.23.2;

(f) by replacing "4 to 7" in the second paragraph of QC.23.2 by "4 and 7";

(g) by adding the following paragraph at the end of QC.23.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 1 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraphs 2 and 5 of the first paragraph, excluding emissions attributable to the combustion or use of biomass or biomass fuels, are emissions attributable to combustion.";

(h) by replacing the definitions of "CO_2, $_G$", "CO_2, $_L$" and "CO_2, $_S$" in equation 23-1 of QC.23.3.2 by the following:

"$CO_{2,\,G}$ = Annual CO_2 emissions attributable to ammonia production for production unit *k* from feedstock the quantity of which is expressed as a volume of gas, calculated in accordance with equation 23-2, in metric tons;

$CO_{2,\,L}$ = Annual CO_2 emissions attributable to ammonia production for production unit *k* from feedstock the quantity of which is expressed as a volume of liquid, calculated in accordance with equation 23-3, in metric tons;

$CO_{2,\,S}$ = Annual CO_2 emissions attributable to ammonia production for production unit *k* from feedstock the volume of which is expressed as a mass, calculated in accordance with equation 23-4, in metric tons;";

(i) by replacing equations 23-2, 23-3 and 23-4 of QC.23.3.2 by the following:

"**Equation 23-2**

$$CO_{2,G} = \sum_{i=1}^{12} \left[Fdstk_i \times C_i \right] \times \frac{MW}{MVC} \times 3.664 \times 1$$

Where:

$CO_{2,\,G}$ = Annual CO_2 emissions attributable to ammonia production for production unit *k* from feedstock the quantity of which is expressed as a volume of gas, in metric tons;

i = Month;

$Fdstk_i$ = Consumption of feedstock the quantity of which is expressed as a volume of gas for month *i*, in thousands of cubic metres at standard conditions, or, when a mass flowmeter is used, in metric tons;

C_i = Carbon content of feedstock the quantity of which is expressed as a volume of gas consumed in month *i*, in kilograms of carbon per kilogram of feedstock;

MW = Molecular weight of feedstock the quantity of which is expressed as a volume of gas, in kilograms per kilomole or, when a mass flowmeter is used, replace

$\frac{MW}{MVC}$ by 1;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres;

Equation 23-3

$$CO_{2,L} = \sum_{i=1}^{12} \left[Fdstk_i \times C_i \right] \times 3.664$$

Where:

$CO_{2,L}$ = Annual CO_2 emissions attributable to ammonia production for production unit *k* from feedstock the quantity of which is expressed as a volume of liquid, in metric tons;

i = Month;

$Fdstk_i$ = Consumption of feedstock the quantity of which is expressed as a volume of liquid for month *i*, in kilolitres;

C_i = Carbon content of the feedstock the quantity of which is expressed as a volume of liquid consumed in month *i*, in metric tons of carbon par kilolitre of feedstock;

3.664 = Ratio of molecular weights, CO_2 to carbon;

Equation 23-4

$$CO_{2,S} = \sum_{i=1}^{12} \left[Fdstk_i \times C_i \right] \times 3.664$$

Where:

$CO_{2,S}$ = Annual CO_2 emissions attributable to ammonia production at production unit *k* from feedstock the quantity of which is expressed as a mass, in metric tons;

i = Month;

$Fdstk_i$ = Consumption of feedstock the quantity of which is expressed as a mass for month *i*, in metric tons;

C_i = Carbon content of the feedstock the quantity of which is expressed as a mass consumed in month *i*, in kilograms of carbon per kilogram of feedstock;

3.664 = Ratio of molecular weights, CO_2 to carbon.";

(j) by replacing equation 23-5 in QC.23.3.3 by the following:

"**Equation 23-5**

$$CO_{2,WR} = \sum_{i=1}^{12} \left[WRG_i \times C_i \right] \times \frac{MW}{MVC} \times 3.664 \times 1$$

Where:

$CO_{2,\,WR}$ = Annual CO_2 emissions attributable to the combustion of gas from the waste recycle stream of each production unit, in metric tons;

i = Month;

WRG_i = Quantity of gas from the waste recycle stream for month *i*, in thousands of cubic metres at standard conditions or, when a mass flowmeter is used, in metric tons;

C_i = Carbon content of gas from the waste recycle stream for month *i*, in kilograms of carbon per kilogram of gas;

MW = Molecular weight of gas from the waste recycle stream, in kilograms per kilomole or, when a mass flowmeter is used, replace

$$\frac{MW}{MVC} \text{ by } 1;$$

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

3.664 = Ratio of molecular weights, CO_2 to carbon;

1 = Conversion factor, kilograms to metric tons and thousands of cubic metres to cubic metres.";

(k) by replacing paragraph 2 of QC.23.4 by the following:

"(2) when the calculation method in QC.23.3.2 is used, determine monthly the carbon content and the average molecular weight of each feedstock consumed and of gas from the waste recycle stream, either by using data from the material supplier or by using one of the following methods:

(a) the most recent version of ASTM D1945 "Standard Test Method for Analysis of Natural Gas by Gas Chromatography";

(b) the most recent version of ASTM D1946 "Standard Practice for Analysis of Reformed Gas by Gas Chromatography";

(c) the most recent version of ASTM D2502 "Standard Test Method for Estimation of Molecular Weight (Relative Molecular Mass) of Petroleum Oils From Viscosity Measurements";

(d) the most recent version of ASTM D2503 "Standard Test Method for Relative Molecular Mass (Molecular Weight) of Hydrocarbons by Thermoelectric Measurement of Vapor Pressure";

(e) the most recent version of ASTM D3238 "Standard Test Method for Calculation of Carbon Distribution and Structural Group Analysis of Petroleum Oils by the n-d-M Method";

(f) the most recent version of ASTM D5291 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants";

(g) the most recent version of ASTM D3176 “Standard Practice for Ultimate Analysis of Coal and Coke”;

(h) the most recent version of ASTM D5373 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal”;

(i) any other analysis method published by an organization listed in QC.1.5;”;

(24) in QC.24:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.24.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by striking out subparagraph 4 of QC.24.2;

(c) by adding the following paragraph at the end of QC.24.2:

“For the purposes of subparagraph 8 of the first paragraph of section 6.2, the emissions referred to in subparagraphs 1 and 2 of the first paragraph are other emissions.”;

(d) by replacing “QC.24.3.1 and QC.24.3.2” in QC.24.3 by “QC.24.3.1 to QC.24.3.3”;

(e) by replacing equations 24-3 and 24-4 in QC.24.3.1 by the following:

“**Equation 24-3**

$$S_{ACQ} = S_{Cvl} + S_{Equip} + S_{\mathrm{Returned}}$$

Where:

S_{ACQ} = Quantity of gas *j* acquired during the year, contained in electrical equipment or storage containers, in kilograms;

S_{Cvl} = Quantity of gas *j* acquired, contained in containers, in kilograms;

S_{Equip} = Quantity of gas *j* acquired, contained in electrical equipment, in kilograms;

$S_{Returned}$ = Quantity of gas *j* returned to the enterprise after off-site recycling, in kilograms;

j = Type of gas;

Equation 24-4

$$S_{SOLD} = S_{Sales} + S_{\mathrm{Returns}} + S_{Destruct} + S_{\mathrm{Recyc}}$$

Where:

S_{SOLD} = Quantity of gas *j* sold or transferred to other facilities or establishments during the year, in storage containers or electrical equipment, in kilograms;

S_{Sales} = Quantity of gas *j* sold to other facilities or establishments, including gas left in electrical equipment that is sold, in kilograms;

$S_{Returns}$ = Quantity of gas *j* returned to suppliers, in kilograms;

$S_{Destruct}$ = Quantity of gas *j* sent to destruction facilities, in kilograms;

S_{Recyc} = Quantity of gas *j* sent off-site for recycling, in kilograms;

j = Type of gas;";

(f) by replacing equation 24-8 of QC.24.3.2 by the following:

"**Equation 24-8**

$$S_D = \sum_{i=1}^{n} \left(NC - S_C\right)_i$$

Where:

S_D = Annual emissions of gas *j* during decommissioning phase of electrical equipment, in kilograms;

n = Number of units of electrical equipment decommissioned during the year;

i = Electrical equipment decommissioned;

NC = Nameplate capacity of decommissioned electrical equipment *i*, in kilograms;

S_C = Quantity of gas *j* collected from decommissioned electrical equipment *i*, in kilograms;

j = Type of gas.";

(g) by adding the following after QC.24.3.2:

"QC.24.3.3. Calculation of fugitive emissions by mass balance and by direct measurement

Fugitive SF_6 and PFC emissions may be calculated using a mixed method by applying the mass balance method to operations and the direct measurement method to decommissioned equipment.

For the purposes of the calculation, all quantities of SF_6 and PFC that cannot be accounted for are assumed to have been emitted.

The fugitive emissions must be calculated using equations 24-9 to 24-13:

Equation 24-9

$$GHG_i = \left(S_O - S_{REC} + S_{DC}\right) \times 0.001$$

Where:

GHG_j = Annual emissions of gas *j* attributable to operations and to the decommissioning of electrical equipment, in metric tons;

S_O = Annual emissions of gas *j* from electrical equipment during the operating phase, calculated using equation 24-10, in kilograms;

S_{REC} = Annual quantity of gas *j* recovered from electrical equipment during the operating phase, calculated using equation 24-13, in kilograms;

S_{DC} = Annual emissions of gas *j* from decommissioned electrical equipment, calculated using equation 24-8, in kilograms;

0.001 = Conversion factor, kilograms to metric tons;

j = Type of gas;

Equation 24-10

$$S_O = \left(S_{Empty}\right) \times \left(1 - f_{j,i}\right)$$

Where:

S_O = Annual emissions of gas *j* during operating phase of electrical equipment, in kilograms;

S_{Empty} = Annual quantity of gas *j* contained in containers used for operations, expressed as the quantity initially contained in containers returned empty to the supplier, in kilograms;

$f_{j,i}$ = Fraction of gas *j* remaining in containers of type *i* returned empty to the supplier, calculated using equation 24-11 when the gas from the container is transferred to electrical equipment without a recovery system or using equation 24-12 when a recovery system is used transfer the gas from the container to the electrical equipment;

i = Type of container;

j = Type of gas;

Equation 24-11

$$f_{j,i} = \left(\frac{M_{res,j}}{M_{initial,j}} \right)$$

Where:

$f_{j,i}$ = Average fraction of gas *j* remaining in containers of type *i* returned empty to the supplier;

$M_{res,j}$ = Average residual mass of gas *j* in empty containers, in kilograms;

$M_{initial,j}$ = Initial mass of gas *j*, based on the average weight of gas indicated by the supplier, in kilograms;

i = Type of container;

j = Type of gas;

Equation 24-12

$$f_{j,i} = \left(\frac{P_{discharge,j}}{P_{charge,j}} \right)$$

Where:

$f_{j,i}$ = Average fraction of gas *j* remaining in containers of type *i* returned empty to the supplier;

$P_{discharge,j}$ = Average discharge pressure of gas *j* in empty containers *i*, in kilopascals;

$P_{charge,j}$ = Average charging pressure of gas *j* in container *i*, in kilopascals;

i = Type of container;

j = Type of gas;

Equation 24-13

$$S_{REC} = S_{Destruct} + S_{\mathrm{Re}cyc}$$

Where:

S_{REC} = Annual quantity of gas *j* recovered from electrical equipment during the operating phase, in kilograms;

$S_{Destruct}$ = Quantity of gas *j* sent to destruction facilities, in kilograms;

S_{Recyc} = Quantity of gas *j* sent to off-site recycling facilities, in kilograms;

j = Type of gas.";

(h) by replacing "An emitter" in the part of QC.24.4 preceding paragraph 1 by "When using the calculation methods in QC.24.3.2 and QC.24.3.3, an emitter";

(25) in QC.25:

(a) by inserting "for fluidized bed boilers" after "equipment" in the third paragraph of QC.25.1;

(b) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.25.2 preceding subparagraph 1 of the first paragraph by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(c) by replacing "the calcination" in subparagraph *a* of subparagraph 3 of the first paragraph of QC.25.2 by "the average annual calcination";

(d) by replacing subparagraph 4 of the first paragraph of QC.25.2 by the following:

"(4) when the calculation method in QC.25.3.3 is used:

(a) the annual quantity of carbonate-based material output, in metric tons;

(b) the average annual carbonate content of each material input and output, in metric tons of carbonate per metric ton of material;";

(e) by striking out subparagraph 6 of the first paragraph of QC.25.2;

(f) by replacing "of the first paragraph does not apply" in the second paragraph of QC.25.2 by "and subparagraph *b* of subparagraph 4 of the first paragraph do not apply";

(g) by adding the following at the end of QC.25.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2, the emissions referred to in subparagraph 1 of the first paragraph are emissions attributable to fixed processes.";

(h) by replacing "Average annual content" in the definitions of the factors "$CC_{j,i}$" in equations 25-1 and 25-2 of QC.25.3.2 by "Average annual content";

(i) by replacing "four" by "procédé" in the French text of the definitions of factors "p," "k," "$OM_{k,\ i}$" and "$CC_{OMK,\ i}$" in equation 25-2 of QC.25.3.3;

(j) by replacing paragraphs 1 and 2 of QC.25.4 by the following:

"(1) when the calculation method in QC.25.3.2 is used, determine annually the calcination fraction for each carbonate used by sampling and chemical analysis, using an analysis method published by an organization listed in QC.1.5, or the value of 1.0;

(2) when the calculation method in QC.25.3.2 or QC.25.3.3 is used, determine the average annual carbonate content by calculating the arithmetic average of the monthly data obtained from raw material suppliers by sampling and chemical analysis using one of the following methods:

(a) the most recent version of ASTM C25 "Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime";

(b) the most recent version of ASTM C1301 "Standard Test Method for Major and Trace Elements in Limestone and Lime by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP) and Atomic Absorption (AA)";

(c) the most recent version of ASTM C1271 "Standard Test Method for X-ray Spectrometric Analysis of Lime and Limestone";

(d) any other analysis method published by an organization listed in QC.1.5;

(e) the value of 1.0;";

(k) in subparagraph 3 of QC.25.4:

i. by replacing “four” by “procédé” in the French text;

ii. by adding “or using a balance based on inventories at the start and end of the year” at the end;

(26) in QC.26:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of the first paragraph of QC.26.2 preceding subparagraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by striking out subparagraph 1 of the first paragraph of QC.26.2;

(c) by striking out “, calculated in accordance with QC.25” in subparagraph 2 of the first paragraph of QC.26.2;

(d) by striking out subparagraph 3 of the first paragraph of QC.26.2;

(e) by replacing subparagraph 4 of the first paragraph of QC.26.2 by the following:

“(4) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion equipment, calculated in accordance with QC.1, in metric tons;”;

(f) by replacing “moyenne annuelle en carbonates” in the French text of subparagraph 6 of the first paragraph of QC.26.2 by “en carbonates moyenne annuelle”;

(g) by striking out subparagraph 10 of the first paragraph of QC.26.2;

(h) by striking out “2, 3,” in the second paragraph of QC.26.2;

(i) by adding the following at the end of QC.26.2:

“For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraphs 3 and 4 of the first paragraph are emissions attributable to combustion.”;

(j) by replacing “An emitter” in the part of preceding paragraph 1 QC.26.4 by “When the calculation method in QC.26.3.2 is used, an emitter”;

(27) in QC.27:

(a) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.27.2 preceding paragraph 1 by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(b) by replacing paragraph 2 of QC.27.2 by the following:

"(2) the annual consumption of each fuel type, in kilolitres.";

(c) by replacing "methods in QC.27.3.1 to QC.27.3.3" in the first paragraph of QC.27.3 by "method in QC.27.3.1";

(d) by replacing QC.27.3.1 by the following:

"QC.27.3.1. Calculation of CO_2 emissions based on the quantity of fuel used

The annual CO_2 emissions attributable to mobile equipment used on-site at a facility or establishment must be calculated, for each type of fuel used, using equation 27-1:

Equation 27-1

$$CO_2 = Fuel \times EF \times 1000 \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to each type of fuel used by the mobile equipment, in metric tons;

Fuel = Annual volume of fuel used by the mobile equipment, in kilolitres;

EF = CO_2 emission factor for the fuel, as specified in Table 27-1 in QC.27.7, in kilograms per litre;

1000 = Conversion factor, litres to kilolitres;

0.001 = Conversion factor, kilograms to metric tons.";

(e) by striking out QC.27.3.2 and QC.27.3.3;

(f) by replacing "methods in QC.27.4.1 to QC.27.4.3" in the first paragraph of QC.27.4 by "method in QC.27.4.1";

(g) by replacing QC.27.4.1 by the following:

“QC.27.4.1. Calculation of CH_4 and N_2O emissions based on the quantity of fuel consumed

The annual CH_4 and N_2O emissions attributable to mobile equipment used on-site at a facility or establishment must be calculated, for each type of fuel used, using equation 27-2:

Equation 27-2

$$CH_4 \ or \ N_2O = Fuel \times EF \times 1000 \times 0.000001$$

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions attributable to each fuel type used by the mobile equipment, in metric tons;

Fuel = Annual volume of fuel used by the mobile equipment, in kilolitres;

EF = CH_4 or N_2O emission factor for the fuel, as specified in Table 27-1 in QC.27.7, in grams per litre;

1000 = Conversion factor, litres to kilolitres;

0.000001 = Conversion factor, grams to metric tons.”;

(h) by striking out QC.27.4.2 and QC.27.4.3;

(i) by replacing “quarterly” in paragraph 2 of QC.27.5 by “annually”;

(j) by replacing Table 27-1 by the following:

“**Table 27-1. Emission factors by fuel type**

(QC.27.3.1, QC.27.4.1)

Mobile equipment	**CO_2 (kg/l)**	**CH_4 (g/l)**	**N_2O (g/l)**
Natural gas vehicle	1.89	0.009	0.00006
Propane vehicle	1.510	0.64	0.028
Gasoline vehicle	2.289	2.7	0.050
Diesel vehicle	2.663	0.15	1.1
Diesel train	2.663	0.15	1.1
Biodiesel vehicle	2.449	0.15	1.1
Ethanol vehicle	1.494	2.7	0.050

.”;

(28) in QC.28:

(a) by replacing “The greenhouse gas emissions report referred to in section 6.2 must” in the part of QC.28.2 preceding paragraph 1 by “In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,”;

(b) by inserting “and reported” after “calculated” in paragraph 2 of QC.28.2;

(c) by replacing subparagraph 8 of QC.28.2 by the following:

“(8) the quantity of each fluorinated gas injected in each process or process category used, as determined in QC.28.4.2;”;

(d) by adding “in each process or process category used” at the end of subparagraph 9 of QC.28.2;

(e) by replacing “the apportioning factors” by “the apportioning of each fluorinated gas” in subparagraph 10 of QC.28.2;

(f) by striking out subparagraph 12 of QC.28.2;

(g) by adding the following at the end of QC.28.2;

“For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion;

(2) the emissions referred to in subparagraph 1 of the first paragraph are other emissions.”;

(h) by replacing “Rate of production of” by “Emission factor of” in the definition of the “P_{jk}” factor of equation 28-3 of the first paragraph of QC.28.3.1;

(i) by replacing “rate” by “emission factors (1-Ui) or P_{jk}” in subparagraph *a* of subparagraph 1 and in subparagraph 3 of the second paragraph of QC.28.3.1;

(j) by replacing equation 28-5 of QC.28.3.3 by the following:

“**Equation 28-5**

$$GHG_{HT,i} = \rho_i \times \left[\left(I_{D,i} - I_{F,i}\right) + \left(NC_{R,i} - NC_{N,i}\right) + \left(TF_{A,i} - TF_{T,i}\right)\right] \times 0.001$$

Where:

$GHG_{HT,i}$ = Annual greenhouse gas emissions attributable to the use of heat transfer fluid *i*, in metric tons;

i = Heat transfer fluid;

ρ_i = Density of heat transfer fluid *i*, in kilograms per litre;

$I_{D,i}$ = Quantity of heat transfer fluid *i* in inventory in containers at the beginning of the year, in litres;

$I_{F,i}$ = Quantity of heat transfer fluid *i* in inventory in containers at the end of the year, in litres;

$NC_{R,i}$ = Total nameplate capacity of equipment that uses heat transfer fluid *i* and that is removed from the facility during the year, in litres;

$NC_{N,i}$ = Total nameplate capacity of equipment that uses heat transfer fluid *i* and that is newly installed during the year, in litres;

$TF_{A,i}$ = Quantity of heat transfer fluid *i* acquired during the year, including amounts obtained from chemical suppliers and equipment suppliers and amounts of fluid returned to the facility after recycling, in litres;

$TF_{T,i}$ = Quantity of heat transfer fluid *i* transferred or sold during the year, including amounts returned to chemical suppliers, sent off-site for recycling or destroyed, in litres;

0.001 = Conversion factor, kilograms to metric tons.”;

(k) by replacing subparagraph 2 of QC.28.4.1 by the following:

“(2) by measuring the residual weight or pressure of a container when replacing it and, when the pressure is measured, by determining the residual weight using equation 28-9:

Equation 28-9

$$W_{r,i} = \frac{M_i \times p_i \times V_i}{Z_i \times R \times T_i}$$

Where:

$W_{r,i}$ = Residual weight of gas *i*, in grams;

M_i = Molar weight of gas *i*, in grams par mole;

p_i = Absolute pressure of gas *i*, in pascals;

V_i = Volume of gas *i*, in cubic metres;

Z_i = Compressibility factor of gas *i*;

R = Perfect gas constant of 8.314 joules par kelvin-mole;

T_i = Absolute temperature of gas *i*, in kelvin;”;

(l) by replacing QC.28.6 by the following:

“QC.28.6. Tables

Table 28-1. Default greenhouse gas emission factors for fluorinated compounds for processes and process categories for semiconductor manufacturing for 150 mm wafer size

(QC.28.3.1, QC.28.4.2)

Processes and process categories	**Gas *i***										
	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	c-C_4F_8	NF_3	SF_6	C_4F_6	C_5F_8	C_4F_8O
PATTERNING/ETCHING											
Oxide etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	S. O.	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitride etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Silicon etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Metal etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CHAMBER CLEANING											
In situ plasma cleaning											
$1-U_i$	0.8-0.95	0.4-0.8	N/A	N/A	0.2-0.6	0.05-0.3	0.05-0.3	N/A	N/A	0.05-0.2	0.05-0.2
P_{CF4}	N/A	0.05-0.2	N/A	N/A	0.05-0.2	0.05-0.2	0.05-0.2	N/A	N/A	0.05-0.2	0.05-0.2
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02-0.08
Remote plasma cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In situ thermal cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WAFER CLEANING											
Bevel cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ashing											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 28-2. Default greenhouse gas emission factors for fluorinated compounds for processes and process categories for semiconductor manufacturing for 200 mm wafer size

(QC.28.3.1, QC.28.4.2)

Processes and process categories	**Gas *i***										
	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	c-C_4F_8	NF_3	SF_6	C_4F_6	C_5F_8	C_4F_8O
PATTERNING/ETCHING											
Oxide etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.5	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitride etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.1-0.7	0.02-0.3	N/A	0.05-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.02-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.005-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silicon etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Metal etch											
$1-U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

CHAMBER CLEANING											
In situ plasma cleaning											
$1-U_i$	0.8-0.95	0.4-0.8	N/A	N/A	0.2-0.6	005-0.3	0.05-0.2	N/A	N/A	0.05-0.2	0.05-0.2
P_{CF4}	N/A	0.05-0.2	N/A	N/A	0.05-0.2	0.05-0.2	0.05-0.1	N/A	N/A	0.05-0.2	0.05-0.2
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.02-0.08
Remote plasma cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	0,005-0,03	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	0.0001-0.2	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In situ thermal cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WAFER CLEANING											
Bevel cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ashing											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 28-3. Default emission factors for processes and process categories for semiconductor manufacturing for 300 mm wafer size

(QC.28.3.1, QC.28.4.2)

Processes and process categories	**Gas *i***										
	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	$c\text{-}C_4F_8$	NF_3	SF_6	C_4F_6	C_5F_8	C_4F_8O
PATTERNING/ETCHING											
Oxide etch											
$1\text{-}U_i$	0.2-0.8	0.2-0.7	0.2-0.4	0.1-0.8	N/A	0.05-0.3	0.1-0.4	0.1-0.4	0.05-0.3	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.005-0.03	0.001-0.01	N/A	0.005-0.1	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.005-0.1	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitride etch											
$1\text{-}U_i$	0.2-0.8	0.2-0.7	0.2-0.4	0.1-0.8	N/A	0.08-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.003-0.1	0.01-0.1	N/A	0.02-0.3	N/A	N/A	0.05-0.4	0.05-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.02-0.3	N/A	N/A	0.05-0.4	0.05-0.4	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silicon etch											
$1\text{-}U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Metaletch											
$1\text{-}U_i$	0.2-0.8	0.2-0.7	0.2-0.7	0.02-0.3	N/A	0.1-0.3	0.1-0.4	0.1-0.4	0.05-0.2	0.05-0.3	N/A
P_{CF4}	N/A	0.05-0.5	0.01-0.8	0.05-0.1	N/A	0.01-0.3	N/A	N/A	0.02-0.4	0.02-0.4	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.01-0.3	N/A	N/A	0.02-0.3	0.02-0.3	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CHAMBER CLEANING											
In situ plasma cleaning											
$1\text{-}U_i$	N/A	N/A	N/A	N/A	N/A	N/A	0.1-0.4	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	0.001-0.6	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

In situ thermal cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	0.002-0.03	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	0.001-0.05	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In situ thermal cleaning											
$1-U_i$	N/A	N/A	N/A	N/A	N/A	N/A	0.1-0.4	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	0.005-.05	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WAFER CLEANING											
Bevel cleaning											
$1-U_i$	0.3-0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ashing											
$1-U_i$	0.3-0.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{CF4}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C2F6}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 28-4. Default emission factors for micro-electrical-mechanical systems manufacturing

(QC.28.3.1, QC.28.4.2)

Process type factors	**Gas *i***										
	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	c-C_4F_8	NF_3 remote	NF_3	SF_6	C_4F_6[a]	C_5F_8[a]	C_4F_8O[a]
Etch $1-U_i$	0.7	0.4[1]	0.4[1]	0.06[1]	N/A	0.2[1]	N/A	0.2	0.2	0.1	0.2	N/A
Etch P_{CF4}	N/A	0.4[1]	0.07[1]	0.08[1]	N/A	0.2	N/A	N/A	N/A	0.3[1]	0.2	N/A
Etch P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.2	N/A	N/A	N/A	0.2[1]	0.2	N/A
CVD $1-U_i$	0.9	0.6	N/A	N/A	0.4	0.1	0.02	0.2	N/A	N/A	0.1	0.1
CVD P_{CF4}	N/A	0.1	N/A	N/A	0.1	0.1	0.02[2]	0.1[2]	N/A	N/A	0.1	0.1
CVD P_{C3F8}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.4

[1] Estimate includes multi-gas etch processes.

[2] Estimate reflects presence of low-k, carbide and multi-gas etch processes that may contain a fluorinated GHG greenhouse gas additive.

Table 28-5. Default emission factors for LCD screen manufacturing

(QC.28.3.1, QC.28.4.2)

Process type factors	Gas *i*								
	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	c-C_4F_8	NF_3 remote	NF_3	SF_6
Etch 1-U_i	0.6	N/A	0.2	N/A	N/A	0.1	N/A	N/A	0.3
Etch P_{CF4}	N/A	N/A	0.07	N/A	N/A	0.009	N/A	N/A	N/A
Etch P_{CHF3}	N/A	N/A	N/A	N/A	N/A	0.02	N/A	N/A	N/A
Etch P_{C2F6}	N/A	N/A	0.05	N/A	N/A	N/A	N/A	N/A	N/A
CVD 1-U_i	N/A	N/A	N/A	N/A	N/A	N/A	0.03	0.3	0.9

Table 28-6. Default emission factors for photovoltaic cell manufacturing

(QC.28.3.1, QC.28.4.2)

Process type factors	Process gas *i*								
	CF_4	C_2F_6	CHF_3	CH_2F_2	C_3F_8	c-C_4F_8	NF_3 remote	NF_3	SF_6
Etch 1-U_i	0.7	0.4	0.4	N/A	N/A	0.2	N/A	N/A	0.4
Etch P_{CF4}	N/A	0.2	N/A	N/A	N/A	0.1	N/A	N/A	N/A
Etch P_{C2F6}	N/A	N/A	N/A	N/A	N/A	0.1	N/A	N/A	N/A
CVD 1-U_i	N/A	0.6	N/A	N/A	0.1	0.1	N/A	0.3	0.4
CVD P_{CF4}	N/A	0.2	N/A	N/A	0.2	0.1	N/A	N/A	N/A

";

(29) in QC.29:

(a) by adding "but including the pipelines and equipment necessary for deliveries to a customer located close to a transmission pipeline" at the end of paragraph 5 of QC.29.1;

(b) by replacing "The greenhouse gas emissions report referred to in section 6.2 must" in the part of QC.29.2 preceding subparagraph 1 of the first paragraph by "In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular,";

(c) by striking out subparagraph 1 of the first paragraph of QC.29.2;

(d) by inserting "and reported" after "calculated" in subparagraph 2 of the first paragraph of QC.29.2;

(e) by inserting “pneumatic” after “gas” in subparagraph ii of subparagraph *a* of subparagraph 3 of the first paragraph of QC.29.2;

(f) by replacing “QC.29.3.9” in subparagraph vi of subparagraph *a* and in subparagraphs *d*, *i* and *j* of subparagraph 3, in subparagraph v of subparagraph *a* and in subparagraph *d* of subparagraph 4, in subparagraph iii of subparagraph *a* and in subparagraph *d* of subparagraph 5, in subparagraph iv of subparagraph *a* and in subparagraph *d* of subparagraph 6 and in subparagraphs *g* and *h* of subparagraph 7 of the first paragraph of QC.29.2 by “QC.29.3.11”;

(g) by adding “or QC.29.3.8” at the end of subparagraph *b* of subparagraph 3 of the first paragraph of QC.29.2;

(h) by striking out “including third party hits” from subparagraph *i* of subparagraph 3 of the first paragraph of QC.29.2;

(i) by inserting “fugitive” after “annual” in subparagraph *j* of subparagraph 3 of the first paragraph of QC.29.2;

(j) by replacing subparagraph *k* of subparagraph 3 of the first paragraph of QC.29.2 by the following:

“*(k)* annual CO_2 and CH_4 emissions from natural gas transmission storage tanks, calculated in accordance with QC.29.3.10;

(l) annual CH_4 emissions attributable to third party pipeline hits, calculated in accordance with QC.29.3.9;”;

(k) by adding the following after subparagraph iv of subparagraph *a* of subparagraph 6 of the first paragraph of QC.29.2:

“v. annual CH_4 emissions attributable to third party pipeline hits, calculated in accordance with QC.29.3.9;”;

(l) by inserting “transmission and” after “natural gas” in the part of subparagraph 7 of the first paragraph of QC.29.2 preceding subparagraph *a*;

(m) by inserting the following after subparagraph *b* of subparagraph 7 of the first paragraph of QC.29.2:

“*(b.1)* annual CO_2 and CH_4 fugitive emissions from above ground meters and regulators at regulation and measurement stations, including fugitive emissions from the station equipment components, calculated in accordance with QC.29.3.8;”;

(n) by replacing subparagraph *f* of subparagraph 7 of the first paragraph of QC.29.2 by the following:

"*(f)* annual CO_2, CH_4 and N_2O emissions from transmission and distribution system flares and equipment flares connected to transmission and distribution system, calculated in accordance with QC.29.3.4;";

(*o)* by inserting "fugitive" before "emissions from other venting sources" in subparagraph *g* of subparagraph 7 of the first paragraph of QC.29.2;

(p) by striking out "to third party hits" in subpargraph *h* of subparagraph 7 of the first paragraph of QC.29.2;

(q) by adding the following after subparagraph *h* of subparagraph 7 of the first paragraph of QC.29.2:

"*(i)* annual fugitive CO_2 and CH_4 emissions from connection equipment, calculated in accordance with QC.29.3.8;

(j) annual CH_4 emissions attributable to third party pipeline hits, calculated in accordance with QC.29.3.9;

(k) annual venting emissions, namely:

i. emissions from high bleed pneumatic devices and natural gas driven pumps, calculated in accordance with QC.29.3.1;

ii. emissions from low bleed or intermittent bleed pneumatic devices, calculated in accordance with QC.29.3.2;";

(r) by "and reported" after "calculated" in subparagraph 8 of the first paragraph of QC.29.2;

(s) by inserting the following after subparagraph *d* of subparagraph 9 of the first paragraph of QC.29.2:

"*(d.1)* the emission factors used in replacement of those specified in Tables 29-1 to 29-5 in QC.29.6;";

(t) by replacing subparagraph ii of subparagraph *f* of subparagraph 9 of the first paragraph of QC.29.2 by the following:

"ii. compressor nameplate capacity, in kilowatts;";

(u) by replacing "le mode" in the French text of subparagraph iv of subparagraph *f* of subparagraph 9 of the first paragraph of QC.29.2 by "les modes";

(v) by adding the following after subparagraph iv of subparagraph *f* of subparagraph 9 of the first paragraph of QC.29.2:

"v. number of compressor starts during the year;";

(w) by adding the following after subparagraph ii of subparagraph *h* of subparagraph 9 of the first paragraph of QC.29.2:

"iii. the number of third party pipeline hits by volume of gas emitted to the atmosphere;";

(x) by striking out subparagraph 11 of the first paragraph of QC.29.2;

(y) by adding the following at the end of QC.29.2:

"For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 2 and 8 of the first paragraph are emissions attributable to combustion;

(2) the emissions referred to in subparagraphs 3 to 7 of the first paragraph are other emissions.";

(z) by replacing "QC.29.3.9" in the first paragraph of QC.29.3 by "QC.29.3.11";

(aa) by replacing "high bleed pneumatic device venting and natural gas driven pneumatic pump venting" in the part of QC.29.3.1 preceding equation 29-1 by "the venting of high bleed pneumatic devices, in other words devices with a venting flow rate above 0.17 m^3 per hour, and the venting of natural gas driven pneumatic pumps";

(bb) by replacing equations 29-1 to 29-4 of QC.29.3.1 by the following:

"**Equation 29-1**

$$GHG_i = GHG_{m,i} + GHG_{n-m,i}$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device venting and natural gas driven pneumatic pump venting, in metric tons;

$GHG_{m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device venting and natural gas driven pneumatic pump venting, calculated using equation 29-2 when the annual volume of natural gas consumed by the devices or pumps is measured, in metric tons;

$GHG_{n\text{-}m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device venting and natural gas driven pneumatic pump venting, when the annual volume of natural gas consumed by the devices or pumps is not measured, calculated using equation 29-3 for high bleed pneumatic devices and using equation 29-4 for natural gas driven pneumatic pumps, in metric tons;

i = CO_2 or CH_4;

Equation 29-2

$$GHG_{m,i} = V_{NG} \times MF_i \times \frac{MW_i}{MVC} \times 0.001$$

Where:

$GHG_{m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device venting or natural gas driven pneumatic pump venting, in metric tons;

V_{NG} = Measured annual volume of natural gas consumed by the high bleed pneumatic devices or natural gas driven pneumatic pumps, in cubic metres at standard conditions;

MF_i = Molar fraction of gas *i* in natural gas, determined in accordance with paragraph 3 of QC.29.4;

MW_i = Molecular weight of gas *i*, in kilograms per kilomole or, when a mass flowmeter is used, replace

$$\frac{MW}{MVC} \text{ by } 1;$$

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

Equation 29-3

$$GHG_{n-m,i} = \sum_{j=1}^{n} \left[D_j \times t_j \right] \times MF_i \times \rho_i \times 0.001$$

Where:

$GHG_{n-m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device venting, in metric tons;

n = Total number of high bleed pneumatic devices;

j = High bleed pneumatic device;

D_j = Natural gas flow for pneumatic device *j*, determined in accordance with paragraph 2 of QC.29.4.1 or using Table 29-6 in QC.29.6, in cubic metres per hour at standard conditions;

t_j = Annual operating time for pneumatic device *j*, in hours;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.29.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

Equation 29-4

$$GHG_{n-m,i} = \sum_{k=1}^{m} \left[Q_{NG,k} \times V_k \right] \times MF_i \times \rho_i \times 0.001$$

Where:

$GHG_{n-m,i}$ = Annual emissions of greenhouse gas *i* attributable to natural gas driven pneumatic pump venting, in metric tons;

m = Total number of natural gas driven pneumatic pumps;

k = Natural gas driven pneumatic pump;

$Q_{NG,k}$ = Quantity of natural gas consumed by the natural gas driven pneumatic pump *k*, determined in accordance with paragraph 3 of QC.29.4.1, in cubic metres per litre of liquid pumped at standard conditions;

V_k = Annual volume of liquid pumped, in litres;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.29.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.";

(cc) by replacing equation 29-5 of QC.29.3.2 by the following:

"Equation 29-5

$$GHG_i = \sum_j \left[N_j \times EF_j \times t_j\right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to low bleed or intermittent bleed natural gas pneumatic device venting, in metric tons;

j = Type of low bleed or intermittent bleed natural gas pneumatic device;

N_j = Number of pneumatic devices *j* determined in accordance with QC.29.4.2;

EF_j = Emission factor for pneumatic device *j* as specified in Tables 29-1 and 29-2 in QC.29.6, in cubic metres per hour at standard conditions, either

- indicated in Table 29-1, 29-2 or 29-6 in QC.29.6, for low bleed or intermittent bleed pneumatic devices that maintain operating conditions such as liquid level, pressure, pressure differential or temperature, or

- provided by the manufacturer for intermittent bleed pneumatic devices used for compressor startup;

t_j = Annual operating time for pneumatic device *j*, in hours;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.29.4;

ρ_i = Density of greenhouse gas *i*, of 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.”;

(dd) by replacing equation 29-6 of QC.29.3.3 by the following:

“**Equation 29-6**

$$GHG_i = \sum_{j=1}^{n} \left[N_j \times V_j \times \left(\frac{T_{SC}}{T_B \times P_{SC}} \right) \times \left(P_{b1} - P_{b2} \right) \right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to natural gas emissions to the atmosphere from equipment blowdown vent stacks, in metric tons;

n = Total number of types of equipment;

j = Type of equipment with the same gas volume in the blowdown equipment chambers between isolation valves;

N_j = Annual number of blowdowns for each equipment type *j*, determined in accordance with QC.29.4.3;

V_j = Total volume of gas in blowdown equipment chambers, between isolation valves, for equipment type *j*, determined in accordance with QC.29.4.3, in cubic metres;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_B = Temperature at blowdown conditions, in kelvin;

P_{b1}= Absolute pressure before blowdown, in kilopascals;

P_{b2} = Absolute pressure after blowdown or a value of 0 if the purge gas used is not CO_2 or CH_4, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.29.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.”;

(ee) by replacing “pentanes plus” in the definition of the factor “CA_k” in equation 29-7 of paragraph 1 of QC.29.3.4 by “pentane, 6 for hexane, and 7 for hexanes plus”;

(ff) by inserting “at standard conditions” after “cubic metres” in the definition of “V_G” and after “per cubic metre” in the definition of “HHV” in equation 29-9 in paragraph 3 of QC.29.3.4;

(gg) by replacing equation 29-10 in paragraph 2 of QC.29.3.5 by the following:

“**Equation 29-10**

$$GHG_i = \sum_{j=1}^{n}\left[\sum_{m=1}^{z}\left(F_{G,j} \times t_j\right)_m \times \left(1 - FG_j\right)\right] \times MF_i \times \left[\frac{T_{SC} \times P_{cc}}{T_{cc} \times P_{SC}}\right]_j \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to atmospheric centrifugal compressor vents, in metric tons;

n = Total number of centrifugal compressors;

j = Centrifugal compressor;

m = Operating mode of centrifugal compressor *j*;

z = Number of operating modes of centrifugal compressor *j*;

$F_{G,j}$ = Gas flow from the atmospheric vent of centrifugal compressor *j*, in operating mode *m*, determined in accordance with QC.29.4.5, in cubic metres per hour;

t_j = Annual operating time of centrifugal compressor *j* equipped with a wet seal oil degassing tank, in operating mode *m*, in hours;

FG_j = Portion of gas from the atmospheric vent of centrifugal compressor *j* that is recovered using a vapour recovery system or destined for another use, determined in accordance with QC.29.4.5, expressed as a percentage;

MF_i = Molar fraction of greenhouse gas *i* in the gas from atmospheric vents, determined in accordance with paragraph 3 of QC.29.4;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{cc} = Temperature at the atmospheric vent of centrifugal compressor, in kelvin;

P_{cc} = Pressure at the atmospheric vent of centrifugal compressor, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;”;

(hh) by replacing equation 29-11 of QC.29.3.6 by the following:

“**Equation 29-11**

$$GHG_i = \sum_{j=1}^{n} \left[\sum_{m=1}^{z} \left(F_{G,j} \times t_j \right) \times \left(1 - FG_j \right) \right] \times MF_i \times \left[\frac{T_{SC} \times P_{ca}}{T_{ca} \times P_{SC}} \right]_j \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to reciprocating compressor vents, in metric tons;

n = Total number of reciprocating compressors;

j = Reciprocating compressor;

z = Number of operating modes of reciprocating compressor *j*;

m = Operating mode of reciprocating compressor *j*;

$F_{G,j}$ = Gas flow from the venting of reciprocating compressor *j*, in operating mode *m*, determined in accordance with QC.29.4.6, in cubic metres per hour;

t_j = Annual operating time of reciprocating compressor *j*, in operating mode *m*, in hours;

FG_j = Quantity of gas from the vent of reciprocating compressor *j* that is recovered using a vapour recovery system, determined in accordance with paragraph 4 of QC.29.4.5, expressed as a percentage;

MF_i = Molar fraction of greenhouse gas *i* in gas from reciprocating compressor vents, determined in accordance with paragraph 3 of QC.29.4;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{ca} = Atmosheric temperature at the reciprocating compressor vent, in kelvin;

P_{ca} = Atmosheric pressure at the reciprocating compressor vent, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.";

(ii) by replacing the part of QC.29.3.7 preceding paragraph 1 by the following:

"Except for emissions from emission sources for which the total weight of CO_2 and CH_4 in the natural gas is below 10%, which must be calculated in accordance with QC.29.3.11, the annual fugitive CO_2 and CH_4 emissions attributable to leaks identified following a leak detection survey must be calculated in accordance with the following methods:";

(jj) by adding ", in the case of stations with emissions equal to or greater than 10,000 metric tons CO_2 equivalent" at the end of subparagraph i of subparagraph *c* of paragraph 1 of QC.29.3.7;

(kk) in equation 29-12 in paragraph 2 of QC.29.3.7,

i. by replacing the definition of the factor "N_j" by the following:

"N_j = Total number of components of type *j*;";

ii. by inserting "at standard conditions" after "cubic metres per hour" in the definition of the factor "EF_j";

(ll) in equation 29-13 in paragraph 2 of QC.29.3.7,

i. by replacing the definition of the factor "N_j" by the following:

"N_j = Total number of components of type *j*;";

ii. by inserting "at standard conditions" after "metric tons per hour" in the definition of the factor "EF_j";

iii. by replacing "with QC.29.4.7" by "with subparagraph 4 of QC.29.4.8" in the definition of factor "C_i";

(mm) by replacing the heading of QC.29.3.8 and the part preceding paragraph 1 of QC.29.3.8 by the following:

"QC.29.3.8. Calculation of fugitive CO_2 and CH_4 emissions attributable to all components not subject to a detection survey

Except for emissions from emission sources for which the total weight of CO_2 and CH_4 in the natural gas is below 10%, which do not need to be calculated, the annual fugitive CO_2 and CH_4 emissions attributable to all components not subject to a detection survey must be calculated in accordance with the following methods:";

(nn) by adding "in the case of stations with emissions below 10,000 metric tons CO_2 equivalent" at the end of subparagraph i of subparagraph *b* of paragraph 1 of QC.29.3.8;

(oo) in equation 29-14 in paragraphe 2 of QC.29.3.8,

i. by replacing the definition of the factor "N_j" by the following:

"N_j = Total number of components of type *j* determined in accordance with QC.29.4.8;";

ii. by inserting "at standard conditions" after "cubic metres per hour" in the definition of the factor "EF_j";

(pp) by replacing the definition of the factor "N_j" in equation 29-15 in paragraph 2 of QC.29.3.8 by the following:

"N_j = Total number of components of type *j*;";

(qq) by replacing QC.29.3.9 by the following:

“QC.29.3.9. Calculation of CH_4 emissions attributable to third party pipeline hits

The annual CH_4 emissions attributable to third party pipeline hits that are equal to or greater than 1.416 m^3 of CH_4 at standard conditions, must be calculated using equations 29-16 and 29-17 for catastrophic pipeline ruptures and pipeline puncture incidents when, as determined under paragraph 1 of QC.29.4.9, the flow is choked and using equation 29-18 for pipeline puncture incidents when the flow is not choked.

Equation 29-16

$$CH_4 = \frac{3.6\times10^6 \times A}{\rho_{ref}} \sqrt{\frac{K \times MW}{1000 \times Z \times R \times T}} \times \frac{P_a \times M}{\left(1+\frac{K-1}{2}M^2\right)^{\frac{K+1}{2(K-1)}}} \times Cd \times t \times \left[\frac{T_{SC} \times P_{ge}}{T_{ge} \times P_{SC}}\right] \times \rho_{ref} \times 0.001$$

Where:

CH_4 = Annual CH_4 emissions attributable to a third party pipeline hit or to a pipeline puncture incident when the flow is choked, in metric tons;

A = Leak area of the pipe, in square metres;

K = Specific heat ratio of CH_4, namely 1.299;

MW = Molecular weight of CH_4, namely 16.043 kg per mole;

M = Mach number of the flow, calculated using equation 29-17 when M is equal to or greater than 1 or a value of 1 in other cases;

ρ_{ref} = Density of CH_4, namely 0.690 kg per cubic metre at standard conditions;

T = Temperature inside pipe, in kelvin;

P_a = Absolute pressure inside the pipe, determined in accordance with paragraph 2 of QC.29.4.9, in kilopascals;

R = Universal gas constant, namely 8.3145 kPa m^3 per kilmole per kelvin;

Z = Compressibility factor of the gas, determined by the emitter or a default value of 1;

Cd = Discharge coefficient, determined by the emitter or a default value of 1;

t_j = Duration of venting following hit, in hours;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{ge} = Temperature of gas emitted, in kelvin;

P_{ge} = Absolute pressure of gas emitted, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

0.001 = Conversion factor, kilograms to metric tons;

Equation 29-17

$$M = \sqrt{\frac{2\left[\left(\frac{P_a}{P_e}\right)^{\frac{K-1}{K}} - 1\right]}{K-1}}$$

Where:

M = Mach number of the flow;

K = Specific heat ratio of CH_4, namely 1.299;

P_a = Absolute pressure inside the pipe, determined in accordance with paragraph 2 of QC.29.4.9, in kilopascals;

P_e = Absolute pressure at the damage point, in kilopascals;

Equation 29-18

$$CH_4 = \frac{A_e}{\rho_{ref}} \sqrt{\frac{2000 \cdot K}{K-1} P_a \rho_a \left[\left(\frac{P_{Atm}}{P_a}\right)^{2/K} - \left(\frac{P_{Atm}}{P_a}\right)^{(K+1)/K}\right]} \times Cd \times t \times \left[\frac{T_{SC} \times P_{ge}}{T_{ge} \times P_{SC}}\right] \times \rho_{ref} \times 0.001$$

Where:

CH_4 = Annual CH_4 emissions attributable to third party pipeline puncture incident when the flow is not choked, in metric tons;

A_e = Leak area in the pipe, in square metres;

K = Specific heat ratio of CH_4, namely 1.299;

ρ_{ref} = Density of CH_4, namely 0.690 kg per cubic metre at standard conditions;

ρ_a = Density of CH_4 inside the pipe at the puncture location, in kilograms per cubic metre;

P_a = Absolute pressure inside the pipe, determined in accordance with paragraph 3 of QC.29.4.9, in kilopascals;

P_{atm} = Absolute pressure at the damage point, in kilopascals;

R = Universal gas constant, namely 8.3145 kPa m^3 per kilmole per Kelvin;

Cd = Discharge coefficient, determined by the emitter or a default value of 1;

t = Duration of venting following puncture incident, in hours;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{ge} = Temperature of gas emitted, in kelvin;

P_{ge} = Absolute pressure of gas emitted, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

0.001 = Conversion factor, kilograms to metric tons.

QC.29.3.10. Calculation of CO_2 and CH_4 emissions attributable to transmission storage tanks

Except for emissions sent to flares, which must be calculated in accordance with QC.29.3.4 using the quantities measured in accordance with paragraph 1 of QC.29.4.10, the annual CH_4 and CO_2 emissions attributable to compressor scrubber dump valve leakage from condensate storage tanks for either water or hydrocarbon connected to transmission storage tanks, must be calculated using equation 29-19:

Equation 29-19

$$GHG_i = \sum_{j=1}^{n} \left[EF \times t\right]_j \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to compressor scrubber dump valve leakage from condensate storage tanks connected to transmission storage tanks, in metric tons;

n = Number of equipments;

j = Device;

EF = Emission factor for leakage from device *j*, determined in accordance with QC.29.4.10, in metric tons per hour;

t = Duration of leakage from device *j*, determined in accordance with QC.29.4.10, in hours;

MF_i = Molar fraction of greenhouse gas *i* in gas from reciprocating compressor vents, determined in accordance with paragraph 3 of QC.29.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.29.3.11. Calculation of fugitive emissions from other sources

Fugitive emissions from other sources that are not calculated using the methods in QC.29.3.1 to QC.29.3.10 must be calculated in accordance with the following methods:

(1) the methods in the most recent version of "Methodology Manuel: Estimation of Air Emissions from the Canadian Natural Gas Transmission, Storage and Distribution System" published by Clearstone Engineering Ltd.;

(2) a sector specific method published by the Canadian Gas Association.";

(rr) by replacing the part of subparagraph 1 of QC.29.4 preceding subparagraph *a* by the following:

"(1) ensure that all instruments used for sampling, analysis and measurement are calibrated before the first emissions report and that for subsequent years they are calibrated and used in accordance with the instructions of the manufacturer or the methods and frequency published by the following organizations:";

(ss) by adding the following at the end of QC.29.4:

"Beginning on 1 January 2015, all high bleed pneumatic devices and natural gas driven pneumatic pumps must be equipped with meters.";

(tt) by replacing paragraph 1 of QC.29.4.1 by the following:

"(1) when using equation 29-2, determine the annual volume of natural gas consumed by high bleed pneumatic devices or natural gas driven pneumatic pumps using the measuring equipment installed on the device;";

(uu) by adding "If there is no similar device, the emitter must perform the calculation using the data in Table 29-1 in QC.29.6;" at the end of paragraph 2 and subparagraph *a* of subparagraph 3 of QC.29.4.1;

(vv) by inserting "natural gas driven" after "each" in subparagraph *b* of paragraph 3 of QC.29.4.1;

(ww) by striking out paragraph 3 of QC.29.4.3;

(xx) by replacing "and pentane-plus" in subparagraph ii of subparagraph *b* of paragraph 2 of QC.29.4.4 by ", pentane, hexane and hexane-plus";

(yy) by replacing paragraph 1 of QC.29.4.5 by the following:

"(1) determine the volume of gas from a wet seal oil degassing tank sent to an atmospheric vent or the volume of gas sent to a flare, using a temporary or permanent flow meter, for each operating mode, namely:

(a) the centrifugal compressor is in operating, standby pressurized mode and the gas emitted is from leaks in the blowdown vent stack;

(b) the centrifugal compressor is in operating mode;

(c) the centrifugal compressor is in not operating, depressurized mode; the gas emitted is from isolation valve leakage through the blowdown vent stack. In that case,

i. a centrifugal compressor that is not equipped with blind flanges must be sampled at least once in every 3 consecutive years;

ii. sampling is not required if a centrifugal compressor has been equipped with blind flanges for at least 3 consecutive years;

(zz) by inserting "for less than 200 hours per year" in paragraph 2 of QC.29.4.5 after "purpose";

(aaa) by replacing "is equipped with blind flanges for the entire 3 consecutive year period" in subparagraph ii of subparagraph *c* of paragraph 2 of QC.29.4.6 by "has been equipped with blind flanges for at least 3 consecutive years";

(bbb) by striking out subparagraph iii of subparagraph *c* of paragraph 2 of QC.29.4.6;

(ccc) by adding the following after subparagraph *c* of paragraph 2 of QC.29.4.6:

"(*d*) the reciprocating compressor is used for peaking purposes for no more than 200 hours per year and is not equipped with a meter; the volume of gas must be determined using data from meters installed on similar equipment;";

(*ddd*) by replacing "the CO_2 and CH_4 concentrations in natural gas using one of" in the part of QC.29.4.7 preceding subparagraph *a* of paragraph 2 by "emission factor for leakage from each type of device using";

(eee) by replacing subparagraph ii of subparagraph *d* of paragraph 2 of QC.29.4.8 by the following:

"ii. emission factor calculated using equation 29-20 for above ground meters and regulators at non-custody transfer gate stations:

Equation 29-20

$$EF_i = \frac{GHG_i \times 1000}{N \times \rho_i \times 8760}$$

Where:

EF_i = Enterprise-specific emission factor for above grade meters and regulators at non-custody transfer gate stations, in cubic metres per hour per component at standard conditions;

GHG_i = Annual emissions of greenhouse gas *i* from leaks from above ground meters and regulators at custody transfer gate stations, calculated in accordance with equation 29-12, in metric tons;

N = Total number of components, namely above grade meters and regulators, at custody transfer gate stations;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

1000 = Conversion factor, metric tons to kilograms;

8760 = Conversion factor, years to hours;

i = CH_4 or CO_2;";

(fff) by adding the following after QC.29.4.8:

"29.4.9. Emissions attributable to third party pipeline hits

For emissions attributable to third party pipeline hits, the emitter must

(1) for a pipeline puncture incident, determine whether or not the flow is choked using the following method:

If P atm / Pa $\geq$ 0.546 flow is not choked;

If P atm / Pa $<$ 0.546 flow is choked;

Where:

P_a = Absolute pressure inside the pipe, determined in accordance with paragraph 3 of QC.29.4.9, in kilopascals;

P_{atm} = Absolute pressure at the damage point, in kilopascals;

(2) determine the pressure inside the pipe:

(a) for a catastrophic pipeline rupture, at the place where the ruptured pipeline joins a larger pipeline;

(b) for a pipeline puncture incident, at the damage point.

29.4.10. Fugitive emissions from transmission storage tanks

For transmission storage tanks, the emitter must

(1) to measure compressor scrubber dump valve leakage from condensate storage tanks connected to transmission storage tanks, determine the emission factor for leaks from each type of component using the following methods:

(a) using equipment specific factors for the operation of the enterprise's equipment;

(b) using the method in the most recent version of "Methodology Manuel: Estimation of Air Emissions from the Canadian Natural Gas Transmission, Storage and Distribution System" published by Clearstone Engineering Ltd.;

(2) determine the duration of the equipment leakage, using the following methods:

(a) when only one leak detection survey is conducted each year, the emitter must assume that the component was leaking from the start of the year until the leak was repaired. If the leak was not repaired, the emitter must assume that the component was leaking for the entire year;

(b) when more than one leak detection survey is conducted each year, the emitter must assume that the component has been leaking since the last survey. If a leak was detected at the last survey, the emitter must assume that the component, unless the leak has been repaired, was leaking for the entire year.";

(ggg) by replacing Tables 29-1 to 29-5 in QC.29.6 by the following:

"**Table 29-1. Emission factors for natural gas leaks by component during compression for onshore transmission**

(QC.29.3.2, QC.29.3.4, (2), QC.29.4.7, (1))

Leaker emission factor by component type	
Component type	**Natural gas (metric tons/hour)**
Connector	4.484×10^{-5}
Block valve	1.275×10^{-4}
Control valve	8.205×10^{-5}
Compressor blowdown valve	5.691×10^{-3}
Pressure relief valve	5.177×10^{-4}
Orifice meter	2.076×10^{-4}
Other meter	3.493×10^{-7}
Regulator	1.125×10^{-4}
Open ended line	1.580×10^{-4}
Fugitive emission factors by component type	
Component type	**Total organic carbon (m^3/hour)**
Low bleed pneumatic device	5.07×10^{-2}
High bleed pneumatic device	5.69×10^{-1}
Intermittent bleed pneumatic device	5.69×10^{-1}
Pneumatic pump	$3.766 X10^{-1}$

Table 29-2. Emission factors for natural gas leaks by component type during underground storage

(QC.29.3.2, QC.29.3.4, (2), QC.29.4.7, (1), QC.29.4.8, (2))

Component type	Natural gas (m^3/hour)
Leaker emission factor by component type following a leak detection survey	
Valve	0.4268
Connector	0.1600
Open ended line	0.4967
Pressure relief valve	1.140
Meter	0.5560
Fugitive emission factor by component type	
Connector	2.8×10^{-4}
Valve	2.8×10^{-3}
Pressure relief valve	4.8×10^{-3}
Open ended line	8.5×10^{-4}
Low bleed pneumatic device	5.07×10^{-2}
High bleed pneumatic device	5.69×10^{-1}
Intermittent bleed pneumatic device	5.69×10^{-1}

Table 29-3. Emission factors for natural gas leaks by component type during liquefied natural gas storage

(QC.29.4.7, (1), QC.29.4.8, (2))

Component type	Natural gas (m^3/hour)
Leaker emission factor by component type following leak detection survey	
Valve	3.43×10^{-2}
Pump seal	1.15×10^{-1}
Connector	9.9×10^{-3}
Other	5.10×10^{-2}
Fugitive emission factor by component type	
Vapor recovery compressor	1.20×10^{-1}

Table 29-4. Emission factors for natural gas leaks by component type during imports and exports of liquid natural gas

(QC.29.4.7, (1), QC.29.4.8, (2))

Component type	**Natural gas (m^3/hour)**
Leaker emission factor by component type following leak detection survey	
Valve	3.43 x 10^{-2}
Pump seal	1.15 x 10^{-1}
Connector	9.90 x 10^{-3}
Other	5.10 x 10^{-2}
Fugitive emission factor by component type	
Vapor recovery compressor	1.20 x 10^{-1}

Table 29-5. Emission factors for natural gas leaks by component type during natural gas during distribution

(QC.29.4.7, (1), QC.29.4.8, (2))

Component type	**Natural gas (metric tons/hour)**
Connector	6.875 x 10^{-6}
Block valve	1.410 x 10^{-5}
Control valve	7.881 x 10^{-5}
Pressure relief valve	3.524 x 10^{-5}
Orifice meter	8.091 x 10^{-6}
Regulator	2.849 x 10^{-5}
Open ended line	1.216 x 10^{-4}
Component type	**Natural gas (m^3/hour)**
Below ground meter and regulator, inlet pressure greater than 300 psig	3.74 x 10^{-2}
Below ground meter and regulator, inlet pressure between 100 and 300 psig	5.7 x 10^{-3}
Below ground meter and regulator, inlet pressure below 100 psig	2.8 x 10^{-3}
Fugitive emission factor by type of distribution pipeline	
Pipeline type	**Natural gas (m^3/hour)**
Unprotected steel	1.83 x 10^{-1}
Protected steel	7.22 x 10^{-2}
Plastic	7.75 x 10^{-2}
Cast iron	7.83 x 10^{-1}

Fugitive emission factor by type of distribution pipeline	
Pipeline type	**Natural gas (m^3/hour)**
Unprotected steel	7.08×10^{-2}
Protected steel	3.23×10^{-2}
Plastic	1.04×10^{-2}
Copper	2.7×10^{-2}

Table 29-6. Average manufacturer bleed rates for certain liquid level controllers, positioners, pressure controllers, transducers and transmitters

(QC.29.3.1, QC.29.3.2)

Equipment type	**Manufacturer**	**Model**	**Operating condition**	**Manufacturer rate (m^3/hour)**
Liquid level controller	Bristol Babcock	Series 5453-Model 624-II	Continuous	0.0850
Liquid level controller	Fisher	2100	Continuous	0.0283
Liquid level controller	Fisher	2500	Continuous	1.1893
Liquid level controller	Fisher	2660	Continuous	0.0283
Liquid level controller	Fisher	2680	Continuous	0.0283
Liquid level controller	Fisher	2900	Continuous	0.6513
Liquid level controller	Fisher	L2	Continuous	0.0425
Liquid level controller	Invalco	AE-155	Continuous	1.5008
Liquid level controller	Invalco	CT Series	Continuous	1.1327
Liquid level controller	Norriseal	1001 (A) 'Envirosave'	Intermittent	0.0000
Liquid level controller	Norriseal	1001 (A) snap	Intermittent	0.0057
Liquid level controller	Norriseal	1001 (A) throttle	Intermittent	0.0002
Liquid level controller	Wellmark	2001 (snap)	Intermittent	0.0057
Liquid level controller	Wellmark	2001 (throttling)	Intermittent	0.0002
Positioner	Becker	EFP-2.0	Intermittent	0.0000
Positioner	Becker	HPP-5	Continuous	0.1416

Positioner	Fisher	3582	Continuous	0.4531
Positioner	Fisher	3590	Continuous	0.8495
Positioner	Fisher	3660	Continuous	0.1982
Positioner	Fisher	3661	Continuous	0.2959
Positioner	Fisher	3582i	Continuous	0.5833
Positioner	Fisher	3610J	Continuous	0.4531
Positioner	Fisher	3620J	Continuous	0.7532
Positioner	Fisher	DVC 5000	Continuous	0.2832
Positioner	Fisher	DVC 6000	Continuous	0.3964
Positioner	Fisher	Fieldview Digital	Continuous	0.8920
Positioner	Masoneilan	7400	Continuous	1.0477
Positioner	Masoneilan	4600B Series	Continuous	0.6796
Positioner	Masoneilan	4700B Series	Continuous	0.6796
Positioner	Masoneilan	4700E	Continuous	0.6796
Positioner	Masoneilan	SV	Continuous	0.1133
Positioner	Moore Products	73N-B	Continuous	1.0194
Positioner	Moore Products	750P	Continuous	1.1893
Positioner	PMV	D5 Digital	Continuous	0.0283
Positioner	Sampson	3780 Digital	Continuous	0.0283
Positioner	VCR	VP700 PtoP	Continuous	0.0283
Pressure controller	Ametek	Series 40	Continuous	0.1699
Pressure controller	Becker	HPP-SB	Continuous	0.0000
Pressure controller	Becker	VRP-B-CH	Continuous	0.1416
Pressure controller	Becker	VRP-SB	Continuous	0.0000
Pressure controller	Becker	VRP-SB Gap Controller	Continuous	0.0000
Pressure controller	Becker	VRP-SB-CH	Continuous	0.0000
Pressure controller	Becker	VRP-SB-PID Controller	Continuous	0.0000
Pressure controller	Bristol Babcock	Series 5453-Model 10F	Continuous	0.0850
Pressure controller	Bristol Babcock	Series 5455-Model 624-III	Continuous	0.0708
Pressure controller	CSV	4150	Continuous	0.6853
Pressure controller	CSV	4160	Continuous	0.6853
Pressure controller	Dyna-Flow	4000	Continuous	0.6853

Pressure controller	Fisher	2506	Continuous	0.6853
Pressure controller	Fisher	2516	Continuous	0.6853
Pressure controller	Fisher	4150	Continuous	0.7362
Pressure controller	Fisher	4160	Continuous	0.7362
Pressure controller	Fisher	4194	Continuous	0.1203
Pressure controller	Fisher	4195	Continuous	0.1203
Pressure controller	Fisher	4660	Continuous	0.1416
Pressure controller	Fisher	4100 (large orifice)	Continuous	1.4158
Pressure controller	Fisher	4100 (small orifice)	Continuous	0.4248
Pressure controller	Fisher	C1	Continuous	0.1472
Pressure controller	Fisher	DVC 6010	Continuous	0.0878
Pressure controller	Foxboro	43AP	Continuous	0.5097
Pressure controller	ITT Barton	338	Continuous	0.1699
Pressure controller	ITT Barton	358	Continuous	0.0510
Pressure controller	ITT Barton	359	Continuous	0.0510
Pressure controller	ITT Barton	335P	Continuous	0.1699
Pressure controller	ITT Barton	335P	Continuous	0.1699
Transducer	Bristol Babcock	9110-00A	Continuous	0.0119
Transducer	Bristol Babcock	Series 502 A/D	Continuous	0.1671
Transducer	Fairchild	TXI 7800	Continuous	0.2407
Transducer	Fisher	546	Continuous	0.8495
Transducer	Fisher	646	Continuous	0.2209
Transducer	Fisher	846	Continuous	0.3398
Transducer	Fisher	i2P-100	Continuous	0.2832

Transmitter	Bristol Babcock	Series 5457-70F	Continuous	0.0850
Transmitter	ITT Barton	273A	Continuous	0.0850
Transmitter	ITT Barton	274A	Continuous	0.0850
Transmitter	ITT Barton	284B	Continuous	0.0850
Transmitter	ITT Barton	285B	Continuous	0.0850

";

(30) by replacing QC.30.4 by the following:

"QC.30.4. Sampling, analysis and measurement requirements

An emitter who operates an enterprise that distributes fuel must ensure that the instruments used to measure quantities of fuel are calibrated in accordance with the following methods:

(1) calibrate, prior to the first emissions report and for subsequent years in accordance with the instructions of the manufacturer, at the maximum frequency specified by the manufacturer or once per year;

(2) in accordance with the methods, frequency and specifications determined by Measurement Canada.";

(31) by adding the following after QC.30:

"QC.31. TITANIUM DIOXIDE PRODUCTION

QC.31.1. Covered sources

The covered sources are all the chloride processes used for the production of titanium dioxide.

QC.31.2. Greenhouse gas reporting requirements

In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular, include the following information:

(1) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion units, calculated and reported in accordance with QC.1, in metric tons;

(2) the annual CO_2 emissions attributable to the coke used in the chloride process as a reducing agent, in metric tons;

(3) the annual quantity of coke used in the chloride process as a reducing agent, in metric tons;

(4) the average annual carbon content of the coke used in the chloride process as a reducing agent, in metric tons of carbon per metric ton of carbonaceous material;

(5) the annual quantity of waste, in dry metric tons;

(6) the average annual carbon content of the waste, in metric tons of carbon per dry metric ton of waste;

(7) the number of times that the methods for estimating missing data provided for in QC.31.5 were used;

(8) the annual quantity of each product used to calculate the quantity of titanium oxide pigment equivalent, in metric tons;

(9) the annual quantity of titanium oxide pigment equivalent, in metric tons.

Subparagraphs 5 to 7 of the first paragraph do not apply to the CO_2 emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraph 3 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 2 of the first paragraph are emissions attributable to combustion.

QC.31.3. Calculation methods for CO_2 emissions attributable to titanium dioxide processes

The annual CO_2 emissions attributable to titanium dioxide production processes must be calculated in accordance with one of the methods in QC.31.3.1 and QC.31.3.2.

QC.31.3.1. Use of a continuous emission monitoring and recording system

The annual CO_2 emissions may be calculated using data from a continuous emission monitoring and recording system in accordance with QC.1.3.4.

QC.31.3.2. Calculation by mass balance

The annual CO_2 emissions attributable to the carbonaceous materials used in the chloride process as reducing agents may be calculated using equation 31-1:

Equation 31-1

$$CO_2 = [[RA \times CC_{RA}] - [M_{waste} \times CC_{waste}] - [LS \times CC_{LS}]] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the coke used in the chloride process as a reducing agent, in metric tons;

RA_i = Annual consumption of coke used in the chloride process as a reducing agent, in metric tons;

CC_{RA} = Average annual carbon content of the coke used in the chloride process as a reducing agent in month *i*, in metric tons of carbon per metric ton of coke;

M_{waste} = Annual quantity of waste, in dry metric tons;

CC_{waste} = Average annual carbon content of waste, in metric tons of carbon per dry metric ton of waste;

LS = Annual quantity of limestone used, in metric tons;

CC_{LS} = Average annual carbon content of limestone, in metric tons of carbon per metric ton of limestone;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.31.4. Sampling, analysis and measurement requirements

When the calculation method in QC.31.3.2 is used, an emitter who operates a facility or establishment that produces titanium dioxide must

(1) determine the carbon content of the coke, either by using data from the material supplier or by analyzing a minimum of 3 representative samples per year using one of the following methods:

(a) the most recent version of ASTM D5373 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal”;

(b) the most recent version of ASTM D3176 “Standard Practice for Ultimate Analysis of Coal and Coke”;

(c) any other analysis method published by an organization listed in QC.1.5;

(2) calculate the annual quantity of coke used, using the same plant instruments used for inventory purposes, such as weigh hoppers or belt weigh feeders or using the supply documentation;

(3) based on the data determined in accordance with paragraph 1, calculate annually the average annual carbon content of the coke using equation 1-18 in QC.1.5.5 by replacing the quantity of fuel by the quantity of coke;

(4) determine annually the average carbon content of the waste using an annual composite sample based on monthly composite samples in accordance with the most recent version of method MA. 310-CS 1 of the Centre d'expertise en analyse environnementale du Québec;

(5) determine annually the average carbon content of limestone in accordance with an analysis method published by an organization referred to in QC.1.5;

(6) calculate the annual quantity of waste used by weighing the waste using the same plant instruments as those used for inventory purposes, such as mass balances, weigh hoppers or belt weight feeders;

(7) calculate the annual quantity of each product used to determine the annual quantity of titanium oxide pigment equivalent by weighing the products using the same plant instruments as those used for inventory purposes, such as weigh hoppers or belt weight feeders.

QC.31.5. Methods for estimating missing data

When, in conducting sampling activities, an emitter is unable to obtain analytical data, the original sample, back-up sample or replacement sample must be analyzed again, using the methods prescribed in this protocol, for the same measurement and sampling periods.

When sampling or measurement data required by this protocol for the calculation of emissions is missing, the emitter must demonstrate that everything possible has been done to ensure that 100% of the data is sampled. The emitter must then use replacement data determined as follows:

(1) for an emitter who uses one of the calculation methods in this protocol:

(a) when the missing value concerns carbon content or other sampled data, the emitter must

i. determine the sampling or measurement rate using the following equation:

Equation 31-2

$$S = Q_{EReal} / Q_{EReq}$$

Where:

S = Actual sampling rate or measurement rate, expressed as a percentage;

Q_{EReal} = Actual number of samples or measurements carried out by the emitter;

Q_{EReq} = Number of samples or measurements required under QC.31.4;

ii. for data requiring sampling or analysis, the emitter must

- when T ≥ 0.9: replace the missing value by the arithmetic average of the data sampled or measured immediately preceding and following the missing data period. If no data are available prior to the missing data period, the emitter must use the first data obtained after the missing data period;

- when 0.75 ≤ T< 0.9: replace the missing value by the highest value sample or analyzed during the report year for which the calculation is made;

- when T < 0.75: replace the missing value by the highest value sample or analyzed during the 3 preceding years;

(b) when the missing value concerns coke consumption, the annual quantity of each product used to determine the annual quantity of titanium oxide pigment equivalent, the quantity of waste or the quantity of limestone, the replacement value must be estimated on the basis of all the data relating to the processes used;

(2) for an emitter who uses a continuous emission monitoring system, apply the procedure in the EPS 1/PG/7 protocol entitled “Protocols and performance specifications for continuous monitoring of gaseous emissions from thermal power generation” published in November 2005 by Environment Canada or apply the method in subparagraph *a* of paragraph 2 of QC.1.6 to the missing parameters.

QC.32. TITANIUM DIOXIDE SLAG FROM ILMENITE REDUCTION AND MOLTEN CAST IRON TREATMENT

QC.32.1. Covered sources

The covered sources are processes of titanium dioxide slag production from ilmenite reduction and molten cast iron treatment.

QC.32.2. Greenhouse gas reporting requirements

In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular, include the following information:

(1) the total annual CO_2 emissions attributable to ilmenite reduction, in metric tons;

(2) the total annual CO_2 emissions attributable to molten cast iron treatment, in metric tons;

(3) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion units, calculated and reported in accordance with QC.1, in metric tons;

(4) for the ilmenite reduction process:

(*a*) the annual consumption of each type of ilmenite, in metric tons;

(*b*) the annual consumption of each material used, other than ilmenite, that contributes 0.5% or more of the total carbon in the process, in metric tons;

(*c*) the annual consumption of carbon electrodes, in metric tons;

(*d*) the annual production of molten cast iron, in metric tons;

(*e*) the annual production of titanium dioxide (TiO_2) slag, in metric tons;

(*f*) the annual quantity of air pollution control residue collected, in metric tons;

(*g*) the annual quantity of waste other than those referred to in subparagraph *f*, in metric tons;

(5) in the calculation of the treatment of molten cast iron:

(a) in the annual consumption of molten cast iron, in metric tons;

(b) in the annual consumption of each material used, other than ilmenite, that contributes 0.5% or more of the total carbon in the process, in metric tons;

(c) the annual production of treated cast iron, in metric tons;

(d) the annual quantity of slag produced, in metric tons;

(e) the annual quantity of waste from the antipollution system, in metric tons;

(f) the annual quantity of waste other than those referred to in subparagraph *e*, in metric tons;

(6) the carbon content of the materials and products in the ilmenite reduction process and molten cast iron treatment process referred to in subparagraphs 4 and 5 that contribute 0.5% or more of the total carbon in the process, in metric tons of carbon per metric ton of material and products;

(7) the number of times that the methods for estimating missing data provided for in QC.32.5 were used.

Subparagraph 6 of the first paragraph does not apply to the CO_2 emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in paragraphs 1 and 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in paragraph 3 of the first paragraph are emissions attributable to combustion.

QC.32.3. Calculation methods for CO_2 emissions

The emitter must calculate the annual CO_2 emissions attributable to ilmenite reduction and molten cast iron treatment processes in accordance with one of the methods in QC.32.3.1 to QC.32.3.3.

QC.32.3.1. Use of a continuous emission monitoring and recording system

The annual CO_2 emissions attributable to ilmenite reduction and molten cast iron treatment processes may be calculated using data from a continuous emission monitoring and recording system in accordance with QC.1.3.4.

QC.32.3.2. Calculation of annual CO_2 emissions attributable to the ilmenite reduction process

The annual CO_2 emissions attributable to the ilmenite reduction process may be calculated using equation 32-1. Materials or products whose carbon content contributes less than 0.5% of the carbon in the process do not need to be considered in the calculation.

Equation 32-1

$$CO_2 = \left[\sum_{i=1}^{n} \left(IL_i \times CC_{IL,i} \right) + \sum_{k=1}^{p} \left(M_k \times CC_{M,k} \right) + \left(EL \times CC_{EL} \right) - \left(I \times CC_I \right) - \left(SL \times CC_{SL} \right) - \left(R \times CC_R \right) - \left(W \times CC_W \right) \right] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to ilmenite reduction, in metric tons;

n = Number of types of ilmenite;

i = Type of ilmenite;

IL_i = Annual consumption of ilmenite *i*, in metric tons;

$CC_{IL, i}$ = Average annual carbon content of ilmenite *i*, in metric tons of carbon per metric ton of ilmenite *i*;

p = Number of materials other than ilmenite used;

k = Material other than ilmenite used;

M_k = Annual quantity of each material *k* other than ilmenite used, in metric tons;

$CC_{M,k}$ = Average annual carbon content of each material *k* other than ilmenite used, in metric tons of carbon per metric ton of material *k*;

EL = Annual consumption of carbon electrodes, in metric tons;

CC_{EL} = Average annual carbon content of the carbon electrodes, in metric tons of carbon per metric ton of carbon electrodes;

I = Annual production of molten cast iron, in metric tons;

CC_I = Average annual carbon content of the molten cast iron produced, in metric tons of carbon per metric ton of molten cast iron;

SL = Annual production of TiO_2 slag, in metric tons;

CC_{SL} = Average annual carbon content of the TiO_2 slag, in metric tons of carbon per metric ton of TiO_2 slag;

R = Annual quantity of air pollution control residue collected, in metric tons;

CC_R = Average annual carbon content of the air pollution control residue collected, in metric tons of carbon per metric ton of residue;

W = Annual quantity of other waste produced, in metric tons;

CC_W = Average annual carbon content from other waste produced or a default value of 0, in metric tons of carbon per metric ton of waste;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.32.3.3. Calculation of annual CO_2 emissions attributable to the treatment of cast iron

The annual CO_2 emissions attributable to the treatment of molten cast iron may be calculated using equation 32.2. Materials or products whose carbon content contributes less than 0.5% of the carbon in the process do not need to be considered in the calculation.

Equation 32-2

$$CO_2 = \left[(IT \times C_{IT}) + \sum_{k=1}^{p} (M_k \times C_{M,k}) - \sum_{i=1}^{n} (IP_i \times C_{IP,i}) - (SL \times C_{SL}) - (R \times C_R) - (Rp \times C_{Rp}) \right] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the treatment of molten cast iron, in metric tons;

IT = Annual quantity of molten cast iron treated, in metric tons;

C_{IT} = Average annual carbon content of molten cast iron treated, in metric tons of carbon per metric ton of molten cast iron;

p = Number of materials used other than molten cast iron;

k = Material used other than molten cast iron;

M_k = Annual quantity of each material *k* used, other than molten cast iron, in metric tons;

$C_{M,k}$ = Annual average carbon content of each material *k* used, other than molten cast iron, in metric tons of carbon per metric ton of material;

IP_i = Annual quantity of molten cast iron produced after treatment, in metric tons;

$C_{IP,i}$ = Average annual carbon content of molten cast iron after treatment, in metric tons of carbon per metric ton of molten cast iron after treatment;

n = Number of types of molten cast iron;

i = Type of molten cast iron;

SL = Annual quantity of slag produced, in metric tons;

C_{SL} = Average annual carbon content of slag produced or a default value of 0, in metric tons of carbon per metric ton of slag produced;

R = Annual quantity of air pollution control residue collected, in metric tons;

C_R = Average annual carbon content of air pollution control residue collected or a default value of 0, in metric tons of carbon per metric ton of residue;

Rp = Annual quantity of other residue produced, in metric tons;

C_{Rp} = Average annual carbon content of other residue produced or a default value of 0, in metric tons of carbon per metric ton of residue;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.32.4. Sampling, analysis and measurement requirements

QC.32.4.1. Carbon content

When the calculation methods in QC.32.3.2 and QC.32.2.3 are used, the emitter who operates a facility or establishment that uses an ilmenite reduction process and a molten cast iron treatment process must, for materials or products whose carbon content contributes 0.5% or more of the carbon in the process, use the data provided by the supplier or determine the carbon content by analyzing a minimum of 3 representative samples per year using the following methods:

(1) for fossil fuels, in accordance with QC.1.5.5;

(2) for the materials used in the ilmenite reduction process or the TiO_2 slag produced, in accordance with an analysis method published by an organization referred to in QC.1.5;

(3) for coal, coke and the carbon electrodes used in electric arc furnaces, using the most recent version of ASTM D5373 “Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal”, or using any other analysis method published by an organization listed in QC.1.5;

(4) for fuels, feedstock or liquid products, using the most recent version of ASTM D7582 “Standard Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis”, or using any other analysis method published by an organization listed in QC.1.5;

(5) for molten cast iron, using the most recent version of ASTM E1019 “Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques” or ASTM E415 “Standard Test Method for Atomic Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel”, or using any other analysis method published by an organization listed in QC.1.5;

(6) for slag, air pollution control residue or other residue, using an analysis method published by an organization listed in QC.1.5 or using a default value of 0.

QC.32.4.2. Consumption of process materials

The emitter must determine the quantity of solid, liquid and gaseous materials and the quantities required for the calculation in equation 32-1 or 32-2 using the same plant instruments as those used for inventory purposes, such as weigh hoppers or belt weigh feeders.

QC.32.5. Methods for estimating missing data

When, in conducting sampling activities, an emitter is unable to obtain analytical data, the original sample, back-up sample or replacement sample must be analyzed again, using the methods prescribed in this protocol, for the same measurement and sampling periods.

When sampling or measurement data required by this protocol for the calculation of emissions is missing, the emitter must demonstrate that everything possible has been done to ensure that 100% of the data is sampled. The emitter must then use replacement data determined as follows:

(1) for an emitter who uses one of the calculation methods in this protocol:

(a) when the missing value concerns carbon content or another sampled value, the emitter must

i. determine the sampling or measurement rate using the following equation:

Equation 32-3

$$S = Q_{E\mathrm{Real}} / Q_{E\mathrm{Req}}$$

Where:

S = Actual sampling rate or measurement rate, expressed as a percentage;

Q_{EReal} = Actual number of samples or measurements carried out by the emitter;

Q_{EReq} = Number of samples or measurements required under QC.32.4;

ii. for data requiring sampling or analysis, the emitter must

- when T ≥ 0.9: replace the missing value by the arithmetic average of the data sampled or measured immediately preceding and following the missing data period. If no data are available prior to the missing data period, the emitter must use the first data obtained after the missing data period;

- when 0.75 ≤ T< 0.9: replace the missing value by the highest value sample or analyzed during the report year for which the calculation is made;

- when T < 0.75: replace the missing value by the highest value sample or analyzed during the 3 preceding years;

(b) when the missing value concerns the consumption of ilmenite, the consumption of raw materials, the consumption of carbon electrodes, the quantity of molten cast iron treated, the production of slag, the production of molten cast iron or the production of other by-products, the replacement value must be estimated on the basis of all the data relating to the processes used;

(2) for an emitter who uses a continuous emission monitoring system, apply the procedure in the EPS 1/PG/7 protocol entitled "Protocols and performance specifications for continuous monitoring of gaseous emissions from thermal power generation" published in November 2005 by Environment Canada or apply the method in subparagraph *a* of paragraph 2 of QC.1.6.

QC.33. OIL AND NATURAL GAS EXPLORATION AND PRODUCTION AND NATURAL GAS PROCESSING

QC.33.1. Covered sources

The covered sources are the following processes and equipment used for

(1) offshore petroleum and natural gas exploration and production from any temporary or permanent platform, which includes

(a) the use of equipment to extract hydrocarbons from submerged land;

(b) the use of equipment to transfer oil or natural gas to storage, transport vessels, or onshore, including secondary platform structures and storage tanks associated with the platform structure;

(2) onshore oil and natural gas exploration and production, which includes

(a) the use of equipment associated with wells, such as compressors, generators, storage facilities and piping, such as flowlines or intra-facility gathering lines;

(b) the use of portable non-self-propelled equipment, such as well drilling, completion and workover equipment;

(c) the use of gravity separation equipment;

(d) the use of auxiliary non-transportation-related equipment, including leased, rented or contracted equipment used in exploration and production, extraction, recovery, lifting, stabilization, separation or treating of petroleum and natural gas, including condensate;

(e) storage facilities and all systems engaged in gathering produced gas from multiple wells;

(f) all enhanced oil recovery (EOR) operations using CO_2;

(g) all exploration and production facilities located on islands, artificial islands or structures connected by a causeway to land or to an island or artificial island;

(3) onshore natural gas processing, which includes

(a) oil and condensate removal;

(b) water extraction;

(c) the separation of natural gas liquids;

(d) hydrogen sulphide (H_2S) and CO_2 removal;

(e) fractionation of natural gas liquids;

(f) the capture of CO_2 separated from natural gas streams for delivery outside the facility;

(g) field gathering or boosting stations that gather and process natural gas from multiple wellheads, and compress and transport natural gas (including but not limited to flowlines or intra-facility gathering lines or compressors) as feed to the natural gas processing plants;

(h) any other treatment process.

QC.33.2. Greenhouse gas reporting requirements

In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular, include the following information:

(1) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion units calculated and reported in accordance with QC.1 or, when process vent gas, field gas or any other type of gas is used, in accordance with QC.33.3.19, in metric tons;

(2) the annual CO_2, CH_4 and N_2O emissions attributable to the use of portable equipment, calculated and reported in accordance with QC.1 or, when process vent gas, field gas or any other type of gas is used, in accordance with QC.33.3.19, in metric tons;

(3) the annual fugitive emissions of CO_2, CH_4 and N_2O from offshore oil and gas exploration and production facilities originating from equipment leaks, venting and flares, calculated in accordance with QC.33.3.21, in metric tons;

(4) the annual CO_2, CH_4 and N_2O emissions from onshore oil and gas exploration and production facilities, in metric tons, specifying

(a) the annual CO_2 and CH_4 emissions attributable to high bleed pneumatic device venting and natural gas driven pneumatic pump venting, calculated in accordance with QC.33.3.1;

(b) the annual CO_2 and CH_4 emissions attributable to natural gas driven low bleed and intermittent bleed pneumatic device venting, calculated in accordance with QC.33.3.2;

(c) the annual CO_2 emissions attributable to acid gas scrubbing equipment, calculated in accordance with QC.33.3.3;

(d) the annual CO_2, CH_4 and N_2O emissions attributable to dehydrator venting, calculated in accordance with QC.33.3.4;

(e) the annual CO_2 and CH_4 emissions attributable to well venting for liquids unloading, calculated in accordance with QC.33.3.5;

(f) the annual CO_2 and CH_4 emissions attributable to natural gas well venting during completions or workovers, calculated in accordance with QC.33.3.6;

(g) the annual CO_2 and CH_4 emissions attributable to blowdown vent stacks, calculated in accordance with QC.33.3.7;

(h) the annual CH_4 emissions attributable to third party line hits, calculated in accordance with QC.33.3.8;

(i) the annual CO_2, CH_4 and N_2O emissions attributable to venting from storage tanks associated with onshore oil and natural gas exploration, production, processing and storage facilities, calculated in accordance with QC.33.3.9;

(j) the annual CO_2, CH_4 and N_2O emissions attributable to transmission storage tanks, calculated in accordance with QC.33.3.10;

(k) the annual CO_2, CH_4 and N_2O emissions attributable to well testing venting and flaring, calculated in accordance with QC.33.3.11;

(l) the annual CO_2, CH_4 and N_2O emissions attributable to associated gas venting and flaring, calculated in accordance with QC.33.3.12;

(m) the annual CO_2, CH_4 and N_2O emissions attributable to flare stacks, calculated in accordance with QC.33.3.13;

(n) the annual CO_2 and CH_4 emissions attributable to centrifugal compressor venting, calculated in accordance with QC.33.3.14;

(o) the annual CO_2 and CH_4 emissions attributable to reciprocating compressor venting, calculated in accordance with QC.33.3.15;

(p) the annual fugitive CO_2 and CH_4 emissions attributable to gathering pipeline equipment leaks, calculated in accordance with QC.33.3.17;

(q) the annual fugitive CO_2 and CH_4 emissions from equipment components such as valves, connectors, open ended lines, pressure relief valves, pumps, flanges, metrological instruments, loading arms, safety valves, stuffing boxes, compressor seals, dump lever arms, and breather caps for crude oil processing, calculated in accordance with QC.33.3.17;

(r) the annual CO_2 and CH_4 emissions attributable to Enhanced Oil Recovery (EOR) injection pump blowdown, calculated in accordance with QC.33.3.18;

(s) the annual fugitive emissions from other sources of fugitive emissions, calculated in accordance with QC.33.3.20;

(5) the annual CO_2, CH_4 and N_2O emissions from onshore natural gas processing facilities, in metric tons, specifying

(a) the annual CO_2 emissions attributable to acid gas scrubbing equipment, calculated in accordance with QC.33.3.3;

(b) the annual CO_2, CH_4 and N_2O emissions attributable to dehydrator venting, calculated in accordance with QC.33.3.4;

(c) the annual CO_2 and CH_4 emissions attributable to blowdown vent stacks, calculated in accordance with QC.33.3.7;

(d) the annual CO_2, CH_4 and N_2O emissions attributable to natural gas storage, calculated in accordance with QC.33.3.9;

(e) the annual CO_2, CH_4 and N_2O emissions attributable to flare stacks, calculated in accordance with QC.33.3.13;

(f) the annual CO_2 and CH_4 emissions attributable to centrifugal compressor venting, calculated in accordance with QC.33.3.14;

(g) the annual CO_2 and CH_4 emissions attributable to reciprocating compressor venting, calculated in accordance with QC.33.3.15;

(h) the annual fugitive CO_2 and CH_4 emissions from equipment components such as valves, connectors, open ended lines, pressure relief valves and meters, calculated in accordance with QC.33.3.16;

(i) the annual fugitive CO_2 and CH_4 emissions attributable to gathering pipeline component leaks, calculated in accordance with QC.33.3.17;

(j) the annual fugitive emissions from other fugitive emission sources, such as reciprocating compressor rod-packing vents and centrifugal compressor wet and dry seal vents, calculated in accordance with QC.33.3.20;

(6) the following data for each emission source referred to in paragraphs 2 to 4:

(a) the specific emission factors used in place of the values indicated in Tables 33-1 and 33-2 in QC.33.6;

(b) the number of natural gas driven pneumatic devices used, by type, namely high bleed, low bleed or intermittent bleed;

(c) the number of natural gas driven pneumatic pumps;

(d) the total throughput of acid gas scrubbing equipment;

(e) if glycol dehydrators are used, the number of dehydrators operated, specifying

i. the number of dehydrators with throughput less than 11 328 m^3 per day at standard conditions;

ii. the number of dehydrators with throughput equal to or greater than 11 328 m^3 per day at standard conditions;

(f) the number of wells vented to the atmosphere for liquids unloading;

(g) the number of third party line hits, including volumes of natural gas emitted to the atmosphere by hit;

(h) the number of gas wells venting during well completions, specifying

i. the number of conventional well completions;

ii. the number of well completions employing hydraulic fracturing;

(i) the number of wells vented during workovers;

(j) for each compressor used:

i. the type of compressor;

ii. where the aggregate rated power for the sum of compressors at the establishment is equal to or greater than 186.4 kW:

- the compressor driver capacity in kilowatts;
- the annual number of blowdowns;

iii. the number of compressor starts during the year;

(k) the number of EOR injection pump blowdowns;

(l) the number of wells tested;

(m) the number of wells venting or flaring associated gas;

(n) the number of wells being unloaded for liquids;

(o) the number of wells worked over;

(p) when the calculation methods in QC.33.3.16 and QC.33.3.17 are used:

i. the components of each emission source for which an emission factor is specified in Table 33-1, 33-2 or 33-3 in QC.33.6;

ii. the total number of leaks detected during annual leak detection surveys, for each source having an emission factor determined in accordance with QC.33.4.16;

(q) the quantity of oil produced, in barrels;

(r) the quantity of natural gas produced;

(7) the number of times that the methods for estimating missing data provided for in QC.33.5 were used.

The emissions attributable to well venting or to other fugitive emission sources or to the venting referred to in subparagraphs *q* and *s* of subparagraph 4 and in subparagraph *j* of subparagraph 5 of the first paragraph do not need to be reported when the emissions from a given source are less than 0.5% of the emitter's total emissions and when the total of the unreported emissions under this paragraph does not exceed 1% of the emitter's total emissions.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 1 and 2 of the first paragraph are emissions attributable to combustion;

(2) the emissions referred to in subparagraphs 3 to 5 of the first paragraph are other emissions.

QC.33.3. Calculation methods for CO_2, CH_4 and N_2O emissions

The annual CO_2, CH_4 and N_2O emissions attributable to oil and natural gas exploration and production and to natural gas processing must be calculated in accordance with one of the methods in QC.33.3.1 to QC.33.3.20.

When no calculation method is specified for an emissions source, the emitter must use sector-specific inventory practices.

QC.33.3.1. Calculation of CO_2 and CH_4 emissions attributable to high bleed pneumatic device venting and natural gas driven pneumatic pump venting

The annual CO_2 and CH_4 emissions attributable to venting from high bleed pneumatic devices, in other devices that bleed to the atmosphere at a rate in excess of 0.17 m^3 per hour, and to natural gas driven pneumatic pumps, must be calculated using equations 33-1 to 33-4:

Equation 33-1

$$GHG_i = GHG_{m,i} + GHG_{n-m,i}$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device and natural gas driven pneumatic pump venting, in metric tons;

$GHG_{m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device and natural gas driven pneumatic pump venting, calculated using equation 33-2 when the annual volume of natural gas consumed is metered, in metric tons;

$GHG_{n-m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device and natural gas driven pneumatic pump venting, calculated, when the annual volume of natural gas consumed by the devices is not metered, using equation 33-3 for high bleed pneumatic devices and equation 33-4 for natural gas driven pneumatic pumps, in metric tons;

i = CO_2 or CH_4;

Equation 33-2

$$GHG_{m,i} = V_{NG} \times MF_i \times \frac{MW_i}{MVC} \times 0.001$$

Where:

$GHG_{m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device and natural gas driven pneumatic pump venting, in metric tons;

V_{NG} = Annual volume of natural gas consumed by the high bleed pneumatic devices or natural gas driven pneumatic pumps, measured in accordance with paragraph 1 of QC.33.4.1, in cubic metres at standard conditions;

MF_i = Molar fraction of gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

MW_i = Molecular weight of gas *i*, in kilograms per kilomole;

MVC = Molar volume conversion factor (24.06 m^3 per kilomole at standard conditions);

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

Equation 33-3

$$GHG_{n-m,i} = \sum_{j=1}^{n}\left[B_j \times t_j\right] \times MF_i \times \rho_i \times 0.001$$

Where:

$GHG_{n-m,i}$ = Annual emissions of greenhouse gas *i* attributable to high bleed pneumatic device venting, in metric tons;

n = Total number of high bleed pneumatic devices;

j = High bleed pneumatic device;

B_j = Natural gas bleed rate for pneumatic device *j*, determined in accordance with paragraph 2 of QC.33.4.1, in cubic metres per hour at standard conditions;

t_j = Annual operating time of pneumatic device *j*, in hours;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

Equation 33-4

$$GHG_{n-m,i} = \sum_{k=1}^{m}\left[Q_{NG,k} \times V_k\right] \times MF_i \times \rho_i \times 0.001$$

Where:

$GHG_{n-m,i}$ = Annual emissions of greenhouse gas *i* attributable to natural gas driven pneumatic pump venting, in metric tons;

m = Total number of natural gas driven pneumatic pumps;

k = Natural gas driven pneumatic pump;

$Q_{NG,k}$ = Quantity of natural gas consumed by the natural gas driven pneumatic pump *k*, determined in accordance with paragraph 3 of

QC.33.4.1, in cubic metres per litre of liquid pumped at standard conditions;

V_k = Annual volume of liquid pumped, in litres;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.2. Calculation of CO_2 and CH_4 emissions attributable to natural gas driven low or intermittent bleed pneumatic device venting

The annual CO_2 and CH_4 emissions attributable to natural gas driven low or intermittent bleed pneumatic device venting must be calculated separately using equation 33-5:

Equation 33-5

$$GHG_i = \sum_j \left[N_j \times EF_j \times t_j\right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to natural gas driven low or intermittent bleed pneumatic device venting, in metric tons;

j = Type of natural gas driven low or intermittent bleed pneumatic device;

N_j = Number of pneumatic devices of type *j*, determined in accordance with QC.33.4.2;

EF_j = Emission factor for pneumatic device of type *j,* determined in accordance with paragraph 2 of 33.4.2, in cubic metres per hour at standard conditions;

t_j = Annual operating time for pneumatic device of type *j*, in hours;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.3. Calculation of CO_2 emissions attributable to acid gas scrubbing equipment

Except where acid gases emissions are re-injected into an oil/gas field or manifolded to a common flare stack or other equipment, which must be calculated in accordance with QC.33.3.13, the CO_2 emissions attributable to acid gas scrubbing equipment must be calculated in accordance with one of the following methods:

(1) using data obtained from a continuous emission monitoring and recording system in accordance with QC.1.3.4;

(2) when there is no continuous emission monitoring and recording system but an equipment to measure the quantity of gas emitted is available, using equation 33-6:

Equation 33-6

$$CO_2 = V_G \times MF_{CO2} \times \rho_{CO2} \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to acid gas scrubbing equipment, in metric tons;

V_G = Annual volume of unprocessed natural gas output from the acid gas scrubbing equipment, measured in accordance with paragraph 1 of QC.33.4.3, in cubic metres at standard conditions;

MF_{CO2} = Mole fraction of CO_2 in the unprocessed natural gas flow from the acid gas scrubbing equipment, determined in accordance with paragraph 2 of QC.33.4.3;

ρ_{CO2} = Density of CO_2, namely 1.893 kg per cubic metre, at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

(3) when there is no continuous emission monitoring and recording system and no equipment to measure the quantity of gas emitted, using equation 33-7:

Equation 33-7

$$CO_2 = V_G \times \frac{\left[MF_{CO2-in} \times \left(1 - MF_{H2S-out}\right) - MF_{CO2-out} \times \left(1 - MF_{H2S-in}\right)\right]}{\left(1 - MF_{H2S-out} - MF_{CO2-out}\right)} \times \rho_{CO2} \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to acid gas scrubbing equipment, in metric tons;

V_G = Annual volume of unprocessed natural gas flow into the acid gas scrubbing equipment, measured in accordance with paragraph 1 of QC.33.4.3, in cubic metres at standard conditions;

$MF_{CO2\text{-}in}$ = Mole fraction of CO_2 in unprocessed natural gas flow into the acid gas scrubbing equipment, determined in accordance with paragraph 2 of QC.33.4.3;

$MF_{CO2\text{-}out}$ = Mole fraction of CO_2 in unprocessed natural gas out of the acid gas scrubbing equipment, determined in accordance with paragraph 2 of QC.33.4.3;

$MF_{H2S\text{-}in}$ = Mole fraction of H_2S in unprocessed natural gas into the acid gas scrubbing equipment, determined in accordance with paragraph 3 of QC.33.4.3;

$MF_{H2S\text{-}out}$ = Mole fraction of H_2S in processed natural gas out of the acid gas scrubbing equipment, determined in accordance with paragraph 3 of QC.33.4.3;

ρ_{CO2} = Density of CO_2, namely 1.893 kg per cubic metre, at standard conditions;

0.001 = Conversion factor, kilograms to metric tons.

QC.33.3.4. Calculation of CO_2, CH_4 and N_2O emissions attributable to dehydrator vents

The annual CO_2, CH_4 and N_2O emissions attributable to dehydrator vents must be calculated using one of the following methods:

(1) determine the CO_2 and CH_4 emissions using a simulation software package such as GRI-GLYCalc, version 4, or AspenTech HYSYS^{MD}, or a similar software tool. The software or tool must use the Peng-Robinson equation of state to calculate the equilibrium coefficient, speciate CH_4 and CO_2 emissions from dehydrators and have provisions to include regenerator control devises, a separator flash tank, stripping gas and a gas injection pump or gas assist pump, specifying the following parameters:

(a) feed natural gas flow rate;

(b) feed natural gas water content;

(c) outlet natural gas water content;

(d) the type of absorbent circulation pump, namely natural gas pneumatic or air pneumatic or electric;

(e) absorbent circulation rate;

(f) absorbent type, such as triethylene glycol, diethylene glycol or ethylene glycol;

(g) use of stripping gas;

(h) use of flash tank separator and disposition of recovered gas ;

(i) hours operated;

(j) wet natural gas temperature and pressure;

(k) wet natural gas composition, determined in accordance with QC.33.4.4;

(2) for dehydrators that use desiccant, the emissions must be calculated from the amount of natural gas vented from the vessel every time it is depressurized for the desiccant refilling process, using equation 33-8:

Equation 33-8

$$GHG_i = \left(\frac{H \times D^2 \times \pi \times P_{atm} \times G \times 365}{4 \times P \times t} \right) \times \left[\frac{T_{SC} \times P_d}{T_d \times P_{SC}} \right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to dehydrator vents, in metric tons;

H = Height of the dehydrator vessel, in metres;

D = Inside diameter of the dehydrator vessel, in metres;

π = Pi, namely 3.1416;

P = Natural gas pressure, in kilopascals;

P_{atm} = Atmospheric pressure, in kilopascals;

G = Fraction of packed vessel volume that is natural gas;

t = Time between refilling, in days;

365 = Number of days in the year;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_d = Temperature at dehydrator vent, in kelvin;

P_d= Pressure at dehydrator vent, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(3) when the emissions attributable to dehydrator vents are directed to flares, the CO_2, CH_4 and N_2O emissions must be calculated in accordance with the method in QC.33.3.13, using the gas volume and composition determined in accordance with paragraph 1.

For the purposes of the emissions calculation under the first paragraph, where the dehydrator has a vapour recovery system, the emissions must be adjusted downward based on the emissions recovered.

QC.33.3.5. Calculation of CO_2 and CH_4 emissions attributable to well venting for liquids unloading

The annual CO_2 and CH_4 emissions attributable to well venting for liquids unloading must be calculated using one of the following methods:

(1) the annual CO_2 and CH_4 emissions attributable to well venting for liquids unloading may be calculated using equation 33-9:

Equation 33-9

$$GHG_i = \sum_{j=1}^{n} \left[N \times V \times t \right]_j \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to well venting for liquids unloading, in metric tons;

n = Number of groups of wells;

j = Groups of wells where liquids are unloaded;

N = Number of wells in the group;

V = Average flow of natural gas in the vent line used to vent gas from the representative well for group *j*, measured in accordance with paragraph 2 of QC.33.4.5, in cubic metres per hour at standard conditions;

t = Annual venting time for the representative well for group *j*, in hours;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(2) for wells venting for liquid unloading with plunger assist, the emissions may be calculated using equation 33-10:

Equation 33-10

$$GHG_i = \sum_{j} \left[\left(\frac{H \times D^2 \times \pi \times P \times N}{4 \times 101.325} \right) \left(V \times (t - 0.5) \times Z \right) \right]_j \times \left[\frac{T_{SC} \times P_{wv}}{T_{wv} \times P_{SC}} \right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to well venting for liquid unloading with plunger assist, in metric tons;

j = Well venting for liquid unloading with plunger assist;

H = Tubing depth to plunger bumper, in metres;

D = Inside diameter of well, in metres;

π = Pi, namely 3.1416;

P = Absolute pressure of natural gas, in kilopascals;

101.325 = Standard pressure, in kilopascals;

N = Number of vents per year;

V = Average flow rate of gas vented, in cubic metres per hour;

t = Time during which the well was left open to the atmosphere, in hours;

0.5 = Average venting time;

Z = Equal to 0 if $t < 0.5$, or equal to 1 if $t \geq 0.5$;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{wv} = Temperature at well vent, in kelvin;

P_{wv} = Absolute pressure at well vent, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.6. Calculation of CO_2, CH_4 and N_2O emissions attributable to natural gas well venting during completions or workovers

The annual CO_2, CH_4 and N_2O emissions attributable to natural gas well venting during completions or workovers must be calculated using one of the following methods:

(1) where the vented gas is directed to flares, according to the method in QC.33.3.13, using the volumes determined in accordance with paragraph 1 of QC.33.4.6;

(2) using equation 33-11:

Equation 33-11

$$GHG_i = \sum_j \left(V_{ve} - V_{CO2-N2} - V_{res}\right)_j \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to gas well venting during completions or workovers, in metric tons;

j = Gas well;

V_{ve} = Quantity of natural gas vented from well *j*, determined in accordance with paragraph 1 of QC.33.4.6, in cubic metres at standard conditions;

V_{CO2-N2} = Quantity of CO_2 or nitrogen (N_2) injected into well *j* during completion or workover, in cubic metres at standard conditions;

V_{res} = Quantity of natural gas from well *j* sent to the transmission or distribution system during completion or workover, in cubic metres at standard conditions;

MF_i = Molar fraction of greenhouse gas *i* in the gas vented from reciprocating compressor, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(3) where the flow regime is sonic or subsonic, using equation 33-12:

Equation 33-12

$$GHG_i = \sum_j \left(V_{ve-s} + V_{ve-ss} - V_{CO2-N2} - V_{res}\right)_j \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to gas well venting during completions or workovers, in metric tons;

j = Gas well;

V_{ve-s} = Quantity of natural gas emitted during sonic flow conditions from venting of well *j*, calculated in accordance with subparagraph *a*, in cubic metres at standard conditions;

V_{ve-ss} = Quantity of gas emitted during subsonic flow conditions from venting of well *j*, calculated in accordance with subparagraph *b*, in cubic metres at standard conditions;

V_{CO2-N2} = Quantity of CO_2 or N_2 injected into well *j* during completion or workover, in cubic metres at standard conditions;

V_{res} = Quantity of natural gas from well *j* sent to the transmission or distribution system during completion or workover, in cubic metres at standard conditions;

MF_i = Molar fraction of greenhouse gas *i* in the vented gas from reciprocating compressor, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(a) by determining the quantity of natural gas emitted during sonic flow conditions using the following method:

Equation 33-13

$$V_{ve-s} = \left(A \times \sqrt{187.08 \times T_{up}} \times t_s\right)_j \times 3600 \times \left[\frac{T_{SC} \times P_{wv}}{T_{wv} \times P_{SC}}\right]$$

Where:

$V_{ve\text{-}s}$ = Quantity of natural gas emitted during sonic flow conditions from venting of well *j*, in cubic metres at standard conditions;

A = Cross sectional area of the orifice, in square metres;

187.08 = Constant, in square metres per second squared per degree kelvin;

T_{up} = Temperature of gas upstream from the choke point, in kelvin;

t_s = Annual duration of venting from well *j* in during sonic flow conditions, in hours;

3600 = Conversion factor, seconds to hours;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{wv} = Temperature at well vent, in kelvin;

P_{wv} = Absolute pressure at well vent, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

j = Gas well;

(*b*) by determining the quantity of gas emitted during subsonic flow conditions from the venting of a well by calculating the total volume under the curve of a plot having the instantaneous flow rate of natural gas to the vent, determined using equation 33-14, as the Y-axis, and time as the X-axis, for the time period during which the well was flowing during subsonic conditions.

Equation 33-14

$$D_{ss} = \left(A \times \sqrt{3430 \times T_{up} \times \left[\left(\frac{P_{do}}{P_{up}} \right)^{1.515} - \left(\frac{P_{do}}{P_{up}} \right)^{1.758} \right]} \right)_j \times 3600 \times \left[\frac{T_{SC} \times P_{wv}}{T_{wv} \times P_{SC}} \right]$$

Where:

D_{ss} = Instantaneous flow rate of gas emitted during subsonic flow conditions from venting of well *j*, in cubic metres per hour at standard conditions;

A = Cross sectional area of the choke point, in square metres;

3430 = Constant, in square metres per second squared per degree kelvin;

T_{up} = Temperature of gas upstream from the choke point, in kelvin;

P_{do} = Absolute pressure downstream from the choke point, in kilopascals;

P_{up} = Absolute pressure upstream from the choke point, in kilopascals;

j = Gas well;

3600 = Conversion factor, seconds to hours;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{wv} = Temperature at well vent, in kelvin;

P_{wv} = Absolute pressure at well vent, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

QC.33.3.7. Calculation of CO_2 and CH_4 emissions attributable to blowdown vent stacks

The CO_2 and CH_4 emissions attributable to natural gas emissions to the atmosphere from equipment blowdown vent stacks, except equipment depressurizing to a flare, which must be calculated using QC.33.3.13, a dehydrator, which must be calculated using QC.33.3.4, over-pressure relief valve, which must be calculated using QC.33.3.16, or operating pressure control vale, which must be calculated using QC.33.3.1 and QC.33.3.3, must be calculated using equation 33-15:

Equation 33-15

$$GHG_i = \sum_{j=1}^{n} \left[N_j \times V_j \times \left(\frac{T_{SC}}{T_B \times P_{SC}} \right) \times \left(P_{d1} - P_{d2} \right) \right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to natural gas emissions to the atmosphere from equipment blowdown vent stacks, in metric tons;

n = Total number of types of equipment;

j = Type of equipment with the same natural gas volume in the blowdown equipment chambers between isolation valves;

N_j = Annual number of blowdowns for each equipment type *j*, determined in accordance with paragraph 2 of QC.33.4.7;

V_j = Total volume of natural gas in blowdown equipment chambers, between isolation valves, for equipment type *j*, determined in accordance with paragraph 1 of QC.33.4.7, in cubic metres;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_B = Temperature at blowdown conditions, in kelvin;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

P_{d1} = Absolute pressure before depressurization, in kilopascals;

P_{d2} = Absolute pressure after depressurization or a value of 0 if the equipment is purged using a gas other than CO_2 or CH_4, in kilopascals;

MF_i = Molar fraction of greenhouse gas *i* in natural gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.8. Calculation of CH_4 emissions attributable to third party line hits

The annual CH_4 emissions attributable to third party line hits that result in emissions equal to or greater than 1.416 m^3 of CH_4 at standard conditions must be calculated using equations 33-16 and 33-17 for catastrophic pipeline ruptures and pipeline puncture incidents when the flow is choked and using equation 33-18 for pipeline puncture incidents when the flow is not choked:

Equation 33-16

$$CH_4 = \frac{3.6x10^6 \times A}{\rho_s} \times \sqrt{\frac{K \times MW}{1000 \times R \times T}} \times \frac{P_a \times M}{\left(1+\frac{K-1}{2}M^2\right)^{\frac{K+1}{2(K-1)}}} \times t \times \left[\frac{T_{SC} \times P_{ge}}{T_{ge} \times P_{SC}}\right] \times \rho_s \times 0.001$$

Where:

CH_4 = Annual CH_4 emissions attributable to a third party catastrophic pipeline rupture or a pipeline puncture incident when the flow is choked, in metric tons;

A = Cross-sectional flow area of the pipe, in square metres;

ρ_s = Density of CH_4, namely 0.690 kg per cubic metre at standard conditions;

K = Specific heat ratio of CH_4, namely 1.299;

MW = Molecular weight of CH_4, namely 16.043 kg par kilomole;

R = Universal gas constant, namely 8.3145 kPa m^3 per kilomole per degree kelvin;

T = Temperature inside pipe, in kelvin;

P_a = Absolute pressure inside pipe, determined in accordance with paragraph 2 of QC.33.4.8, in kilopascals;

M = Mach number of the flow, calculated using equation 33-17 when M is equal to or smaller than 1 or a value of 1 in other cases;

t_j = Duration of the leak caused by a third party hit, in hours;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{ge} = Temperature of gas emitted, in kelvin;

P_{ge} = Absolute pressure of gas emitted, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

0.001 = Conversion factor, kilograms to metric tons;

Equation 33-17

$$M = \sqrt{\frac{2\left[\left(\frac{P_a}{P_e}\right)^{\frac{K-1}{K}} - 1\right]}{K-1}}$$

Where:

M = Mach number of the flow;

P_a = Absolute pressure inside pipe, determined in accordance with paragraph 2 of QC.33.4.8, in kilopascals;

P_e = Absolute pressure of ambient air at the damage point, in kilopascals;

K = Specific heat ratio of CH_4, namely 1.299;

Equation 33-18

$$CH_4 = \frac{A_e}{\rho_{ref}} \times \sqrt{\frac{2000 \times K}{K-1} \times P_a \times \rho_a \times \left[\left(\frac{P_{atm}}{P_a} \right)^{2/K} - \left(\frac{P_{atm}}{P_a} \right)^{(K+1)/K} \right]} \times t \times \left[\frac{T_{SC} \times P_{ge}}{T_{ge} \times P_{SC}} \right] \times \rho_{ref} \times 0.001$$

Where:

CH_4 = Annual CH_4 emissions attributable to third party pipeline puncture incident when the flow is not choked, in metric tons;

A_e = Size of the hole in the pipe, in square metres;

K = Specific heat ratio of CH_4, namely 1.299;

ρ_{ref} = Density of CH_4, namely 0.690 kg per cubic metre at standard conditions;

ρ_a = Density of CH_4 inside pipe at the damage point, in kilograms per cubic metre;

P_a = Absolute pressure inside pipe, determined in accordance with paragraph 3 of QC.33.4.8, in kilopascals;

P_{atm} = Absolute pressure at the damage point, in kilopascals;

R = Universal gas constant, namely 8.3145 kPa m^3 per kilomole per degree kelvin;

t_j = Duration of the leak caused by the puncture incident, in hours;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{ge} = Temperature of gas emitted, in kelvin;

P_{ge} = Absolute pressure of gas emitted, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

0.001 = Conversion factor, kilograms to metric tons.

QC.33.3.9. Calculation of CO_2, CH_4 and N_2O emissions attributable to venting from storage tanks associated with onshore oil and natural gas exploration, production, processing and storage facilities

The CO_2, CH_4 and N_2O emissions attributable to atmospheric pressure fixed roof storage tanks receiving hydrocarbon produced liquids from onshore oil and natural gas exploration and production facilities and onshore natural gas processing facilities must be calculated using one of the following methods:

(1) when the gas is directed to flares, using the method in QC.33.3.13 and the volumes determined in accordance with paragraph 6 of QC.33.4.9;

(2) in other cases, using equation 33-19:

Equation 33-19

$$GHG_i = \sum_j \left(GLR \times V \times MF_i\right)_j \times \rho_i \times 0.001$$

Where:

GHG_i = Emissions of greenhouse gas *i* attributable to atmospheric pressure fixed roof storage tanks receiving hydrocarbon produced liquids from onshore oil and natural gas exploration and production facilities and onshore natural gas processing facilities, in metric tons;

GLR= Gas oil ratio in storage tank *j*, determined in accordance with QC.33.4.9, in cubic metres of gas per cubic metre of liquid at standard conditions;

j = Atmospheric pressure fixed roof storage tank receiving hydrocarbon produced liquids from onshore oil and natural gas exploration and production facilities and onshore natural gas processing facilities;

V= Annual volume of liquid produced, determined in accordance with paragraph 6 of QC.33.4.9, in cubic metres;

MF_i = Molar fraction of greenhouse gas *i* in the gas, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(3) using the latest software package for E&P Tank (exploration and production tank) of the American Petroleum Institute and the following parameters to characterize emissions:

(a) separator oil composition;

(b) separator temperature;

(c) separator pressure;

(d) sales oil API gravity;

(e) sales oil production rate;

(f) sales oil Reid vapour pressure;

(g) ambient air temperature;

(h) ambient air pressure.

QC.33.3.10. Calculation of CO_2, CH_4 and N_2O emissions attributable to transmission storage tanks

Except for emissions sent to flares, which must be calculated in accordance with QC.33.3.13, the annual CH_4, CO_2 and N_2O emissions attributable to compressor scrubber dump valve leakage from condensate storage tanks, connected to transmission storage tanks for water or hydrocarbon, must be calculated using equations 33-20:

Equation 33-20

$$GHG_i = \sum_{j=1}^{n} \left[EF \times t\right]_j \times MF_i$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to compressor scrubber dump valve leakage from condensate storage tanks connected to transmission storage tanks, in metric tons;

n = Number of equipments;

j = Device;

EF = Emission factor for leakage from device *j*, determined in accordance with QC.33.4.10, in metric tons per hour;

t = Duration of leak from device *j*, determined in accordance with QC.33.4.10, in hours;

MF_i = Molar fraction of greenhouse gas *i* in gas from reciprocating compressor venting, determined in accordance with paragraph 3 of QC.33.4;

i = CO_2 or CH_4.

QC.33.3.11. Calculation of CO_2, CH_4 and N_2O emissions attributable to venting and flaring during well testing

The CO_2, CH_4 and N_2O emissions vented and flared during well testing must be calculated using one of the following methods:

(1) if the gas is directed to flares, using the method in QC.33.3.13 and the volumes determined in accordance with paragraph 2 of QC.33.4.11;

(2) in other cases, when the quantity of liquid is sufficient to calculate a natural gas to liquid ratio (GLR), using equation 33-21:

Equation 33-21

$$GHG_i = \sum_j \left(GLR \times F_L \times MF_i \times t\right)_j \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* vented during well testing, in metric tons;

j = Well tested;

GLR = Gas to liquid ratio for well *j*, determined in accordance with paragraph 1 of QC.33.4.11, in cubic metres of natural gas per cubic metre of liquid at standard conditions;

F_L = Liquid flow rate in well *j*, in cubic metres per hour;

MF_i = Molar fraction of greenhouse gas *i* in gas in well *j*, determined in accordance with paragraph 3 of QC.33.4;

t = Duration of testing of well *j*, in hours;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(3) in other cases, where insufficient liquids are produced and the gas to liquid ratio (GLR) approaches infinity, using equation 33-22:

Equation 33-22

$$GHG_i = \sum_j \left(D_g \times MF_i \times t\right)_j \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* vented during well testing, in metric tons;

j = Well tested;

D_g = Average gas flow rate from venting of well *j* during testing, measured in accordance with paragraph 2 of QC.33.4.11, in cubic metres per hour at standard conditions;

MF_i = Molar fraction of greenhouse gas *i* in the gas du well *j*, determined in accordance with paragraph 3 of QC.33.4;

t = Duration of testing of well *j*, in hours;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.12. Calculation of CO_2, CH_4 and N_2O emissions attributable to associated gas from wells

The annual CO_2, CH_4 and N_2O emissions attributable to associated gas from wells, except emissions attributable to production tests, which must be calculated in accordance with QC.33.3.11, must be calculated using one of the following methods:

(1) using the method in QC.33.3.13 where the gas is directed to flares, using the volumes determined by multiplying the volume of liquid produced by the gas to liquid ration determined in accordance with QC.33.4.12;

(2) in other cases, using equation 33-23:

Equation 33-23

$$GHG_i = \sum_j \left(GLR \times V \times MF_i\right)_j \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to associated gas, in metric tons;

j = Well;

GLR = Associated gas to liquid ratio for well *j*, determined in accordance with QC.33.4.12, in cubic metres of associated gas per cubic metre of liquid at standard conditions;

V = Annual volume of liquid produced, in cubic metres;

MF_i = Molar fraction of greenhouse gas *i* in gas in well *j*, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.13. Calculation of CO_2, CH_4 and N_2O emissions attributable to flaring

The annual CO_2, CH_4 and N_2O emissions attributable to flaring must be calculated using the following methods:

(1) the annual CO_2 emissions attributable to flaring must be calculated using equation 33-24:

Equation 33-24

$$CO_2 = \left[(V_G \times MF_{CO2}) + \left(\sum_{k=1}^{m} (MF_k \times AC_k) \times V_G \times eff_f \right) \right] \times \left[\frac{T_{SC} \times P_f}{T_f \times P_{SC}} \right] \times \rho_{CO2} \times 0.001$$

Where:

CO_2 = Annual CO_2 emissions attributable to flaring, in metric tons;

V_G = Annual volume of gas flared, determined in accordance with QC.33.4.13, in cubic metres;

MF_{CO2} = Mole fraction of CO_2 in the gas flared, determined in accordance with paragraph 3 of QC.33.4;

m = Total number of hydrocarbons in the gas stream;

k = Hydrocarbon in the gas stream;

MF_k = Mole fraction of hydrocarbon *k* in the gas stream, determined in accordance with QC.33.4.13;

AC_k = Number of carbon atoms in hydrocarbon *k* in the gas stream, namely 1 for methane, 2 for ethane, 3 for propane, 4 for butane, 5 for pentanes, 6 for hexanes and 7 for hexanes plus;

eff_f = Flare combustion efficiency determined by the manufacturer, or a default value of 0.98;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_f = Flare combustion temperature, in kelvin;

P_f = Flare combustion pressure, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

ρ_{CO2} = Density of CO_2, namely 1.893 kg per cubic metre, at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

(2) the annual CH_4 emissions attributable to flaring must be calculated using equation 33-25:

Equation 33-25

$$CH_4 = \left[V_G \times MF_{CH4} \times \left(1 - eff_f\right)\right] \times \left[\frac{T_{SC} \times P_f}{T_f \times P_{SC}}\right] \times \rho_{CH4} \times 0.001$$

Where:

CH_4 = Annual CH_4 emissions attributable to flaring, in metric tons;

V_G = Annual volume of gas flared, determined in accordance with QC.33.4.13, in cubic metres;

MF_{CH4} = Mole fraction of CH_4 in the gas flared, determined in accordance with paragraph 3 of QC.33.4;

eff_f = Flare combustion efficiency determined by the manufacturer, or a default value of 0.98;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_f = Flare combustion temperature, in kelvin;

P_f = Flare combustion pressure, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

ρ_{CH4} = Density of CH_4, namely 0.690 kg per cubic metre, at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

(3) the annual N_2O emissions attributable to flaring must be calculated using equation 33-26:

Equation 33-26

$$N_2O = V_G \times HHV \times EF_{N2O} \times 0.001$$

Where:

N_2O = Annual N_2O emissions attributable to flaring, in metric tons;

V_G = Annual volume of gas flared, determined in accordance with QC.33.4.13, in cubic metres at standard conditions;

HHV = High heat value of gas as specified in Tables 1-1 and 1-2 in QC.1.7 or high heat value of 4.579×10^{-2} GJ per cubic metre for gas from equipment venting or determined in accordance with QC.1.5.4, in gigajoules per cubic metre at standard conditions;

EF_{N2O} = N_2O emission factor, namely 9.52×10^{-5} kg per gigajoule;

0.001 = Conversion factor, kilograms to metric tons.

QC.33.3.14. Calculation of CO_2 and CH_4 emissions attributable to centrifugal compressor venting

The annual CO_2 and CH_4 emissions attributable to centrifugal compressor venting must be calculated using the following methods:

(1) for each centrifugal compressor, the emitter must determine, in accordance with QC.33.4.14, the volume of gas from the wet seal oil degasing tank that is vented to the atmosphere and the volume of gas directed to flares;

(2) the annual CO_2 and CH_4 emissions attributable to gas vented to the atmosphere from centrifugal compressors must be calculated using equation 33-27 where the aggregate rated power for the sum of centrifugal compressors at the establishment is equal to or greater than 186.4 kW and using equation 33-28 where the aggregate rated power of the centrifugal compressors at the establishment is less than 186.4 kW:

Equation 33-27

$$GHG_i = \sum_{j=1}^{n} \left[\sum_{m=1}^{z} \left(F_{G,i} \times t_j \right)_m \times \left(1 - FG_j \right) \right] \times MF_i \times \left[\frac{T_{SC} \times P_{cc}}{T_{cc} \times P_{SC}} \right] \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to atmospheric centrifugal compressor vents, in metric tons;

n = Total number of centrifugal compressors;

j = Centrifugal compressor;

z = Number of operating modes of centrifugal compressor;

m = Operating mode of centrifugal compressor;

$F_{G,j}$ = Gas flow from the atmospheric vent of centrifugal compressor *j* in operating mode *m*, determined in accordance with QC.33.4.14, in cubic metres per hour;

t_j = Annual operating time of centrifugal compressor *j* equipped with a wet seal oil degassing tank in operating mode *m*, in hours;

FG_j = Portion of gas from the atmospheric vent of centrifugal compressor *j* that is recovered using a vapour recovery system or destined for another use, determined in accordance with QC.33.4.14, expressed as a percentage;

MF_i = Molar fraction of greenhouse gas *i* in the gas from atmospheric vents, determined in accordance with paragraph 3 of QC.33.4;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{cc} = Temperature at the atmospheric vent of centrifugal compressor, in kelvin;

P_{cc} = Pressure at the atmospheric vent of centrifugal compressor, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

Equation 33-28

$$GHG_i = N \times EF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to atmospheric centrifugal compressor vents, in metric tons;

N = Total number of centrifugal compressors;

EF_j = Emission factor, namely 15,234.5 m^3 for CO_2 and 345,465.5 m^3 for CH_4, at standard conditions;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(3) the annual CO_2 and CH_4 emissions attributable to the gas directed to flares must be calculated in accordance with the calculation methods in QC.33.3.13 using the volumes of gas determined in accordance with QC.33.4.14.

QC.33.3.15. Calculation of CO_2 and CH_4 emissions attributable to reciprocating compressor venting

The annual CO_2 and CH_4 emissions attributable to reciprocating compressor venting must be calculated using the following methods:

(1) for each reciprocating compressor, the emitter must determine the gas flow from the venting in accordance with paragraph 1 of QC.33.4.15;

(2) the annual CO_2 and CH_4 emissions attributable to gas vented to the atmosphere from centrifugal compressors must be calculated using equation 33-29 where the aggregate rated power of the centrifugal compressors at the establishment is equal to or greater than 186.4 kW or using equation 33-30 where the aggregate rated power of the reciprocating compressors at the establishment is less than 186.4 kW:

Equation 33-29

$$GHG_i = \sum_{j=1}^{n}\left[\sum_{m=1}^{z}\left(F_{G,i} \times t_j\right)_m \times \left(1 - FG_j\right)\right] \times MF_i \times \left[\frac{T_{SC} \times P_{rc}}{T_{rc} \times P_{SC}}\right] \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to reciprocating compressor venting, in metric tons;

n = Total number of reciprocating compressors;

j = Reciprocating compressor;

z = Number of operating modes of reciprocating compressor;

m = Operating mode of reciprocating compressor;

$F_{G,j}$ = Gas flow from the venting of reciprocating compressor *j* in operating mode *m*, determined in accordance with paragraph 1 of QC.33.4.15, in cubic metres per hour;

t_j = Annual operating time of reciprocating compressor *j* in operating mode *m*, determined in accordance with QC.33.4.15, in hours;

FG_j = Portion of gas from the vent of reciprocating compressor *j* that is recovered using a vapour recovery system, determined in accordance with paragraph 5 of QC.33.4.15, expressed as a percentage;

MF_i = Molar fraction of greenhouse gas *i* in the gas from the reciprocating compressor venting, determined in accordance with paragraph 3 of QC.33.4;

T_{SC} = Temperature at standard conditions of 293.15 kelvin;

T_{rc} = Temperature at the reciprocating compressor vent, in kelvin;

P_{rc} = Pressure at the reciprocating compressor vent, in kilopascals;

P_{SC} = Pressure at standard conditions of 101.325 kPa;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

Equation 33-30

$$GHG_i = N \times EF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to reciprocating compressor venting to the atmosphere, in metric tons;

N = Total number of reciprocating compressors;

EF_j = Emission factor, namely 15.2 m^3 for CO_2 and 272.7 m^3 for CH_4, at standard conditions;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4;

(3) the annual CO_2 and CH_4 emissions attributable to gas directed to flares must be calculated in accordance with the calculation methods in QC.33.3.13 using the gas flow rates determined in accordance with QC.33.4.15.

QC.33.3.16. Calculation of CO_2 and CH_4 emissions attributable to leaks identified following a leak detection survey

Except for emissions from emission sources for which the total weight of CO_2 and CH_4 in the natural gas is below 10%, which must be calculated in accordance with QC.33.3.20, the annual fugitive CO_2 and CH_4 emissions attributable to leaks identified following a leak detection survey must be calculated for each source for which leaks are detected using equation 33-31:

Equation 33-31

$$GHG_i = \sum_{j=1}^{n} \left[N_j \times EF_j \times t_j \right] \times MF_i \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas ,*i*, for each source of fugitive emissions, in metric tons;

n = Total number of types of components, by fugitive emission source;

j = Type of component;

N_j = Total number of components of type *j*;

EF_j = Emission factor for leaks from each type of component *j*, determined in accordance with paragraph 1 of QC.33.4.16, in cubic metres per hour at standard conditions;

t_j = Duration of leakage from component *j*, determined in accordance with paragraph 2 of QC.33.4.16, in hours;

MF_i = Molar fraction of greenhouse gas *i* in the gas from reciprocating compressor venting, determined in accordance with paragraph 3 of QC.33.4;

ρ_i = Density of greenhouse gas *i* that is 1.893 kg per cubic metre for CO_2 and 0.690 kg per cubic metre for CH_4 at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.17. Calculation of fugitive CO_2 and CH_4 emissions attributable to all components

Except for emissions from emission sources with gas containing less than 10% CO_2 plus CH_4 by weight, which do not need to be calculated, annual fugitive CO_2 and CH_4 emissions must be calculated equation 33-32 for all centrifugal or reciprocating compressor components used in natural gas and oil exploration and production, or using equation 33-33 for gathering pipeline components:

Equation 33-32

$$GHG_i = \sum_k \left[\sum_j \left(N_{j,k} \times \frac{EF_{j,k}}{THC_k} \times Fr_{i,k} \right) \right] \times t$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* for each source of fugitive emissions, in metric tons;

k = Type of service listed in Tables 33-1 and 33-2 in QC.33.6, namely Gas/Vapour or Fuel Gas or Light Liquid or Heavy Liquid;

j = Type of component;

$N_{j,k}$ = Total number of components of type *j*, determined in accordance with QC.33.4.17;

$EF_{j,k}$ = Emission factor for each type of component *j*, determined in accordance with QC.33.4.17, in metric tons of total hydrocarbon per component per hour;

THC_k = Mass fraction of total hydrocarbons in service *k*;

$Fr_{i,k}$ = Mass fraction of greenhouse gas *i* in service *k*;

t = Total time the component type at the origin of the fugitive emissions was operational, in hours;

i = CO_2 or CH_4;

Equation 33-33

$$GHG_i = EF_i \times L \times t$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to gathering pipeline components, in metric tons;

EF_i = Emission factor associated with gathering pipeline components, namely 2.66×10^{-5} for CH_4 and 6.35×10^{-6} for CO_2, in metric tons per kilometre per hour;

L = Length of the gathering pipeline, in kilometres;

t = Total time the gathering pipeline was operational in the year, in hours;

i = CO_2 or CH_4.

QC.33.3.18. Calculation of CO_2 and CH_4 emissions attributable to EOR injection pump blowdown

The annual CO_2 and CH_4 emissions attributable to EOR injection pump blowdown must be calculated using equation 33-34:

Equation 33-34

$$GHG_i = \sum_j \left(N \times V \times F_i\right) \times \rho_i \times 0.001$$

Where:

GHG_i = Annual emissions of greenhouse gas *i* attributable to EOR injection pump blowdown, in metric tons;

j = Injection pump;

N = Annual number of blowdowns for injection pump *j*, determined in accordance with QC.33.4.18;

V = Volume of gas per blowdown, determined in accordance with QC.33.4.18, in cubic metres at standard conditions;

F_i = Mass fraction of greenhouse gas *i* in the gas injected with injection pump *j*;

ρ_i = Density of critical phase greenhouse gas *i*, determined in accordance with QC.33.4.18, in kilograms per cubic metre at standard conditions;

0.001 = Conversion factor, kilograms to metric tons;

i = CO_2 or CH_4.

QC.33.3.19. Calculation of CO_2, CH_4 and N_2O emissions attributable to the combustion of field gas and process vent gas

The annual CO_2, CH_4 and N_2O emissions attributable to the combustion of field gas and process vent gas must be calculated in accordance with QC.33.4.19.

QC.33.3.20. Calculation of fugitive emissions from other sources

Fugitive emissions from other sources that are not calculated using the methods in QC.33.3.1 to QC.33.3.19 must be calculated using the methods in the most recent version of

(1) "Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry" published in August 2009 by the American Petroleum Institute;

(2) Table 6-22, "A National Inventory of Greenhouse Gas (GHG)", published by Clearstone Engineering Ltd.;

(3) "Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry, Volume 5", published in September 2004 by the Canadian Association of Petroleum Producers.

QC.33.3.21. Calculation of annual CO_2, CH_4 and N_2O fugitive emissions at offshore oil and gas exploration and production facilities from equipment leaks, venting and flaring

The annual CO_2, CH_4 and N_2O fugitive emissions at offshore oil and gas exploration and production facilities from equipment leaks, venting and flaring must be calculated using the data estimation and collection method of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), and in accordance with the method in Parts 250.302 to 304 of Title 30 of the Code of Federal Regulations published by the U.S. Environmental Protection Agency (USEPA).

QC.33.4. Sampling, analysis and measurement requirements

An emitter operating an oil or natural gas exploration and production or natural gas processing establishment must

(1) ensure that all the instruments used for sampling, analysis and measurement are calibrated before the first emissions report and for the following years, that they are calibrated and operated in accordance with the manufacturer’s instructions or in accordance with the methods and calibration intervals published by the following organizations:

(a) Canadian Standards Association;

(b) Canadian Gas Association;

(c) Canadian Association of Petroleum Producers;

(d) American National Standards Institute;

(e) American Society of Testing and Materials;

(f) American Petroleum Institute;

(g) American Society of Mechanical Engineers;

(h) North American Energy Standards Board;

(i) Canadian Energy Pipeline Association;

(j) Measurement Canada;

(k) Centre d’expertise en analyse environnementale du Québec;

(2) conduct leak detection surveys and manage transmission and distribution system integrity in accordance with the most recent version of CSA Z662-11 “Oil and gas pipeline systems” published by the Canadian Standards Association in June 2011 and in accordance with the Construction Code (chapter B-1.1, r. 2);

(3) determine the mole fraction of CO_2 and CH_4 in the natural gas by calculating the annual average of the following mole fractions in accordance with the second paragraph;

(4) from 1 January 2015, ensure that all high bleed pneumatic devices and all natural gas driven pneumatic pumps are equipped with meters.

The molar fraction of CO_2 and CH_4 must be determined as follows:

(1) for oil or natural gas exploration or production, by determining the molar fraction in the gas produced;

(a) if the facility is equipped with a continuous gas composition analyzer, using the average annual value;

(b) if the facility is not equipped with a continuous gas composition analyzer, using the annual average of the known gas composition for (in required order of preference):

i. the establishment;

ii. the company for the same oil or gas field operated during the same reporting period or, if not available, the previous reporting period;

(2) for natural gas processing, in the feed natural gas:

(a) for all equipment downstream of the de-methanizer or dew point control, by determining the molar fraction for all gas sources upstream of the de-methanizer or dew point control and in the gas going to transmission pipeline systems;

(b) for facilities that solely fractionate a liquid stream, by determining the molar fraction in the feed natural gas;

(c) for a facility that is equipped with a continuous gas composition analyzer in the feed gas stream, using the average annual value;

(d) for a facility that is not equipped with a continuous gas composition analyzer, using the annual average of the known gas composition for (in required order of preference):

i. the establishment;

ii. the company for the same oil or gas field operated during the same reporting period or, if not available, the previous reporting period.

QC.33.4.1. High bleed pneumatic device venting and natural gas driven pneumatic pump venting

For high bleed pneumatic device venting and natural gas driven pneumatic pump venting, the emitter must determine the number of high bleed pneumatic devices and natural gas driven pneumatic pumps as follows:

(1) for the first emissions report year, count all equipment by type or estimate the total equipment count and break down the result by the estimated percentage of each equipment type;

(2) for subsequent years, update the number of high bleed pneumatic devices and natural gas driven pneumatic pumps to reflect the annual changes.

In addition, the emitter must

(1) when using equation 33-2, determine the annual volume of natural gas consumed by the high bleed pneumatic devices or the quantity of natural gas consumed by the natural gas driven pneumatic pump using measuring equipment, such as a meter, installed on the equipment;

(2) when using equation 33-3, obtain from the equipment manufacturer the natural gas emission factor for each high bleed pneumatic device under normal operating conditions or, when those data are not available, use the flow for similar equipment. If there is no similar equipment, the emitter must use the data from Table 33-3 or 33-4 in QC.33.6;

(3) when using equation 33-4:

(*a*) obtain from the manufacturer the quantity of natural gas consumed per volume of liquid pumped in normal operating conditions for each model of pneumatic pump under normal operating conditions or, when those data are not available, use data for similar equipment;

(b) maintain a log of the quantity of liquid pumped annually by each natural gas driven pneumatic pump venting.

QC.33.4.2. Natural gas driven low or intermittent bleed pneumatic device venting

For natural gas driven low or intermittent bleed pneumatic device venting, the emitter must

(1) determine the number of natural gas driven low bleed pneumatic devices and the number of natural gas driver intermittent bleed pneumatic devices as follows:

(a) for the first emissions report year, by counting all devices by type or estimating the total device count and breaking down the result by the estimated percentage of each device type;

(b) for subsequent years, by updating the number of low bleed pneumatic devices and intermittent bleed devices to reflect annual changes;

(2) determine the emission factor for each type of pneumatic device as follows:

(a) for low bleed pneumatic devices, using the values specified in Table 33-3 in QC.33.6;

(b) for intermittent bleed pneumatic devices that maintain operating conditions such as liquid level, pressure, pressure differential or temperature, using the data available in the following order:

i. the values specified in Table 33-4;

ii. the emission factor for a similar device;

iii. the emission factor for intermittent bleed pneumatic devices specified in Table 33-3;

(c) for intermittent bleed pneumatic devices used for compressor startup, using the emission factor provided by the manufacturer.

QC.33.4.3. Acid gas scrubbing equipment

For acid gas scrubbing equipment, the emitter must

(1) measure the annual volume of processed gas output from the acid gas scrubbing equipment using appropriate measuring equipment in accordance with a method published by one of the organizations listed in paragraph 1 of QC.33.4;

(2) measure the mole fraction of CO_2 in the input and output natural gas of the acid gas scrubbing equipment using a continuous gas composition analyzer or, when the equipment is not equipped with an analyzer, by taking a monthly sample;

(3) measure the mole fraction of H_2S in the input and output natural gas of the acid gas scrubbing equipment using a continuous gas composition analyzer or, when the equipment is not equipped with an analyzer, using an analysis method published by an organization listed in QC.1.5.

QC.33.4.4. Dehydrator vents

To determine wet natural gas composition for dehydrator vents, the emitter must

(1) when the dehydrator is equipped with a continuous gas composition analyzer, use the average annual value;

(2) when the dehydrator is not equipped with a continuous gas composition analyzer, use the annual average of the measured gas composition for the establishment;

(3) use a method published by an organization listed in paragraph 1 of QC.33.4;

(4) when only the dry natural gas composition output from the dehydrator is available, assume that the wet input gas is saturated.

QC.33.4.5. Well venting for liquids unloading

For well venting for liquids unloading, the emitter must

(1) group the wells by well diameter and pressure in each gas producing field where wells are vented to the atmosphere;

(2) for each group of wells, install a meter on a representative well in the group;

(3) determine the average gas flow rate measured on the vent line used to vent gas from the well using the following method:

(a) by dividing the volume of gas measured on the vent line from the well by the total annual venting time for each liquid unloaded;

(b) by applying the average flow rate to all the wells in each group determined in accordance with paragraph 1;

(c) by recalculating the average flow rate for the group each year.

For a new producing field or a new horizon combination, the average flow rate must be calculated beginning in the first year of production.

QC.33.4.6. Natural gas well venting during completions or workovers

For natural gas well venting during completions or workovers, the emitter must

(1) measure the volume of natural gas vented from gas wells during completions or workovers using a flowmeter installed on the vent;

(2) when the method in paragraph 3 of QC.33.3.6 is used:

(a) make a series of measurements of upstream pressure and downstream pressure across a choke during the entire completion and workover period, at a sufficient frequency to determine the flow regime in accordance with subparagraph *b*;

(b) determine the flow regime by calculating the “downstream pressure over upstream pressure” ratio at the choke as follows:

Sonic flow regime if $P_{av} / P_{am} \leq 0.542$

Subsonic flow regime if $P_{av} / P_{am} > 0.542$

Where:

P_{am} = Absolute vent pressure upstream from choke point, in kilopascals;

P_{av} = Absolute vent pressure downstream from choke point, in kilopascals.

QC.33.4.7. Blowdown vent stacks

For blowdown vent stacks, the emitter must

(1) calculate the volume of natural gas in blowdown chambers between the isolation valves for each piece of equipment;

(2) when the volume is equal to or greater than 1.42 m^3 at standard conditions, log the annual number of blowdowns for each piece of equipment.

QC.33.4.8. Third party line hits

For fugitive emissions attributable to third party line hits, the emitter must

(1) for a pipeline puncture incident, determine whether or not the flow is choked, using the following method:

If $P_{atm} / P_a \geq 0.546$ flow is not choked;

If $P_{atm} / P_a < 0.546$ flow is choked;

Where:

P_a = Absolute pressure inside pipe, determined in accordance with paragraph 3 of QC.33.4.8, in kilopascals;

P_{atm} = Absolute pressure at the damage point, in kilopascals;

(2) for a catastrophic pipeline rupture, determine the pressure inside the pipe at the place where the ruptured pipeline joins a larger pipeline;

(3) for a pipeline puncture incident, determine the pressure inside the pipe at the damage point.

33.4.9. Emissions attributable to venting from oil and natural gas storage tanks associated with onshore exploration, production and processing facilities

For emissions attributable to atmospheric pressure fixed roof storage tanks receiving hydrocarbon produced liquids from onshore oil and gas exploration and production facilities and onshore natural gas processing facilities, the emitter must, to calculate the gas oil ratio,

(1) collect a pressurized sample of produced liquids from the separator at a location upstream of the storage tank; the sample must be collected at the pressure of the final separation device before the transition to a storage tank at atmospheric pressure using one of the following methods:

(a) the most recent revision of "E&P TANK Version 2.0 User's Manual Appendix C, Sampling Protocol Section", published by the American Petroleum Institute;

(b) the guidance document "Oil and Gas Production Facilities, Chapter 6, Section 2 Permitting Guidance, Appendix D Sampling and Analysis of Hydrocarbon Liquids and Natural Gas", published in August 2011 by the Wyoming Department of Environmental Quality Air Quality Division;

(c) "Standard 2174-93, Obtaining Liquid Hydrocarbon Samples for Analysis by Gas Chromatography" published by the Gas Processors Association (GPA);

(2) measure the sample pressure at the time of collection and again prior to analysis to insure that sample integrity has been maintained;

(3) measure the liquid temperature at the time of collection;

(4) conduct sampling and analysis at the frequency prescribed below at a time when operational parameters are representative of normal operating conditions:

Oil production rate (m^3 per day)	**Sampling frequency**
$1.75 < \text{rate} \leq 15.9$	Annual
$15.9 < \text{rate} \leq 79.5$	Semi-annual
$\text{rate} > 79.5$	Quarterly

;

(5) collect an additional sample if

(a) the production rate changes more than 20% compared to the normal rate for time periods in excess of one week;

(b) the separator operating pressure changes by more than 10% compared to the normal operating pressure;

(6) measure the volume of liquid produced during the sampling interval using equipment calibrated to be accurate to within 5%.

33.4.10. Emissions attributable to transmission storage tanks

For transmission storage tanks, the emitter must

(1) to measure compressor scrubber dump valve leakage from condensate storage tanks connected to transmission storage tanks for water or hydrocarbon, determine the emission factor for leaks from each type of component using the following methods:

(a) using specific data related to the operation of the equipment by the emitter;

(b) using the method in the most recent version of "Methodology Manuel: Estimation of Air Emissions from the Canadian Natural Gas Transmission, Storage and Distribution System" published by Clearstone Engineering Ltd.;

(2) determine the duration of the equipment leakage using the following methods:

(a) when only one leak detection survey is conducted each year, the emitter must assume that the component was leaking from the start of the year until the leak was repaired. If the leak was not repaired, the emitter must assume that the component was leaking for the entire year;

(b) when more than one leak detection survey is conducted each year, the emitter must assume that the component has been leaking since the last survey. If a leak was detected at the last survey, the emitter must assume that the component, unless the leak has been repaired, was leaking for the entire year.

33.4.11. Emissions attributable to well testing venting

To calculate emissions from well testing, the emitter must

(1) when using equation 33-21, determine the gas to liquid ratio (GLR) using a method published by one of the organizations listed in paragraph 1 of QC.33.4;

(2) when using equation 33-22, determine the average gas flow rate from well venting using measuring equipment installed on the vent.

33.4.12. Associated gas emissions

To calculate associate gas emissions, the emitter must, when using equation 33-23, determine the gas to liquid ratio (GLR) using a method published by one of the organizations listed in paragraph 1 of QC.33.4.

QC.33.4.13. Emissions from flaring

To calculate emissions from flaring, the emitter must

(1) determine the volume of gas directed to flares using one of the following methods:

(a) when the flare is equipped with a continuous gas flow monitoring and recording system, using the gas volume flow or, when part of the gas is not measured by such a system, by estimating the unmeasured gas flow using a sector specific method;

(b) using a method published by an organization listed in paragraph 1 of QC.33.4;

(2) determine the gas composition using one of the following methods:

(a) using a continuous gas composition monitoring and recording system;

(b) when the flare is not equipped with a continuous gas composition analyzer and the exploration and production well is located onshore, using the annual average of the measured gas composition for the establishment;

(c) when the flare is not equipped with a continuous gas composition analyzer, using,

i. for gas processing facilities where the flare is feeded with natural gas, the molar fraction of the feed gas for equipment upstream of the de-methanizer;

ii. for sources downstream of the de-methanizer, the molar fraction of the output gas;

iii. for facilities that solely fractionate a liquid stream, the molar fraction of the feed gas for the de-methanizer;

iv. when the gas directed to the flare is composed of methane, ethane, propane, butane, pentane, hexane or hexanes-plus, the molar fraction determined by engineering calculation or based on available process data for the process concerned.

QC.33.4.14. Centrifugal compressor venting

For centrifugal compressors, the emitter must

(1) determine the gas flow from the wet seal oil degasing vent to the atmosphere and the gas flow directed to flares using a temporary or permanent flow meter in the operating mode in which it is found during the measurement period, namely:

(a) the centrifugal compressor is in operating, standby-pressurized mode and the gas emitted is from blowdown vent leakage;

(b) the centrifugal compressor is in operating mode;

(c) the centrifugal compressor is not operating and is in depressurized mode and the gas emitted is from isolation-valve leakage through the blowdown vent stack. In this case,

i. each centrifugal compressor that is not equipped with blind flanges must be sampled at least once in every 3 consecutive years;

ii. each centrifugal compressor that has been equipped with blind flanges for at least 3 consecutive years does not need to be sampled;

(2) when a centrifugal compressor is used for peaking purposes for no more than 200 hours per year and is not equipped with a meter, determine the volume of gas using data from meters installed on similar equipment;

(3) calibrate the meters in accordance with the methods in paragraph 1 of QC.33.4;

(4) determine the quantity of gas that is recovered using a vapour recovery system or destined for another use, expressed as a percentage, using the number of hours the recovery system is in operation and the quantity of gas directed to the combustible gas system;

(5) add the rated power of all centrifugal compressors at the establishment to determine if the aggregated power is greater than or below 186.4 kW.

QC.33.4.15. Reciprocating compressor venting

For reciprocating compressors, the emitter must

(1) determine the gas flow from reciprocating compressor venting using the following methods:

(a) when the reciprocating rod packing and blowdown vent for the compressor is connected to an open ended vent line, the emitter must determine the gas flow using one of the following methods:

i. by measuring the gas flow from all vents, including gas manifolded to common vents, using calibrated bagging in accordance with paragraph 3 or a high-flow sampler in accordance with paragraph 4;

ii. by measuring the gas flow from all vents, including gas manifolded to common vents, using a temporary or permanent flow meter in accordance with the methods in paragraph 1 of QC.33.4;

iii. for leaks from valves connected to a vent line, such as the isolation valves of compressors that are not operating and pressurized and the blowdown valves of compressors that are pressurized, using an acoustic detection device in accordance with paragraph 2 of QC.33.4;

(b) when the compressor rod packing case is not equipped with a vent line:

i. detect equipment leaks in accordance with paragraph 2 of QC.33.4;

ii. measure the gas flow using a calibrated bag in accordance with paragraph 3, a high-flow sampler in accordance with paragraph 4 or a meter in accordance with a method published by an organization listed in paragraph 1 of QC.33.4;

(2) measure, annually, the gas flow from the reciprocating rod-packing vents, isolation valve vents and blowdown-valve vents of each reciprocating compressor, including gas manifolded to common vents, in the operating mode in which it is found during the measurement period, namely:

(a) reciprocating compressor is in operating, standby-pressurized mode and the gas emitted is from blowdown vent leakage;

(b) the reciprocating compressor is in operating mode and the gas emitted is from the reciprocating rod-packing;

(c) the compressor is not operating and is in depressurized mode and the gas emitted is from isolation valve leakage through the blowdown vent stack. In this case,

i. each reciprocating compressor that is not equipped with blind flanges must be sampled at least once in every 3 consecutive years;

ii. each reciprocating compressor that has been equipped with blind flanges for at least 3 consecutive years does not need to be sampled;

(3) when a reciprocating compressor is used for peaking purposes for no more than 200 hours per year and is not equipped with a flowmeter, determine the volume of gas using data from flowmeters installed on similar equipment;

(4) when using calibrated bags to measure the gas flow from reciprocating compressor venting, use bags only where the emissions are at near-atmospheric pressure and the concentration of hydrogen sulphide is such that it is safe to handle. The calibrated bag must be used according to the manufacturer's instructions and must be able to capture all the gas emitted during the measurement period. The emitter must also

(a) record the time required to completely fill the bag; if the bag inflates in less than once second, assume one second inflation time;

(b) perform 3 measurements of the time required to fill the bag, and use the average of the 3 measurements to determine the gas flow;

(5) when a high-flow sampler is used, measurements must be made in accordance with the manufacturer's instructions. The emitter must also calibrate the sampler following the manufacturer's instructions, at 2.5% CH_4 and 97.5% air and 100% CH_4 using gas samples representative of known concentrations;

(6) to determine the quantity of gas from reciprocating compressor venting recovered by vapour recovery system, maintain a log of operating times and quantities of gas directed to the recovery system.

QC.33.4.16. Leaks identified following a leak detection survey

An emitter must conduct leak detection surveys in accordance with paragraph 2 of QC.33.4, and must

(1) determine the emission leak factor from each type of component using the following methods:

(a) using specific data related to the operation of the equipment by the emitter and sector-specific methods;

(b) using data from Table W-2 in Part W of Title 40 of the Code of Federal Regulations published by the U.S. Environmental Protection Agency (USEPA), converting the factors into units appropriate for use in equation 33-31;

(c) using data from the Methodology Manuals of the Canadian Association of Petroleum Producers, converting the factors into units appropriate for use in equation 33-31;

(2) determine the duration of leakage from a component using the following methods:

(a) when only one leak detection survey is conducted each year, the emitter must assume that the component was leaking from the start of the year until the leak was repaired. If the leak was not repaired, the emitter must assume that the component was leaking for the entire year;

(b) when more than one leak detection survey is conducted each year, the emitter must assume that the component has been leaking since the last survey. If a leak was detected at the last survey, the emitter must assume that the component, unless the leak has been repaired, was leaking for the entire year.

QC.33.4.17. Fugitive emissions from all components

For fugitive emissions from all components, the emitter must

(1) determine the total number of components of each type, for each type of service, using one of the following methods:

(a) a sector specific method published by the Canadian Gas Association or the Canadian Association of Petroleum Producers;

(b) using enterprise-specific data;

(2) for the first emissions report year, use the emission factor for each type of component, by type of service, using the data in Tables 33-1 and 33-2 in QC.33.6. If no emission factor is specified in the Tables, the emitter must use a factor from Tables W-iA and W-2 in Part 98.230 of Title 40 of the Code of Federal Regulations published by the U.S. Environmental Protection Agency (USEPA), or the most recent version of “A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry”, published by Clearstone Engineering Ltd.;

(3) for subsequent emissions report years, determine the emission factor for leaks from each type of component, for each type of service, using the following methods:

(a) using equipment specific factors for the operation of the enterprise's equipment and a method published by an organization listed in paragraph 1 of QC.33.4;

(b) by updating the emission factors at least every 3 years;

(4) determine CO_2 and CH_4 concentration in natural gas in accordance with the methods in the most recent version of "Methodology Manuel: Estimation of Air Emissions from the Canadian Natural Gas Transmission, Storage and Distribution System" published by Clearstone Engineering Ltd.

QC.33.4.18. Enhanced oil recovery (EOR) injection pump blowdown

For EOR injection pump blowdown, the emitter must

(1) determine the volume of gas per blowdown for each pump by calculating the internal volume of the blowdown equipment between the isolation valves;

(2) maintain a log of the number of blowdown for each injecting pump during enhanced oil recovery;

(3) determine the density of critical phase greenhouse gas using a method published by an organization listed in paragraph 1 of QC.33.4 or, if those organizations have published no method, using an industry recognized method.

QC.33.4.19. Emissions attributable to the combustion of field gas and vent gas

An emitter who calculates the emissions attributable to the combustion of field gas and vent gas using equation 1-7 in subparagraph 3 of QC.1.3.3 must determine the carbon content and molecular fraction of the gas in accordance with QC.1.5.5.

QC.33.5. Methods for estimating missing data

When, in conducting sampling activities, an emitter is unable to obtain analytical data, the original sample, back-up sample or replacement sample must be analyzed again, using the methods prescribed in this protocol, for the same measurement and sampling periods.

When sampling or measurement data required by this protocol for the calculation of emissions is missing, the emitter must demonstrate that everything possible has been done to ensure that 100% of the data is sampled. The emitter must then use replacement data determined as follows:

(1) for an emitter who uses one of the calculation methods in this protocol:

(a) when the missing value concerns carbon content, high heat value, molecular weight, molar fraction, mass fraction, gas oil ratio, temperature, pressure or sampled data, the emitter must

i. determine the sampling or measurement rate using the following equation:

Equation 33-35

$$S = Q_{E\mathrm{Re}al} / Q_{E\mathrm{Re}q}$$

Where:

S = Actual sampling rate or measurement rate, expressed as a percentage;

Q_{EReal} = Actual number of samples or measurements carried out by the emitter;

Q_{EReq} = Number of samples required or measurements carried out in accordance with QC.33.4;

ii. for data requiring sampling or analysis:

- when T ≥ 0.9: replace the missing value by the arithmetic average of the data sampled or measured immediately preceding and following the missing data period. If no data are available prior to the missing data period, the emitter must use the first data obtained after the missing data period;

- when 0.75 ≤ T< 0.9: replace the missing value by the highest value sample or analyzed during the report year for which the calculation is made;

- when T < 0.75: replace the missing value by the highest value sample or analyzed during the 3 preceding years;

(b) when the missing value concerns time, quantity of gas, quantity of liquid, liquid flow or gas flow, the replacement value must be estimated on the basis of all the data relating to the processes used;

(2) for an emitter who uses a continuous emission monitoring system, apply the procedure in the EPS 1/PG/7 protocol entitled "Protocols and performance specifications for continuous monitoring of gaseous emissions from thermal power generation" published in November 2005 by Environment Canada or apply the method in subparagraph *a* of paragraph 2 of QC.1.6 to the missing parameters.

QC.33.6. Tables

Table 33-1. Average emission factors for an oil or natural gas exploration or production facility or a natural gas processing facility

(QC.33.3.17)

Emission factor by component type	
Component – Type of service	**Metric tons THC /component - hour**
Valves - fuel gas	2.81×10^{-06}
Valves - light liquid	3.52×10^{-06}
Valves - gas/vapour - all	2.46×10^{-06}
Valves - gas/vapour - sour	1.16×10^{-06}
Valves - gas/vapour - sweet	2.81×10^{-06}
Connectors - fuel gas	8.18×10^{-07}
Connectors - light liquid	5.51×10^{-07}
Connectors - gas/vapour - all	7.06×10^{-07}
Connectors - gas/vapour - sour	1.36×10^{-07}
Connectors - gas/vapour - sweet	8.18×10^{-07}
Control valves - fuel gas	1.62×10^{-05}
Control valves - light liquid	1.77×10^{-05}
Control valves - gas/vapour - all	1.46×10^{-05}
Control valves - gas/vapour - sour	9.64×10^{-06}
Control valves - gas/vapour - sweet	1.62×10^{-05}
Pressure relief valves - fuel gas and gas/vapour	1.70×10^{-05}
Pressure relief valves - light liquid	5.39×10^{-06}
Pressure regulators - fuel gas and gas/vapour	8.11×10^{-06}
Pressure regulators - gas/vapour - sour	4.72×10^{-08}
Pressure regulators - gas/vapour - sweet	8.39×10^{-06}
Open ended lines - fuel gas	4.67×10^{-04}
Open ended lines - light liquid	1.83×10^{-05}
Open ended line- gas/vapour - all	4.27×10^{-04}
Open ended lines - gas/vapour - sour	1.89×10^{-04}
Open ended lines - gas/vapour - sweet	4.67×10^{-04}
Pump seals - light liquid	2.32×10^{-05}

Table 33-2. Average emission factors for an oil and natural gas exploration and production facility

(QC.33.2, QC.33.3.17, Q.33.4.17)

Component – Type of service	**Metric tons THC /component - hour**
Valves - fuel gas and gas/vapour	1.51×10^{-06}
Valves - heavy liquid	8.40×10^{-09}
Valves - light liquid	1.21×10^{-06}
Connectors - fuel gas and gas/vapour	2.46×10^{-06}
Connectors - heavy liquid	7.50×10^{-09}
Connectors - gas/vapour - all	1.90×10^{-07}
Control Valves - fuel gas and gas/vapour	1.46×10^{-05}
Control Valves - light liquid	1.75×10^{-05}
Pressure relief valves - fuel gas and gas/vapour	1.63×10^{-05}
Pressure relief valves - heavy liquid	3.20×10^{-08}
Pressure relief valves - light liquid	7.50×10^{-05}
Pressure regulators - fuel gas and gas/vapour	6.68×10^{-06}
Open ended lines - fuel gas and gas/vapour	3.08×10^{-04}
Open ended lines - light liquid	3.73×10^{-06}
Pump seals - heavy liquid	3.20×10^{-08}
Pump seals - light liquid	2.32×10^{-05}

Table 33-3. Average emission factors for natural gas driven pneumatic devices

(QC.33.4.1, QC.33.4.2)

Component	**m^3 at standard conditions per hour per component**
High bleed pneumatic device venting	1.3620
Intermittent bleed pneumatic device venting	0.4927
Low bleed pneumatic device venting	0.0510
Pneumatic pump	0.3766

Table 33-4. Manufacturer-specified emission rates for leaks from liquid level controllers, positioners, pressure controllers, transducers and transmitters

(QC.33.3.1, QC.33.3.2)

Description	**Manufacturer**	**Model**	**Operating condition**	**Manufacturer rate (m^3/hour)**
Liquid level controller	Bristol Babcock	Series 5453-Model 624-II	Continuous	0.0850
Liquid level controller	Fisher	2100	Continuous	0.0283
Liquid level controller	Fisher	2500	Continuous	1.1893
Liquid level controller	Fisher	2660	Continuous	0.0283
Liquid level controller	Fisher	2680	Continuous	0.0283
Liquid level controller	Fisher	2900	Continuous	0.6513
Liquid level controller	Fisher	L2	Continuous	0.0425
Liquid level controller	Invalco	AE-155	Continuous	1.5008
Liquid level controller	Invalco	CT Series	Continuous	1.1327
Liquid level controller	Norriseal	1001 (A) 'Envirosave'	Intermittent	0.0000
Liquid level controller	Norriseal	1001 (A) snap	Intermittent	0.0057
Liquid level controller	Norriseal	1001 (A) throttle	Intermittent	0.0002
Liquid level controller	Wellmark	2001 (snap)	Intermittent	0.0057
Liquid level controller	Wellmark	2001 (throttling)	Intermittent	0.0002
Positioner	Becker	EFP-2.0	Intermittent	0.0000
Positioner	Becker	HPP-5	Continuous	0.1416
Positioner	Fisher	3582	Continuous	0.4531
Positioner	Fisher	3590	Continuous	0.8495
Positioner	Fisher	3660	Continuous	0.1982
Positioner	Fisher	3661	Continuous	0.2959
Positioner	Fisher	3582i	Continuous	0.5833
Positioner	Fisher	3610J	Continuous	0.4531
Positioner	Fisher	3620J	Continuous	0.7532
Positioner	Fisher	DVC 5000	Continuous	0.2832

Positioner	Fisher	DVC 6000	Continuous	0.3964
Positioner	Fisher	Fieldview Digital	Continuous	0.8920
Positioner	Masoneilan	7400	Continuous	1.0477
Positioner	Masoneilan	4600B Series	Continuous	0.6796
Positioner	Masoneilan	4700B Series	Continuous	0.6796
Positioner	Masoneilan	4700E	Continuous	0.6796
Positioner	Masoneilan	SV	Continuous	0.1133
Positioner	Moore Products	73N-B	Continuous	1.0194
Positioner	Moore Products	750P	Continuous	1.1893
Positioner	PMV	D5 Digital	Continuous	0.0283
Positioner	Sampson	3780 Digital	Continuous	0.0283
Positioner	VCR	VP700 PtoP	Continuous	0.0283
Pressure controller	Ametek	Series 40	Continuous	0.1699
Pressure controller	Becker	HPP-SB	Continuous	0.0000
Pressure controller	Becker	VRP-B-CH	Continuous	0.1416
Pressure controller	Becker	VRP-SB	Continuous	0.0000
Pressure controller	Becker	VRP-SB Gap Controller	Continuous	0.0000
Pressure controller	Becker	VRP-SB-CH	Continuous	0.0000
Pressure controller	Becker	VRP-SB-PID Controller	Continuous	0.0000
Pressure controller	Bristol Babcock	Series 5453-Model 10F	Continuous	0.0850
Pressure controller	Bristol Babcock	Series 5455-Model 624-III	Continuous	0.0708
Pressure controller	CSV	4150	Continuous	0.6853
Pressure controller	CSV	4160	Continuous	0.6853
Pressure controller	Dyna-Flow	4000	Continuous	0.6853
Pressure controller	Fisher	2506	Continuous	0.6853
Pressure controller	Fisher	2516	Continuous	0.6853
Pressure controller	Fisher	4150	Continuous	0.7362
Pressure controller	Fisher	4160	Continuous	0.7362
Pressure controller	Fisher	4194	Continuous	0.1203
Pressure controller	Fisher	4195	Continuous	0.1203
Pressure controller	Fisher	4660	Continuous	0.1416
Pressure controller	Fisher	4100 (large orifice)	Continuous	1.4158
Pressure controller	Fisher	4100 (small orifice)	Continuous	0.4248
Pressure controller	Fisher	C1	Continuous	0.1472
Pressure controller	Fisher	DVC 6010	Continuous	0.0878
Pressure controller	Foxboro	43AP	Continuous	0.5097
Pressure controller	ITT Barton	338	Continuous	0.1699
Pressure controller	ITT Barton	358	Continuous	0.0510
Pressure controller	ITT Barton	359	Continuous	0.0510

Pressure controller	ITT Barton	335P	Continuous	0.1699
Pressure controller	ITT Barton	335P	Continuous	0.1699
Transducer	Bristol Babcock	9110-00A	Continuous	0.0119
Transducer	Bristol Babcock	Series 502 A/D	Continuous	0.1671
Transducer	Fairchild	TXI 7800	Continuous	0.2407
Transducer	Fisher	546	Continuous	0.8495
Transducer	Fisher	646	Continuous	0.2209
Transducer	Fisher	846	Continuous	0.3398
Transducer	Fisher	i2P-100	Continuous	0.2832
Transmitter	Bristol Babcock	Series 5457-70F	Continuous	0.0850
Transmitter	ITT Barton	273A	Continuous	0.0850
Transmitter	ITT Barton	274A	Continuous	0.0850
Transmitter	ITT Barton	284B	Continuous	0.0850
Transmitter	ITT Barton	285B	Continuous	0.0850

QC.34. IRON AND STEEL POWDER PRODUCTION

QC.34.1. Covered sources

The covered sources are all the processes used for iron and steel powder production.

QC.34.2. Greenhouse gas reporting requirements

In accordance with subparagraph 3 of the first paragraph of section 6.2, the greenhouse gas emissions report must, in particular, include the following information:

(1) the annual CO_2 emissions attributable to the atomization process of molten cast iron, in metric tons;

(2) the annual CO_2 emissions attributable to the decarburization process of iron powder, in metric tons;

(3) the annual CO_2 emissions attributable to the steel grading process, in metric tons;

(4) the annual CO_2 emissions attributable to the annealing process of steel powder, in metric tons;

(5) the annual CO_2, CH_4 and N_2O emissions attributable to the use of stationary combustion units, calculated and reported in accordance with QC.1, in metric tons;

(6) in the case of the atomization process for molten cast iron:

(a) the annual consumption of molten cast iron, in metric tons;

(*b)* the annual quantity of every other added material that contributes 0.5% or more of the total carbon in the process, in metric tons;

(c) the annual production of atomized cast iron, in metric tons;

(d) the annual quantity of each by-product that contributes 0.5% or more of total carbon in the process, in metric tons;

(*e)* the average annual carbon content of each material or product referred to in subparagraphs *a* to *d*, in metric tons of carbon per metric ton of material;

(7) in the case of the decarburization process for iron powder:

(a) the annual consumption of iron powder, in metric tons;

(b) the annual production of decarburized powder, in metric tons;

(c) the annual quantity of each by-product that contributes 0.5% or more of total carbon in the process, in metric tons;

(d) the average annual carbon content of each material or product referred to in subparagraphs *a* to *c*, in metric tons of carbon per metric ton of material or product;

(8) in the case of the steel grading process:

(a) the annual quantity of molten steel feeding the furnace, in metric tons;

(b) the annual consumption of each additive that contributes 0.5% or more of total carbon in the process, in metric tons;

(c) the annual consumption of carbon electrodes, in metric tons;

(d) the annual production of molten steel, in metric tons;

(e) the annual quantity of slag produced, in metric tons;

(f) the annual quantity of air pollution control residue collected, in metric tons;

(g) the annual quantity of other residue produced that contributes 0.5% or more of total carbon in the process, in metric tons;

(h) the average annual carbon content of the materials and products referred to in subparagraphs *a* to *g*, in metric tons of carbon per metric ton or materials or products;

(9) in the case of the annealing process for steel powder:

(a) the annual consumption of steel powder, in metric tons;

(b) the annual quantity of steel powder output from annealing furnaces, in metric tons;

(c) the annual quantity of by-products that contribute 0.5% of more of total carbon in the process, in metric tons;

(d) the annual average carbon content of each material or product referred to in subparagraphs *a* to *c,* in metric tons of carbon per metric ton of material or product;

(10) the number of times that the methods for estimating missing data provided for in QC.34.5 were used;

(11) the total annual quantity of iron and steel powder produced, in metric tons.

Subparagraph *e* of subparagraph 6, subparagraph *d* of subparagraph 7, subparagraph *h* of subparagraph 8 and subparagraph *d* of subparagraph 9 of the first paragraph do not apply to the CO_2 emissions of an emitter who calculates emissions using data from a continuous emission monitoring and recording system.

For the purposes of subparagraph 8 of the first paragraph of section 6.2:

(1) the emissions referred to in subparagraphs 1 and 2 of the first paragraph are emissions attributable to fixed processes;

(2) the emissions referred to in subparagraph 3 of the first paragraph are emissions attributable to combustion.

QC.34.3. Calculation methods for CO_2 emissions attributable to iron and steel powder production processes

The annual CO_2 emissions attributable to iron and steel powder production must be calculated in accordance with one of the methods in QC.34.3.1 to QC.34.3.5.

QC.34.3.1. Use of a continuous emission monitoring and recording system

The annual CO_2 emissions may be calculated using data from a continuous emission monitoring and recording system in accordance with QC.1.3.4.

QC.34.3.2. Calculation of CO_2 emissions attributable to the molten cast iron atomization process

The annual CO_2 emissions attributable to the molten cast iron atomization process must be calculated using equation 34-1. Materials or products whose carbon content contribute less than 0.5% of the carbon in the process do not have to be considered in this calculation.

Equation 34-1

$$CO_2 = \left[(MI \times C_{MI}) + \sum_{k=1}^{p} (M_k \times C_{M,k}) - (AI \times C_{AI}) - \sum_{j=1}^{m} (BP_j \times C_{BP,j}) \right] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the molten cast iron atomization process, in metric tons;

MI = Quantity of molten iron fed into the process, in metric tons;

C_{MI} = Average annual carbon content of molten cast iron, in metric tons of carbon per metric ton of molten cast iron;

p = Number of materials used other than molten cast iron;

k = Material used other than molten cast iron;

M_k = Annual quantity of each material *k* other than molten cast iron used, in metric tons;

$C_{M,k}$ = Annual average carbon content of each material *k* used, other than molten cast iron, in metric tons of carbon per metric ton of material *k*;

AI = Annual quantity of atomized cast iron, in metric tons;

C_{AI} = Average annual carbon content of atomized cast iron, in metric tons of carbon per metric ton of atomized cast iron;

j = Number of by-products;

m = By-product;

BP_j = Annual quantity of by-product *j* output from the process, in metric tons;

$C_{BP,j}$ = Annual average carbon content of by-product *j*, or a default value of 0, in metric tons of carbon per metric ton of by-product *j*;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.34.3.3. Calculation of CO_2 emissions attributable to the iron powder decarburization process

Annual CO_2 emissions attributable to the iron powder decarburization process must be calculated using equation 34-2. Materials or products whose carbon content contributes less than 0.5% of the carbon in the process do not have to be included in this calculation.

Equation 34-2

$$CO_2 = \left[\left(IP_f \times C_{IPf} \right) - \left(IP_d \times C_{IPd} \right) - \sum_{j=1}^{m} \left(BP_j \times C_{BP,j} \right) \right] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable to the iron powder decarburization process, in metric tons;

IP_f = Quantity of iron powder fed into the process, in metric tons;

$C_{IPf,}$ = Annual average carbon content of iron powder, in metric tons of carbon per metric ton of iron powder;

IP_d = Annual quantity of decarburized iron powder, in metric tons;

C_{IPd} = Annual average carbon content of decarburized iron powder, in metric tons of carbon per metric ton of decarburized iron powder;

j = Number of by-products;

m = By-product;

BP_j = Annual quantity of by-product *j* output from the process, in metric tons;

$C_{BP,j}$ = Annual average carbon content of by-product *j*, or a default value of 0, in metric tons of carbon per metric ton of by-product *j*;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.34.3.4. Calculation of CO_2 emissions attributable to the steel grading process

Annual CO_2 emissions attributable to the steel grading process must be calculated using equation 34-3. Materials or products whose carbon content contributes less than 0.5% of the carbon in the process do not have to be included in this calculation.

Equation 34-3

$$CO_{2,SGP} = \left[\begin{array}{l} \left(MI_f \times C_{MIf}\right) + \sum_{j=1}^{m} \left(AD_j \times C_{AD,j}\right) + \left(EL \times C_{EL}\right) \\ - \left(MS \times C_{MS}\right) - \left(SL - C_{SL}\right) - \left(R \times C_R\right) - \left(R_p \times C_{Rp}\right) \end{array} \right] \times 3.664$$

Where:

$CO_{2,\ SGP}$ = Annual CO_2 emissions attributable to the steel grading process, in metric tons;

MI_f = Annual quantity of molten steel fed into the process, in metric tons;

C_{MIf} = Annual average carbon content of molten steel, in metric tons of carbon per metric ton of molten steel;

j = Additive;

m = Number of additives;

AD_j = Annual consumption of additive *j*, in metric tons;

$C_{AD,j}$ = Annual average carbon content of additive *j*, in metric tons of carbon per metric ton of additive *j*;

EL = Annual consumption of carbon electrodes, in metric tons;

C_{EL} = Annual average carbon content of carbon electrodes, in metric tons of carbon per metric ton of carbon electrodes;

MS = Annual production of molten steel, in metric tons;

C_{MS} = Annual average carbon content of molten steel, in metric tons of carbon per metric ton of molten steel;

SL = Annual production of slag, in metric tons;

C_{SL} = Annual average carbon content of slag, or a default value of 0, in metric tons of carbon per metric ton of slag;

R = Annual quantity of air pollution control residue, in metric tons;

C_R = Annual average carbon content of air pollution control residue, or a default value of 0, in metric tons of carbon per metric ton of residue;

R_p = Annual quantity of other residue produced, in metric tons;

C_{Rp} = Annual average carbon content of other residue produced, or a default value of 0, in metric tons of carbon per metric ton of residue;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.34.3.5. Calculation of CO_2 emissions attributable to the steel powder annealing process

The annual CO_2 emissions attributable to the steel powder annealing process may be calculated using equation 34-4:

Equation 34-4

$$CO_2 = \left[(P_a \times C_{Pa}) - (SP_p \times C_{SPp}) - \sum_{j=1}^{m} (BP_j \times C_{BP,j}) \right] \times 3.664$$

Where:

CO_2 = Annual CO_2 emissions attributable the steel powder annealing process, in metric tons;

P_a = Annual quantity of steel powder fed into annealing furnaces, in metric tons;

C_{Pa} = Average annual carbon content of steel powder fed into annealing furnaces, in kilograms of carbon per kilogram of steel powder;

SP_p = Annual quantity of steel powder produced, in metric tons;

C_{SPp} = Annual average carbon content of steel powder produced, in metric tons of carbon per metric ton of steel powder;

j = Number of by-products;

m = By-product;

BP_j = Annual quantity of by-product *j* output from the annealing furnaces, in metric tons;

$C_{BP,j}$ = Annual average carbon content of by-product *j*, or a default value of 0, in metric tons of carbon per metric ton of by-product *j*;

3.664 = Ratio of molecular weights, CO_2 to carbon.

QC.34.4. Sampling, analysis and measurement requirements

When the calculation methods in QC.34.3.2 to QC.34.3.5 are used, the emitter who operates a facility or establishment that produces iron and steel powder must:

(1) determine annually the carbon content of each material or product that contributes 0.5% or more of the total carbon in the process, either by using the data provided by the supplier, or by using the following methods:

(a) for iron or iron powder, using the most recent version of ASTM E1019 “Standard Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Fusion Techniques” or ASTM E415 “Standard Test Method for Atomic Emission Vacuum Spectrometric Analysis of Carbon and Low Alloy Steel”, or using any other analysis method published by an organization listed in QC.1.5;

(b) for steel or steel powder, using one of the following methods:

i. the most recent version of ASM CS-104 UNS G10460 “Carbon Steel of Medium Carbon Content” published by ASM International;

ii. the most recent version of ISO/TR 15349-1 “Unalloyed steel - Determination of low carbon content – Part 1: Infrared absorption method after combustion in an electric resistance furnace (by peak separation)”;

iii. the most recent version of ISO/TR 15349-3 “Unalloyed steel - Determination of low carbon content - Part 3: Infrared absorption method after combustion in an electric resistance furnace (with preheating)”;

iv. the most recent version of ASTM E415 “Standard Test Method for Atomic Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel”;

v. any other analysis method published by an organization referred to in QC.1.5;

(c) for carbon electrodes, the most recent version of ASTM D5373 "Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Laboratory Samples of Coal", or any other analysis method published by an organization listed in QC.1.5;

(d) for slag, by-products, air pollution control residue or other residue, an analysis method published by an organization listed in QC.1.5 or using a default value of 0;

(2) calculate the annual quantity of each material and product by direct weight measurement using the same plant instruments used for inventory purposes, such as weigh hoppers or belt weigh feeders.

QC.34.5. Methods for estimating missing data

When, in conducting sampling activities, an emitter is unable to obtain analytical data, the original sample, back-up sample or replacement sample must be analyzed again, using the methods prescribed in this protocol, for the same measurement and sampling periods.

When sampling or measurement data required by this protocol for the calculation of emissions is missing, the emitter must demonstrate that everything possible has been done to ensure that 100% of the data is sampled. The emitter must then use replacement data determined as follows:

(1) for an emitter who uses one of the calculation methods in this protocol:

(a) when the missing value concerns carbon content or another sampled value, the emitter must

i. determine the sampling or measurement rate using the following equation:

Equation 34-5

$$S = Q_{E\mathrm{Re}al} / Q_{E\mathrm{Re}q}$$

Where:

S = Actual sampling rate or measurement rate, expressed as a percentage;

Q_{EReal} = Actual number of samples or measurements carried out by the emitter;

Q_{EReq} = Number of samples or measurements required under QC.34.4;

ii. for data requiring sampling or analysis, the emitter must

- when T ≥ 0.9: replace the missing value by the arithmetic average of the data sampled or measured immediately preceding and following the missing data period. If no data are available prior to the missing data period, the emitter must use the first data obtained after the missing data period;

- when 0.75 ≤ T< 0.9: replace the missing value by the highest value sample or analyzed during the report year for which the calculation is made;

- when T < 0.75: replace the missing value by the highest value sample or analyzed during the 3 preceding years;

(b) when the missing value concerns the consumption of molten cast iron, the consumption of carbon electrodes, the quantity of molten steel, the consumption of additive, the quantity of iron or steel powder, the production of atomized cast iron, the quantity of slag or the quantity of by-products, the replacement value must be estimated on the basis of all the data relating to the processes used;

(2) for an emitter who uses a continuous emission monitoring system, apply the procedure in the EPS 1/PG/7 protocol entitled "Protocols and performance specifications for continuous monitoring of gaseous emissions from thermal power generation" published in November 2005 by Environment Canada or apply the method in subparagraph *a* of paragraph 2 of QC.1.6 to the missing parameters.".

21. Schedule B of the Regulation is repealed.

22. For the 2012 emissions report:

(1) an emitter required by section 6.1 of the *Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere* (chapter Q-2, r. 15), as it read prior to January 1, 2013, to communicate monthly and quarterly data to the Minister that are no longer required as of that date must retain the data but is no longer required to communicate them;

(2) an emitter may use the calculation methods as amended by this Regulation;

(3) an emitter does not need to have the emissions referred to in the second paragraph of section 6.6, as amended by section 11 of this Regulation, verified.

23. This Regulation comes into force on 1 January 2013.

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