Australian Government
Clean Energy Regulator

NATIONAL GREENHOUSE AND ENERGY REPORTING

Estimating emissions and energy from industrial processes guidance

July 2021

Changes for 2020-21 reporting:

- clarifying the carbon mass balance calculations for metal production
- clarifying the quantities of a fuel or carbonaceous input to be reported in EERS.

Contents

Definitions and abbreviations

Term	Meaning
CO_2	Carbon dioxide
F_{cal}	Amount of carbonate calcined in the production of cement clinker during the year, expressed as a decimal fraction
F_{ckd}	Fraction of calcination achieved for cement kiln dust lost from the kiln in the production of cement clinker during the year
NGER	National Greenhouse and Energy Reporting
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NGER Legislation	NGER Act, NGER Regulations, and NGER Measurement Determination
NGER Measurement Determination	National Greenhouse and Energy Reporting (Measurement) Determination 2008
NGER Regulations	National Greenhouse and Energy Reporting Regulations 2008
t CO_2-e	Tonnes carbon dioxide equivalence
2006 IPCC Guidelines	2006 IPCC Guidelines for National Greenhouse Gas Inventories[1] as published by the Intergovernmental Panel on climate change.

[1] https://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

Disclaimer

This guideline has been developed by the Clean Energy Regulator (the agency) to assist entities to comply with their reporting obligations under the *National Greenhouse and Energy Reporting Act 2007*[2] (NGER Act) and associated legislation.

The guideline should be read in conjunction with the NGER Act, National Greenhouse and Energy Reporting Regulations 2008[3] (NGER Regulations) and National Greenhouse and Energy Reporting (Measurement) Determination 2008[4] (NGER Measurement Determination) in their current form at the time of reading. These laws and their interpretation are subject to change, which may affect the accuracy of the information contained in the guideline.

The guidance provided in this document is not exhaustive, nor does it consider all circumstances applicable to all entities. The guideline is not intended to comprehensively deal with its subject area, and it is not a substitute for independent legal advice. Although entities are not bound to follow the guidance provided in this document, they must ensure they meet their obligations under the National Greenhouse and Energy Reporting[5] scheme (NGER) at all times. The agency encourages all users of this guideline to seek independent legal advice before taking any action or decision on the basis of this guideline.

The agency and the Commonwealth of Australia will not be liable for any loss or damage from any cause (including negligence) whether arising directly, incidentally or as consequential loss, out of or in connection with, any use of this guideline or reliance on it, for any purpose.

If an entity chooses to meet their obligations under the NGER scheme in a manner that is inconsistent with the guidance provided in this document, the agency, or an independent auditor, may require the entity to demonstrate that they are compliant with requirements of the NGER Act, NGER Regulations, and the NGER Measurement Determination. Entities are responsible for determining their obligations under the law and for applying the law to their individual circumstances.

[2] https://www.legislation.gov.au/Series/C2007A00175
[3] https://www.legislation.gov.au/Series/F2008L02230
[4] https://www.legislation.gov.au/Series/F2008L02309
[5] http://www.cleanenergyregulator.gov.au/NGER/Pages/default.aspx

1. Overview

The NGER Act requires entities that reach certain thresholds to register with the agency and report their greenhouse gas emissions, energy consumption and energy production.

This guideline is intended to provide general information to assist registered reporters in defining and reporting industrial processes under the NGER Act.

This guideline should be read in conjunction with the NGER Act, the NGER Regulations and the NGER Measurement Determination. Current versions are available on the Australian Government's legislation website[6].

Industrial process emissions are a significant source of emissions in Australia and are generated from a wide variety of activities. Sources of industrial process emissions include:

- Mineral products — emissions from the consumption (heating) of carbonate materials (such as limestone) and from processes that generate carbon dioxide from the use of carbonates.
- Chemical industry — emissions from using fuels as a feedstock or reductant.
- Metal products — emissions from the use of fuels (such as coke) as carbon reductants, and from perfluorocarbons released from aluminium metal production.
- Synthetic gas emissions — the release of hydrofluorocarbons and sulphur hexafluoride including release as fugitive emissions or leakages.

Other sources of emissions released in the course of these industrial processes, such as from the combustion of fuels for energy, are not referred to in this guidance document. Further guidance[7] is available on the agency's website.

2. Mineral Products

Part 4.2 of the NGER Measurement Determination applies to any industry that generates emissions of carbon dioxide through the consumption of carbonates such as calcium carbonate (limestone) or magnesium carbonate.

In order to calculate the amount of carbon dioxide captured for permanent storage, reporters are required to use method 2 or higher. These higher order methods provide a more accurate estimate of the carbon dioxide emissions than under method 1, the default method. As the amount of carbon dioxide captured is deducted from the emissions estimate, it is necessary to have a greater level of accuracy in the emissions estimate than can be achieved by applying method 1.

2.1 Cement clinker production

Carbon dioxide is generated during the production of clinker, an intermediate product from which cement is made. The manufacture of cement involves a multi-stage process whereby calcium carbonate ($CaCO_3$) from calcium rich raw materials such as limestone, chalk and natural cement rock is heated at temperatures of approximately 1500 °C in cement kilns to form lime (CaO) and CO_2. In addition to $CaCO_3$, the raw materials used in cement production may also contain small quantities of magnesium carbonate ($MgCO_3$). On heating, $MgCO_3$ also decomposes to generate CO_2. Some clinker manufacturers also use materials containing lime

[6] http://www.legislation.gov.au/
[7] http://www.cleanenergyregulator.gov.au/NGER/Forms-and-resources/Guides-and-factsheets

and magnesium oxide as inputs into their process which can reduce the amount of CO_2 generated by that facility.

The fraction of carbonate calcined in the production of cement clinker during the year (F_{ca}) and fraction of calcination achieved for cement kiln dust lost from the kiln in the production of cement clinker during the year (F_{ckd}) are involved in emission estimations. It is intended that the parameters F_{cal} and F_{ckd} in methods 1, 2 and 3 in Division 4.2.1 of the NGER Measurement Determination be estimated by the Industry based on the principles of Section 1.13 of the NGER Measurement Determination - transparency, comparability, accuracy and completeness. Where actual data for these parameters is not available it is assumed that, at the temperatures and residence times achieved in cement (clinker) kilns, the degree of calcination achieved for all material incorporated in the clinker is 100%.

2.1.1 Method 1

Method 1 for calculation of emissions of CO_2 released from the production of cement clinker is derived from the National Greenhouse Account national methodology as published in the National Inventory Report. It involves the collection of data on the quantities of cement clinker and cement kiln dust produced and the use of the specified emission factors for cement clinker and carbon-bearing non-fuel raw material, and the actual or presumed degree of calcination of cement kiln dust produced as a result of production of cement clinker during the year. Section 4.4 of the NGER Measurement Determination sets out the calculations for method 1.

2.1.2 Method 2

Method 2 requires the derivation of more accurate, facility-specific emission factors to generate more accurate estimates of emissions of carbon dioxide from the production process. It utilises sampling and analysis of the clinker outputs to estimate the composition of its contents and, from an understanding of the chemical reactions involved in the calcination, the derivation of facility-specific emission factors. The fractions of calcium oxide and magnesium oxide in subsection 4.5(2) should only include the calcium oxide and magnesium oxide that were derived from carbonate sources and produced from the operations of the facility. Section 4.5 of the NGER Measurement Determination sets out the calculations for method 2, with sections 4.6 and 4.7 setting out the general requirements for sampling and analysis of cement clinker.

2.1.3 Method 3

Method 3 is based on the Tier 3 approach in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines). This method requires sampling and analysis of the raw materials to determine the qualities that affect emission levels such as the raw material's pure carbonate content. Section 4.8 of the NGER Measurement Determination sets out the calculations for method 3, with sections 4.9 and 4.10 setting out the general requirements for sampling and analysis of carbonates.

2.2 Lime Production

Lime is a chemical having major uses in metallurgy and construction. Lime is produced by heating carbonate raw materials in a kiln. During this process, carbon dioxide is emitted.

Lime kiln dust may be produced as part of the lime production process and can be recycled through the system. At the end of the process some lime kiln dust may remain. The quantity of kiln dust produced impacts on the emissions estimate and is included in the methods as the quantity of lime kiln dust lost as a result of the production of lime.

Emissions from the in-house production of lime in the metals industry is estimated under Division 4.2.3 of the NGER Measurement Determination. See section 2.3 of this guidance for more information.

2.2.1 Method 1

Method 1 for the production of lime is derived from the National Greenhouse Account national methodology as published in the National Inventory Report. It involves the multiplication of the quantity of lime produced by the emission factor for lime.

Lime is also produced using varying grades of limestone which contain impurities such as magnesium carbonate ($MgCO_3$). For method 1 estimation, default emission factors have been provided for lime produced using limestone with higher concentrations of magnesium carbonate.

Section 4.13 of the NGER Measurement Determination sets out the calculations for method 1.

2.2.2 Method 2

Method 2 requires the derivation of more accurate, facility-specific emission factors to generate more accurate estimates of emissions of carbon dioxide from the production process. It utilises sampling and analysis of the lime outputs to estimate the composition of its contents and, from an understanding of the chemical reactions involved in the consumption of carbonate (calcination), the derivation of facility-specific emission factors. Method 2 also factors in any carbon dioxide captured for permanent storage.

Section 4.14 of the NGER Measurement Determination sets out the calculations for method 2, with sections 4.15 and 4.16 setting out the general requirements for sampling and analysis of the lime produced.

2.2.3 Method 3

Method 3 is based on the Tier 3 approach in the 2006 IPCC Guidelines. This method requires sampling and analysis of the raw materials for qualities that affect emission levels such as the material's pure carbonate content.

Section 4.17 of the NGER Measurement Determination sets out the calculations for method 3, with sections 4.18 and 4.10 setting out the general requirements for sampling and analysis of each carbonate.

2.3 Use of carbonates for production of a product other than cement clinker, lime or soda ash

Division 4.2.3 of the NGER Measurement Determination is a catch all division for reporting of consumption or any other use of carbonates that generates carbon dioxide emissions other than the production of cement clinker and lime, soda ash or general industries. Carbon dioxide emissions from the production of cement clinker and lime are addressed in Divisions 4.2.1 and 4.2.2; soda ash is addressed in Division 4.2.4; and activities that may be likely to use carbonates that generate emissions include the industries listed in Section 4.20.

One process where limestone is consumed is the production of phosphoric acid from phosphate rock using the 'wet process'. The carbon dioxide emissions result from a secondary reaction in which limestone present in the phosphate rock reacts with the acid. The emissions associated with the consumption of limestone during phosphoric acid production should be reported under Division 4.2.3. The quantity of limestone in the phosphate rock must be known to apply the methods outlined.

2.4 Soda ash use and production

Division 4.2.4 addresses emissions from the consumption and from the production of soda ash. The consumption of soda ash generates carbon dioxide emissions regardless of the industry that consumes the product. Examples of industries that use soda ash are given in Section 4.26 of the NGER Measurement Determination.

2.4.1 Soda ash use

Method 1 is derived from the methodology used for the National Greenhouse Accounts. It involves the multiplication of the quantity of soda ash consumed in the production process by the emission factor for soda ash.

Section 4.29 of the NGER Measurement Determination sets out the calculations for method 1.

2.4.2 Soda ash production

Emissions from soda ash production arise from the consumption of fuels for energy and from the calcination of limestone and sodium bicarbonate. The production of soda ash is a multi-step process involving the generation and reabsorption of carbon dioxide. To obtain a more accurate estimation of emissions from the consumption of fuels and calcination processes, a carbon balance approach is taken.

2.5 Measurement of quantity of carbonates consumed and products derived from carbonates

Division 4.2.5 sets out how quantities of carbonates consumed from the operation of the activity and the quantities of products derived from carbonates and produced from the operation of the activity are to be estimated and used to work out the emissions released from the consumption and production of carbonates. The quantities determined under Division 4.2.5 are input into the calculations of the estimated emissions of facilities that are constituted by the production of cement clinker, the production of lime, the calcination of carbonates in an industrial process, or the use and production of soda ash.

There are four criteria available for the estimation of the quantities of carbonates, or quantities of products derived from carbonates, reflecting differing levels of measurement effort and precision: criterion A, criterion AA, criterion AAA, and criterion BBB.

Under the NGER Regulations, the criterion chosen by the reporter to estimate carbonate inputs and outputs must be reported. The reference in sections 4.37 and 4.38 of the NGER Measurement Determination to 'measuring equipment calibrated to a measurement requirement' means calibrated to a specific characteristic, such as a unit of weight, that is traceable to a measurement requirement provided for under the *National Measurement Act 1960* or any instrument made under that act for that equipment, or a measurement requirement under an equivalent standard for that particular characteristic.

Section 4.37 of the NGER Measurement Determination provides that for measurement of carbonates consumed for an activity, measured data (using measuring equipment calibrated to a measurement requirement) for carbonates delivered at the point of sale would also meet the criterion AAA under certain circumstances. These circumstances are that the change in the stockpile of carbonates for the activity during the year amounts to less than 1% of the total consumption of the carbonates from the operation of the activity on average during the year, and that the stockpile of the carbonates for the activity at the beginning of the reporting year is less than 5% of the total consumption of the carbonates from the operation of the activity during the year.

The simplified measurement of consumption criterion (criterion BBB) is available in those cases where the reporter does not purchase their carbonates and where the reporter does not have metering equipment installed that meets the requirements of criterion AAA. In these cases, it is intended that reporters should estimate consumption using metering devices or measurement techniques in practice in the industry. Such measurements would need to meet the criteria set out in Section 1.13 of the NGER Measurement Determination of transparency, comparability, accuracy and completeness. Such data would be classified and reported as 'BBB' data.

The restriction on the choice of criterion at sub-section 4.35 (3) of the NGER Measurement Determination is designed to ensure time series consistency of the measurements.

3. Chemical industry

Part 4.3 of the NGER Measurement Determination applies to any chemical industry that generates emissions of carbon dioxide by using fuels as feedstocks or as carbon reductants, as described below. Nitric acid production is also addressed below.

It is intended that estimations of fuel quantities consumed for industrial process purposes be performed in the same manner as fuels consumed by combustion in Chapter 2 of the NGER Measurement Determination.

Other sources of emissions arising from the production of the products listed below, such as from the combustion of fuels for energy purposes, are not described in this chapter and must be estimated using the methods described in other chapters of the NGER Measurement Determination.

3.1 Ammonia production

Ammonia production involves the consumption of fossil fuels for both energy and non-energy purposes. Carbon dioxide emissions are generated in the primary steam reforming process in which the source of fuel, commonly natural gas, is used to derive hydrogen. This is an example where natural gas is consumed for its non-energy purposes.

Emissions from the use of natural gas for its energy value should be separated from its non-energy purposes, if possible. Emissions and fuels consumed for energy should be estimated using methods within the NGER Measurement Determination provided for fuel combustion. Emissions and fuel use as an input into ammonia production should be estimated using methods provided in Division 4.3.1. If this separation cannot be completed then, to minimise the risk of duplication or omission all emissions from the use of gas in ammonia production should be included within the industrial processes sector using methods detailed in Division 4.3.1.

Reporters are required to use method 2 or higher to deduct the amount of carbon dioxide captured for permanent storage from the total amount of carbon dioxide emissions. These higher methods provide a more accurate estimate of the carbon dioxide emissions than under method 1, the default method. As the carbon dioxide captured is deducted from the emissions estimate, it is necessary to have a greater level of accuracy in the emissions estimate than is achieved using method 1.

3.2 Nitric acid production

The manufacture of nitric acid (HNO_3) generates nitrous oxide (N_2O) is a by-product of the high temperature catalytic oxidation of ammonia (NH_3). The level of pressure used in nitric acid production will affect the amount of emissions. Under method 1, default emission factors are available for the three broad categories of production plants. Method 2 requires periodic emissions monitoring for the determination of a more accurate emission factor.

3.3 Adipic acid production

Adipic acid is a long-chain organic acid with the Internal Union of Pure and Applied Chemistry (IUPAC) name of hexanedioic acid. Adipic acid is manufactured from the oxidation of a cyclohexanone/cyclohexanol mixture, known as ketone-alcohol oil (KA oil), by nitric acid.

No method is prescribed within the NGER Legislation for estimating emissions released in the production of adipic acid. Section 4.50 of the NGER Measurement Determination provides that reporters must use one of

the methods set out in section 3.4 of the 2006 IPCC Guidelines for measuring emissions from the manufacture of adipic acid, subject to section 1.18 of the NGER Measurement Determination.

3.4 Carbide production

Carbides are a type of compound where a metal and carbon are bonded, often in stoichiometric equivalency. Division 4.3.4 of the NGER Measurement Determination refers to section 3.6 of the 2006 IPCC Guidelines, which relates to emissions of carbon dioxide from the manufacture of silicon carbide (SiC) and calcium carbide (CaC_2).

Silicon carbide is used as an artificial abrasive, while calcium carbide is important in the manufacture of acetylene and as a reductant in electric arc steel furnaces.

No method is prescribed within the NGER Legislation for estimating emissions released in the production of carbide. Section 4.52 of the NGER Measurement Determination provides that reporters must use one of the methods set out in section 3.6 of the 2006 IPCC Guidelines for measuring emissions from the manufacture of carbides, subject to section 1.18 of the NGER Measurement Determination.

3.5 Chemical or mineral production, other than carbide production, using a carbon reductant or carbon anode

Emissions of carbon dioxide released from the use of carbon reductants or carbon anodes in the production of chemical or mineral products (other than the production of carbide) should be estimated using methods provided in Division 4.3.5 of the NGER Measurement Determination.

In order to deduct carbon dioxide captured for permanent storage reporters are required to use method 2 or higher. These higher methods provide a more accurate estimate of the carbon dioxide emissions than under method 1, the default method. As the carbon dioxide captured is deducted from the emissions estimate it is necessary to have a greater level of accuracy in the emissions estimate than is achieved using method 1.

3.6 Sodium cyanide production

Division 4.3.6 of the NGER Measurement Determination concerns emissions of carbon dioxide and nitrous oxide released from the production of sodium cyanide.

Depending on the production process employed, emissions of carbon dioxide and nitrous oxide may result. Nitrous oxide can only be estimated using method 4 under Part 1.3 or incidental emissions reporting provisions[8]. Carbon dioxide emissions can be estimated using method 1 (Section 4.66), 2 (Section 4.67), 3 (Section 4.68), 4 (Part 1.3), or incidental reporting provisions.

4. Metal industry

Part 4.4 of the NGER Measurement Determination applies to carbon dioxide emissions resulting from the production of certain metals. Perfluorocarbon emissions from aluminium production are also addressed in this part of the NGER Measurement Determination.

[8] See the Aggregated facility reporting, percentage estimates and incidental emissions and energy guideline

The quantities of fuels consumed for industrial process purposes should be estimated in accordance with the same criteria as has been set out for fuels consumption listed within Chapter 2 of the NGER Measurement Determination. The relevant Divisions under Chapter 2 of the NGER Measurement Determination set out the specific requirements.

Other sources of emissions arising from the production of the products listed below, such as from the combustion of fuels for energy, are not described in this part of the NGER Measurement Determination.

A key aspect of many of the estimated emissions calculations for this Part will be the 'carbon mass balance' approach. It is based on the concept that if a known amount of carbon has entered the process, and a known amount of carbon as left the process (either within the product, or as solid and liquid waste materials), then the difference between the input and known output must have been released as gaseous emissions.

The carbon mass balance can be simplified as:

$$\text{Emissions} = \text{Inputs} - (\text{Products} + \text{Stock increases} + \text{Waste}) \times 3.664$$

Note that a stock decrease would be a negative value and reduce the value of the second part of the equation.

All fuels and carbonaceous inputs acquired by the facility during the reporting period must be entered into the above calculation within the 'inputs' component. This includes fuels and carbonaceous inputs stored for later use, and not used in the activity within the reporting period.

The quantity of unused fuels and carbonaceous inputs acquired by the facility during the reporting period are added to the 'stock increases' component of the above calculation.

4.1 Iron, steel or other metal production using an integrated metalworks

Division 4.4.1 of the NGER Measurement Determination applies to any facility that produces iron, steel or any metals produced using an integrated metalworks. Metals such as iron, steel, lead and silicon may be produced in an integrated metalworks where the metal and coke is produced on the same site. In this case it is difficult to identify emissions attributable to each part of the production process. Accordingly, emissions are estimated from the activity as a whole by estimating the inputs and outputs. The methods for estimating emissions of carbon dioxide are based on a carbon balance approach, reducing the complexity of the calculation for these facilities.

Steel is also produced using an electric arc furnace (EAF) or similar process. While not considered an integrated metalworks, emissions from iron or steel production using an EAF are to be estimated and reported within Division 4.4.1 of the NGER Measurement Determination.

Reporters are required to use method 2 or higher to deduct carbon dioxide captured for permanent storage. These higher methods provide a more accurate estimate of the carbon dioxide emissions than under method 1, the default method. As the carbon dioxide captured is deducted from the emissions estimate it is necessary to have a greater level of accuracy in the emissions estimate than is achieved using method 1.

Note that emissions from limestone and dolomite use in iron and steel production are to be reported under Division 4.2.3 of the NGER Measurement Determination – being 'Use of carbonates for the production of a product other than cement clinker, lime or soda ash'. See 2.3 Use of carbonates for production of a product other than cement clinker, lime or soda ash of this guideline for more information.

4.1.1 Method 1

Section 4.66 of the NGER Measurement Determination sets out method 1 for the estimation of emissions from an integrated metalworks – a facility producing both a metal and coke. It specifies that emissions should be estimated using a carbon mass balance approach for the facility. Method 1 utilises carbon content factors listed in Schedule 3 in the NGER Measurement Determination. These carbon content factors are derived directly from the carbon dioxide emission factors. There are no carbon content factors specified for products or for waste by-products. It is the agency's view that these factors should be determined by the reporter based on the principles of Section 1.13 of the NGER Measurement Determination, namely transparency, comparability, accuracy and completeness.

The carbon mass balance approach requires fuels (or other carbonaceous input materials) to be estimated based on quantities of fuels delivered rather than consumed. Method 1 provides that the quantity of fuel or carbonaceous input material is to be estimated in accordance with criterion A as set out in Divisions 2.2.5, 2.3.6, 2.4.6 and 4.2.5 of the NGER Measurement Determination. However, if the fuel or carbonaceous input material is not acquired in a commercial transaction, the quantity can be estimated in accordance with industry practice, consistently with the principles in section 1.13 of the NGER Measurement Determination – transparency, comparability, accuracy and completeness.

4.1.2 Example – Estimating emissions from iron and steel production

Iron and steel production can involve integrated processes such as coke making and steel furnace operations within a facility. The complex carbon and energy flows within the integrated facility can make the estimation of total emissions difficult to estimate when a bottom-up approach is taken. The carbon mass balance provides a top-down approach that simplifies the emission estimation process, allowing the emissions to be estimated as a whole, while taking into account the carbon input and outputs to the facility as well as stockpile changes.

An emission estimation example using the method 1 carbon balance approach is provided below. The example is of an integrated iron and steel facility that uses coke oven coke, coking coal and fuel oil to produce coke, iron and then steel. The facility also produces coal tar and waste containing carbon, in addition to experiencing fuel stock changes during the year. The relevant data for the integrated iron and steel facility is outlined in the table below.

Data inputs for integrated iron and steel carbon balance example:

Fuel or product type	Fuel delivered during the reporting year	Products produced and leaving the activity during the reporting year	Change in stocks during the year	Carbon Content Factor (CCF)
Coke oven coke	-	60,000 tonnes	–5000 tonnes	0.789
Coking coal	750,000 tonnes	-	3000 tonnes	0.752
Fuel oil	3000 kilolitres	-	-	0.797

Coal tar	-	15,000 tonnes	200 tonnes	0.837
Crude steel	-	920,000 tonnes	1000 tonnes	0.0017

Step 1

Calculate the carbon content in fuel types (i) or carbonaceous input material delivered for the activity during the year measured in tonnes of carbon as follows:

Where: $\sum_i CCF_i \times Q_i$

CCFi is the carbon content factor measured in tonnes of carbon for each appropriate unit of fuel type (i) or carbonaceous input material consumed during the year from the operation of the activity.

The method 1 default carbon content factors can be found in Schedule 3 of the NGER Measurement Determination.

Qi is the quantity of fuel type (i) or carbonaceous input material delivered for the activity during the year measured in an appropriate unit and estimated in accordance with criterion A in Division 2.2.5, 2.3.6 and 2.4.6. In this case the quantities of input materials are shown in the table above.

> When reporting fuels against the activity in EERS, the value of *Qi* is entered along with the measurement criteria used.

To calculate the carbon content for the input materials:

- carbon content of coking coal = (750,000 x 0.752) = 564,000 tonnes of carbon
- carbon content of fuel oil = (3,000 x 0.797) = 2,391 tonnes of carbon,

therefore, total carbon = (564,000 + 2,391) = 566,391 tonnes.

> Note that all the 750,000 tonnes of coking coal acquired during the reporting period is included within this step of the calculation.
>
> The 3000 tonnes of coking coal that was not consumed and instead added to a stockpile on-site will be considered during Step 4 of the calculation.

Step 2

Calculate the carbon content in products (p) leaving the activity during the year measured in tonnes of carbon as follows:

Where: $\sum_p CCF_p \times A_p$

CCFp is the carbon content factor measured in tonnes of carbon for each tonne of product type (p) produced during the year. In this case the carbon content factor of each product type is shown in the table above.

Ap is the quantity of product types (p) produced leaving the activity during the year measured in tonnes. In this case the quantity of product is shown in the table above.

To calculate the carbon content for the products leaving the activity during the year:

- carbon Content of crude steel = (920,000 x 0.0017) = 1,564 tonnes of carbon
- carbon Content of coke oven coke = (60,000 x 0.789) = 47,340 tonnes of carbon
- carbon Content of coal tar = (15,000 x 0.837) = 12,555 tonnes of carbon,

therefore, total carbon = (1,564 + 47,340 + 12,555) = 61,459 tonnes.

Step 3

Calculate the carbon content in waste by product types (r) leaving the activity, other than as an emission of greenhouse gas, during the year, measured in tonnes of carbon, as follows:

Where: $\sum_r CCF_r \times Y_r$

CCFr is the carbon content factor measured in tonnes of carbon for each tonne of waste by product types (r).

Yr is the quantity of waste by product types (r) leaving the activity during the year measured in tonnes. In this case the quantities of waste by-products are:

- Slag, of which 230,000 tonnes was produced. The facility estimated the carbon content of the slag was 0.0005 tonnes per tonne of slag.
- Other non-oxidised carbon sources estimated in accordance with the NGER Measurement Determination as being 1500 tonnes.

To calculate the carbon content for the waste products leaving the activity during the year:

- carbon Content of slag = (230,000 x 0.0005) = 115 tonnes of carbon
- carbon Content of other non-oxidised carbon = 1500 tonnes of carbon,

therefore, total carbon = (115 + 1,500) = 1,615 tonnes

Step 4

Calculate the carbon content in the amount of the increase in stocks of inputs, products and waste by products held within the boundary of the activity during the year in tonnes of carbon as follows:

Where: $\sum_i CCF_i \times \Delta S_{qi} + \sum_p CCF_p \times \Delta S_{ap} + \sum_r CCF_r \times \Delta S_{yr}$

CCFi has the same meaning as in step 1.

ΔSqi is the increase in stocks of fuel type (i) for the activity and held within the boundary of the activity during the year measured in tonnes. In this case the quantities of increases in stocks are shown in the table above.

To calculate the carbon content for increase of fuel types:

- Carbon content of coke oven coke = (–5000 x 0.789) = –3945 tonnes of carbon

- Carbon content of coking coal = (3000 x 0.752) = 2256 tonnes of carbon,

therefore, total carbon = (–3945 + 2256) = –1689 tonnes

CCFp has the same meaning as in step 2.

ΔSap is the increase in stocks of product types (p) produced by the activity and held within the boundary of the activity during the year measured in tonnes. In this case the quantities of product types shown in the table above.

To calculate the carbon content for increase in stock of product type:

- Carbon content of coal tar = (200 x 0.837) = 167.4 tonnes of carbon
- Carbon content of crude steel = (1000 x 0.0017) = 1.7 tonnes of carbon,

therefore, total carbon = (167.4 + 1.7) = 169.1 tonnes.

CCFr has the same meaning as in step 3.

ΔSyr is the increase in stocks of waste by product types (r) produced from the operation of the activity and held within the boundary of the activity during the year measured in tonnes.

There was no change in waste product stock produced and held during the year.

To calculate the total carbon contained in the change of stock:

- Carbon content of increase in fuel types = –1689 tonnes
- Carbon content of increase in product types = 169.1 tonnes
- Carbon content of increase in waste by-products = 0 tonnes,

therefore, total carbon = (–1689 + 169.1 + 0) = –1519.9 tonnes.

Step 5

Calculate the emissions of carbon dioxide released from the operation of the activity during the year measured in CO_2-e tonnes as follows:

a) add the amounts worked out under steps 2, 3 and 4 to work out a new amount (amount A)

In this case A is:

= 61,459 + 1,615 + –1,519.9

= 61,554.1 tonnes of carbon.

b) subtract amount A from the amount worked out under step 1 to work out a new amount (amount B)

In this case B is:

= 566,391 – 61,554.1

= 504,836.9 tonnes of carbon.

c) multiply amount B by 3.664 to work out the amount of emissions released from the operation of the activity during a year.

= 504,836.9 x 3.664

= 1,849,722.4016 tonnes CO_2-e,

therefore, total carbon balance CO_2 emissions from the source = 1,849,722 tonnes.

4.2 Ferroalloys production

Division 4.4.2 of the NGER Measurement Determination applies to the estimation of carbon dioxide emissions from the production of a ferroalloy, including silicomanganese and silicon. The formulas for methods 1, 2, and 3 for determining emissions under Division 4.4.2 are similar to the formulas for methods 1,2, and 3 set out in Division 4.4.1 of the NGER Measurement Determination, and accordingly, Part 4.1 of this guidance will be of assistance in interpreting this Division. Method 4, under Part 1.3 of the NGER Measurement Determination, is the same for both Divisions.

4.3 Aluminium production – Carbon dioxide emissions

Division 4.4.3 of the NGER Measurement Determination lists the methods available to estimate carbon dioxide emissions that result from aluminium production. Separate subdivisions of the NGER Measurement Determination specifically relate to the individual sources of emissions:

- Subdivision 4.4.3.1 – Emissions from consumption of carbon anodes in aluminium production.
- Subdivision 4.4.3.2 – Emissions from production of baked carbon anodes in aluminium production.

4.4 Aluminium production – Perfluoronated carbon compound emissions

Division 4.4.4 of the NGER Measurement Determination lists the methods available to estimate perfluoronated carbon compound emissions resulting from aluminium production. Separate subdivisions of the NGER Measurement Determination relate to different compounds:

- Subdivision 4.4.4.1 – Emissions of tetrafluoromethane in aluminium production.
- Subdivision 4.4.4.2 – Emissions of hexafluoroethane in aluminium production.

Methods 2 and 3 involve measurement of the anode effect event data to estimate a more accurate quantity of emissions. The NGER Measurement Determination refers to this document as the Perfluorocarbon protocol – the full title is: Protocol for Measurement of Tetrafluoromethane (CF_4) and Hexafluoroethane (C_2F_6) Emissions from Primary Aluminium Production. It was published by the US EPA and the International Aluminium Institute in 2008 and is referenced in the International Aluminium Institute Greenhouse Gas Protocol[9].

4.5 Other metals production

Division 4.4.5 of the NGER Measurement Determination concerns other metals production and applies to emissions from consumption of a fossil fuel reductant and oxidation of a fossil fuel electrode, other than the production of aluminium, ferroalloys, iron, steel, or any other metal produced using an integrated metalworks. The formulas for methods 1, 2, and 3 for determining emissions under Division 4.4.5 are similar to the formulas for methods 1, 2, and 3 set out in Division 4.4.1 of the NGER Measurement Determination,

[9] http://www.world-aluminium.org/media/filer_public/2013/01/15/fl0000234.pdf

and accordingly, Part 4.1 of this guidance will be of assistance in interpreting this Division. Method 4, under Part 1.3 of the NGER Measurement Determination, is the same for both Divisions.

5. Emissions from the use of hydrofluorocarbons and sulphur hexafluoride

Part 4.5 of the NGER Measurement Determination concerns the emissions from the use of hydrofluorocarbons and sulphur hexafluoride.

Due to the widespread use of these gases across multiple industries, the agency has created a specific guideline on this part of the NGER legislation. See Reporting hydrofluorocarbons and Sulphur Hexafluoride gases guideline for more information[10].

More information

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Website: www.cleanenergyregulator.com.au

[10] http://www.cleanenergyregulator.gov.au/NGER/Forms-and-resources/Guides-and-factsheets