

Emissions Inventory Reporting

Reference number: GN 25

Document Owner: Regulatory Business Board (ITG)

What is this document about?

This document provides guidance for operators reporting emissions to the Natural Resources Wales Emissions Inventory

The Emissions Inventory is the Natural Resources Wales (NRW) equivalent of the Environment Agency's Pollution Inventory. The Emissions Inventory collects data about emissions from the industrial activities we regulate. Emissions data includes releases to air and controlled waters, off-site transfers of waste and transfers of pollutants to wastewater. This data is collected from operators annually.

The Emissions Inventory is used to provide information to the public and to policy makers, so that they can make informed decisions about how we manage our environment for future generations. It also helps Government to meet its national and international environmental reporting commitments, the National Atmospheric Emissions Inventory [NAEI](#) and the European & UK Pollutant Release and Transfer Registers ([E-PRTR](#) and [UK-PRTR](#))

Who is this document for?

This guidance is for operators who have received an EPR Regulation 61 notice requiring them to report emissions data to the Emissions Inventory. It provides information to help you to make an accurate return and outlines some general principles. It is also an aide for NRW personnel to provide clarity on what is required from operators with regard to reporting emissions to air and water, and off site transfers of waste.

You can find more detailed advice in Annex 1 of this document which includes additional information on quantifying emissions

Contact for queries and feedback

PRTR National Data manager – PRTR.national.manager@cyfoethnaturiolcymru.gov.uk

Version History

Document Version	Date Published	Summary of Changes
1.0	02/2018	Document published in DRAFT – air emissions only
2.0	January 2019	Amended to include all emissions
Review Date: Dec 2020		

To report issues or problems with this guidance [contact Guidance Development](#)

Contents

1	How to report	4
2	Guidance for specific sectors.....	5
3	Reporting releases.....	6
3.1	Releases to air	7
3.2	Releases to controlled waters	8
3.3	Off-site transfers in waste water	8
3.4	Waste transfer data.....	8
4	Reporting conventions - help to complete the reporting form	8
4.1	Total releases (including notifiable releases)	8
4.2	Accidental releases (Notifiable releases)	9
4.3	Fugitive releases	9
4.4	Limit of detection	9
4.5	Mass units and significant figures	10
4.6	Codes for methods used to determine releases.....	10
4.7	Reporting substances – general principles:.....	12
5	Guidance on monitoring techniques	13
6	Sources of information for emission factors and release determination.....	13
6.1	Releases to air (in priority order for UK use)	13
6.2	Releases to water	14
6.3	Other sources of information	14
	Annex 1: Additional technical guidance	15
I.	Quantification of emissions to air	15
a.	Sampling data	15
b.	Continuous emission monitoring systems (CEMS) data.....	17
c.	Emission factors	19
d.	Carbon dioxide factors.....	20
e.	Carbon dioxide excluding biomass	21
f.	Dioxins and Furans.....	21
II.	Quantification of emissions to water	21
a.	Direct measurement techniques.....	21
b.	Mass Balance techniques.....	22
c.	Emission factors	22
d.	Subtracting the background load	22
e.	Calculating the mass emission	22
III.	Reporting basis.....	23
IV.	Converting emissions - ppm to mg/m ³ and vice versa	23

1 How to report

Since 2016, operators in Wales have submitted their emissions data to the NRW Emissions Inventory via an online reporting system operated by Ricardo Energy & Environment (Ricardo). This has replaced the Environment Agency's online Pollution Inventory reporting system, PIEDC

There are differences in the data that operators are required to report to the Emissions Inventory compared to what was previously required for the Pollution Inventory:

- The list of pollutants is different: fewer pollutants are required. (The list of pollutants is reduced to only those required for E-PRTR and NAEI (the National Atmospheric Emissions Inventory.) These pollutants are detailed in Schedule 1 of the Emissions Inventory EPR Regulation 61 notice sent to all operators since 2016.
- You are no longer required to report disposal and recovery codes and EWC codes for waste transfers. Waste is reported as disposal and recovery total figures for non-hazardous domestic waste, hazardous domestic waste and trans-boundary hazardous waste.

You must make your annual return online via the PRTR online reporting system <http://prtr.defra.gov.uk/data-entry-system/>. It is not possible to submit a paper return.

If you have any problems using or gaining access to this system, please contact the NRW PRTR site administrator by email PRTR.national.manager@cyfoethnaturiolcymru.gov.uk

The online reporting system will be available to operators from the second week of February of each year for reporting emissions data for the previous calendar year, and the deadline for submitting data will be **31 March** each year.

You need to use the best data and techniques available to you, including any samples analysed and monitoring data. We do not require you to do additional monitoring and this guidance will help you to quantify releases where you do not have site-specific data available.

General guidance about how to report and how to use the online reporting system is in the document *PRTR Data Management System Operator User Guidelines Report for NRW* which is available on the online reporting system login page by clicking the *View operator guidelines for the PRTR Data Entry system for NRW sites* link:



Welcome

If you have access to the PRTR Data Entry system, please login with your email address and password below.

Your email address

Your password

By logging in you are agreeing to the [PRTR Data Entry System's cookie policy](#).

Login

[Help! I've forgotten my username and password](#)

Information

» This is a secure site for registered users only. If you are a new user and wish to create an account please contact your Local Authority who will do this for you. If you are unsure who this is please [contact the Defra site administrator](#). If you are regulated by Natural Resources Wales (NRW) please [contact the NRW site administrator](#).

» [View the PRTR Data Submission Timetable](#) for Local Authority sites

» [View the PRTR Data Submission Timetable](#) for NRW sites

» [View Operator guidelines for the PRTR data entry system](#) for Local Authority sites

» [View Operator guidelines for the PRTR data entry system](#) for NRW sites

» [View Local Authority Data Manager Guidelines for PRTR data entry system](#)

» [View Regional Data Manager Guidelines for PRTR data entry system](#)

If you need help with reporting your emissions, please speak to your local Natural Resources Wales contact or you can call our general enquiries number.
General enquiries: 0300 065 3000 (Mon-Fri, 9am-5pm)

Email: enquiries@naturalresourceswales.gov.uk

2 Guidance for specific sectors

There is an NRW guidance note for intensive farming (GN25a) which is available on our website.

You can still refer to the Environment Agency Pollution Inventory sector-specific guidance for guidance about relevant substances and calculation of emission factors but please bear in mind the differences between the Emissions Inventory and the Pollution Inventory described in the previous section. This guidance can be found on the Gov.uk website:

<https://www.gov.uk/government/publications/pollution-inventory-reporting-guidance-notes>

- combustion
- refineries

- cement and lime
- incineration
- paper and pulp
- landfill
- waste transfer stations
- chemical treatment of waste, including waste oil
- food & drink
- mines and quarries
- ferrous & non-ferrous metals
- chemicals

3 Reporting releases

The reporting process for emissions to air and water follows four basic steps:

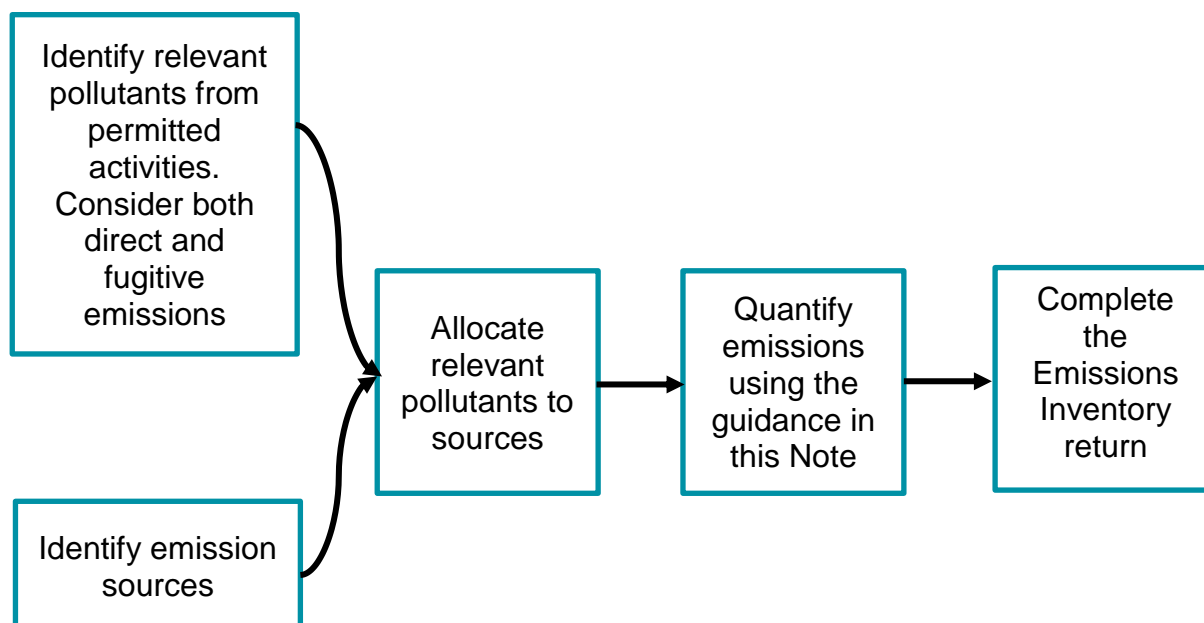
Step 1 - identification of relevant pollutants

Step 2 - identification of emission sources

Step 3 - quantification of emissions

Step 4 - completing the Emissions Inventory return

These steps are shown in the following flowchart. The process is described in more detail in the Annex to this note.



You should use an appropriate release estimation technique (RET) to quantify your emissions.

There are four types of RET:

- sampling or direct monitoring;
- emission factors;
- fuel analysis or other engineering calculations; and
- mass balance.

Depending on the particular site, pollutant or process, any of the above techniques may be the most appropriate. You should have an understanding of the factors that lead to the selection of the most appropriate RET and be able to justify why the technique has been selected. You should always select the RET based on the application for which it has been designed.

Some mandatory RETs exist, such as when reporting emissions under EU Directives or in accordance with permit conditions. An example is the reporting requirement under the European Emissions Trading Scheme (2003/87/EC) for greenhouse gases.

In the absence of mandatory or industry methodologies, you should use site-specific data in the form of monitored emission concentrations or mass balance techniques where appropriate. Ideally, measured emission concentrations should be based on data obtained using appropriately certified equipment, and/or accredited services. You should normally use continuous monitoring data in preference to periodically sampled data.

Where emission factors are used, you should give preference to site-specific emission factors rather than those developed from other representative plant. However, to develop a site-specific emission factor you will need to relate the level of emissions to an activity within the process. This is normally achieved by sampling and monitoring, from the manufacturer's information or by calculation.

Some emissions from a process will have more impact on the environment than others. You need to concentrate efforts, and use the most accurate RETs, on those emissions that have associated emission limit values in a permit and also on those which exceed the Emissions Inventory reporting threshold values the most.

The four RETs relate principally to representative operating conditions. Emissions resulting from significant operating deviations (for instance failure of abatement plant) and/or accidental events, such as spills, also need to be estimated. In the case of air emissions from spillage events, it may be necessary to make an estimate of the amounts of substances released as vapour. For all spills, you should report the net emission, that is, the quantity of the substance spilled minus the quantity recovered or consumed during clean-up operations.

Contact us if an emission factor or other emission estimation technique is not available.

3.1 Releases to air

In this context, 'air' includes both the inside and outside of a building. Take care not to double count when you are quantifying the amounts released from a given point. For example, if you have vapours coming off a process inside a building which are then collected and discharged through a stack, only count the emissions from the stack. If you

have some collected vapours and some which are not collected but escape through doors and windows, you will need to count both.

3.2 Releases to controlled waters

These include:

- Groundwaters (G) - any waters contained in underground strata.
- Rivers and inland waters (R) - this includes surface fresh waters, that is those inland surface fresh waters which are not part of, and are upstream of, an estuary.
- Estuary (E) - the transitional area at the mouth of a river between fresh water and coastal waters. The UK has established estuary boundaries and we hold maps of these.
- Sea (S) - coastal waters up to three miles from the coast with respect to a landward baseline. We hold maps of this baseline.

3.3 Off-site transfers in waste water

This comprises all relevant substances transferred to wastewater treatment plant via sewer or other means, for example by tanker. As with air emissions, take care not to double count. For example, if you transfer effluent within your site, or pre-treat it before discharge to sewer, only count the final discharge from the site.

3.4 Waste transfer data

You need to report the total amount of non-hazardous and hazardous waste transferred off site during the year for disposal or recovery. Exclude liquid wastes transferred via sewer or other means to wastewater treatment plant (report these as substance-specific off-site transfers in wastewater).

Ensure that waste is described accurately as being sent for recovery or disposal. Recovery of waste includes recycling, re-use, processing to extract secondary raw materials or use primarily as a fuel to generate energy (co-incineration). Disposal covers operations other than recovery, for example landfill or burning of waste in an incineration plant.

You do not need to provide details of each waste classification code and disposal or recovery codes. However, if you transfer hazardous waste to another country you will need to provide details of the company and site it is transferred to.

You should not report wastes that are temporarily stored on site by yourself, as these are not classed as off-site waste transfers for the Emissions Inventory. However, waste transferred to third parties (even if stored on your site), should be reported.

4 Reporting conventions - help to complete the reporting form

4.1 Total releases (including notifiable releases)

You must report your total annual mass releases or transfers for each pollutant and each medium in the *Total (including accidental)* field. Include point source, fugitive and any notifiable releases in this figure.

You should report the mass emission of every substance that you are required to monitor in your permit. The system may flag up the amount as below the reporting threshold, but including this data in your submission makes for a more complete national inventory of emissions.

You do not need to enter N/A for substances that are not released from your process. The system will assume that they are not applicable if you leave the field blank; although it may flag up a warning if you have entered data for that substance previously.

You should add an explanatory comment to the *Remarks* field if the release is significantly higher or lower than normal.

4.2 Accidental releases (Notifiable releases)

These are unplanned and unauthorised releases of a particular substance or substances to the environment. They may result from an emergency, mis-operation, accident or plant failure. The permit or authorisation requires you to provide us with a specific notification, followed by specific information on the releases. If they were made during the reporting year, the amounts released should be quantified and detailed in the Accidental Release field and included with any other releases in the Total (including accidental) field. You should estimate the mass lost to each release medium. There is no reporting threshold for this category. If none has taken place then leave the Accidental Release field as 0.000000.

4.3 Fugitive releases

These are emissions that are not released from a point source such as a chimney. Examples include dust emissions from stockpiles and volatile substances that are not captured by abatement equipment.

4.4 Limit of detection

If the best available information indicates that a substance is not released from your process, then you don't need to enter a value for that substance. Where a substance may be released but at a release concentration that is below the limit of detection, you also don't need to enter a value unless an alternative release estimation technique, such as mass balance, produces an applicable result. By limit of detection we mean the lowest concentration which can be measured by the analytical method prescribed in the Permit, or such other method as we approve.

We recognise that there may be circumstances where some analyses in a series do not detect a substance but others do. Provided that no more than 5% of the readings show a positive value, and the values obtained are not more than 20% above the accepted limit of detection, you can treat them as if they were also reported as below the limit of detection. In any other case, use the values obtained and make the assumption that where the substance is reported as not detected it is present at 50% of the LOD. In these cases, you need to multiply each concentration (that is, those measured at above the LOD as measured and those measured at below the LOD as $\frac{1}{2}$ of the LOD) by the total flow during the period that the measurement relates to in order to determine the mass emission. In some cases, we may have agreed a different methodology with you for a particular substance or process. If so, use this in place of the procedure above.

4.5 Mass units and significant figures

Quote all releases to air and water and transfers to wastewater in kilograms (Kg) per year with three significant figures. Rounding to three significant figures does not refer to the statistical or scientific uncertainty but provides a common standard for all reported data. When rounding the figures, please note that the numbers 5 and higher should be revised up and 4 or lower should be revised down. Examples of rounding raw data to 3 significant figures are shown below:

Original result of the release determination	Result to be reported (to 3 significant figures)
0.0123456 kg/year	0.0123 kg/year
1.54789 kg/year	1.55 kg/year
7,071.567 kg/year	7,070 kg/year
123.45 kg/year	123 kg/year
10,009 kg/year	10,000 kg/year

4.6 Codes for methods used to determine releases

Choose the code that corresponds to the method you used to determine the largest proportion of the annual releases. The three code types are:

- **Measurement (M)** – based on standardised or accepted methods. You may need additional calculations to convert into annual releases. Continuous release monitoring will yield the most accurate figures. Use ‘measurement methods’ where:
 - release data is based on measurements (even if additional calculations are needed to convert the results of measurements into annual release data)
 - the annual releases are determined based on the results of short-term and spot measurements
 - the releases of a facility are derived from direct monitoring results for specific processes at the facility, based on actual continuous or discontinuous measurements of pollutant concentrations for a given release route.
- **Calculation (C)** – based on nationally or internationally agreed estimation methods and emission factors that represent the industrial sectors. This covers activity data such as fuel used, production, mass balance approaches and published references. Use ‘calculation methods’ where:
 - release data is based on calculations using activity data (fuel used, production rate, etc.) and emission factors or mass balances. In some cases, more complicated calculation methods can be applied, using variables like temperature, global radiance etc.
- **Estimation (E)** – these are non-standardised and are based on expert judgement. Use the ‘estimation method’ where:

- the release data is determined by best assumptions or expert guesses that are not based on publicly available references or in case of absence of recognised emission estimation methodologies or good practice guidelines. This method is also sometimes referred to as calculations done on the ‘back of an envelope’. No further code selection is required when using the estimation method.

Each measurement method has a number of suffix options to further categorise the method. These are:

- ISO – internationally approved standard. This is either a CEN¹ or ISO² standard (for further info please see Appendix 3, page 103 of: http://prtr.ec.europa.eu/docs/en_prtr.doc) or methods described in the following sources:
 - Guidelines for the monitoring and reporting of greenhouse gas emissions under the Emission Trading Scheme https://ec.europa.eu/clima/policies/ets/monitoring_en
 - Intergovernmental Panel on Climate Change Guidelines
 - <https://www.ipcc-nggip.iges.or.jp/public/2006gl/>
 - EMEP/EEA air pollutant emission inventory guidebook - 2016 <https://www.eea.europa.eu/publications/emep-eea-guidebook-2016>

Please note that you will only be prompted to enter either the CEN or ISO codes if the M-ISO or C-ISO options are selected,. Please note that your entry should match the number given in the above link.

- PER – method specified in a permit condition
- ALT – an alternative measurement method, which is equivalent to existing CEN/ISO measurement standards
- WEIGH – Where the substance is weighed (eg for waste)
- SSC – European-wide sector specific calculation method
- OTH – other measurement or calculation methodology.

Other method type codes are defined in http://prtr.ec.europa.eu/docs/en_prtr.doc

Choose the appropriate code from the drop-down menu which corresponds to the method you have used to determine the largest proportion of the annual release of a specific substance. If it is 50/50, then make your own choice.

¹ European Committee for Standardisation

² International Organisation for Standardization

Worked examples – how to obtain method codes

Example 1: The annual release of a substance to air from a plant was determined purely from monitoring data of stack releases, and there were no other sources of this substance to air from the plant – choose M.

Then select the appropriate detailed measurement method from the drop-down list.

Example 2: The annual release of a substance to air was determined from three processes by different approaches

- 30% of the total from measurement (releases from a stack)
- 15% of the total by estimation (fugitive releases)
- 55% of the total by calculation (releases from vents)

The greatest proportion of the total annual releases to air was determined by calculation – choose C.

Then select the appropriate detailed calculation method from the drop-down list.

4.7 Reporting substances – general principles:

- For inorganics and organics, you should report the total mass of the specified substance.
- For metals and compounds you should convert the mass of each relevant compound to the mass of the metal it contains.
- For other substance groups, you should normally report the total mass although there are some specified exceptions (for example dioxins and furans).

You can find guidance on reporting specific substances and substance groups in the sector guidance notes and in the Annex, below.

5 Guidance on monitoring techniques

If you are using source monitoring data to generate annual mass releases, you can download best practice guidance from the EA series of Monitoring Technical Guidance Notes. Use the links below to go straight to the publication.

Report number	Report title
M1	Sampling requirements for stack-emissions monitoring
M2	Monitoring of stack emissions to air
M17	Monitoring ambient particulate matter in ambient air around waste facilities
M18	Monitoring discharges to water and sewer
M20	Quality assurance of continuous emissions monitoring systems
MCERTS for flow monitoring	Minimum requirements for the self monitoring of flow

Additionally, a range of documents on good monitoring practice has been published by the International Standards Organisation (ISO), the European Committee for Standardisation (CEN), the British Standards Institute (BSI) and a number of other organisations including the German and American standards organisations (DIN & ASTM respectively). You can find details via the following web links.

ISO <http://www.iso.org>

CEN <http://www.cen.eu/cenorm/homepage.htm>

BSI <https://www.bsigroup.com/en-GB/>

DIN <https://www.din.de/en>

ASTM <http://www.astm.org>

6 Sources of information for emission factors and release determination

6.1 Releases to air (in priority order for UK use)

The National Atmospheric Emissions Inventory (NAEI): This includes estimates of releases of 19 atmospheric pollutants. It is useful for estimating releases from industrial combustion processes and for VOC speciation. <http://www.naei.org.uk/>

Atmospheric Emission Inventory Guidebook: A task force on emission inventories within the UNECE's EMEP programme maintains this. It contains updated chapters for specific source sectors, where all available emission factors and calculation methods are collected. It is a useful source of emission factors which are not available from the NAEI. <https://www.eea.europa.eu/publications/emep-eea-guidebook-2016>

Intergovernmental Panel on Climate Change (IPCC): The IPCC has produced guidelines for the establishment of emission inventories of greenhouse gases within its National Greenhouse Gas Inventory Programme (NGGIP). The revised IPCC guidelines (1996) for national greenhouse gas inventories contain emission factors and release estimation methods for all sectors as defined in the United Nations Framework convention on Climate Change. Furthermore, the IPCC developed a report on 'Good practice guidance and uncertainty management in national greenhouse gas inventories'. This can be downloaded from the website. <http://www.ipcc-nggip.iges.or.jp/>

USEPA Office of Air Quality Planning and Standards: USEPA maintains a comprehensive website where all material on emission factors and release estimation methods in the US can be viewed and, in many cases, downloaded. In general, emission factors from these sources should only be used in the absence of appropriate UK or European values. <https://www.epa.gov/chief>

Environment Australia: Australian Emission Estimation Technique industry manuals. <http://www.npi.gov.au/publications/emission-estimation-technique/index.html>

6.2 Releases to water

OSPAR Commission: Information on the releases and pollutants to water covered by this agreement <https://www.ospar.org/>

6.3 Other sources of information

European IPPC bureau and BREF documents: The Industrial Emissions Directive (IED) states that the conditions of permits Member States issue on Annex I activities must be based on Best Available Techniques (BAT) to achieve a high level of protection of the environment as a whole. The European IPPC Bureau is developing, in co-operation with Member States and industry, a series of reference documents to cover, as far as practicable, most of the Annex I activities. These documents are called BAT Reference Documents – BREFs.

They contain information on:

- production processes and techniques
- current release levels
- release reduction measures and techniques in the determination of BAT

The BREF documents are posted on the European IPPC Bureau website: <http://eippcb.jrc.ec.europa.eu/reference/>

UNEP: United Nations Environment Programme, 'Inventory on information sources on chemicals': <https://www.unenvironment.org/resources/report/persistent-organic-pollutants-inventory-information-sources-chemicals>

Annex 1: Additional technical guidance

This annex explains how to convert periodic or continuous monitoring results into mass emission data needed for the emissions inventory. It also explains how to use emission factors to report your releases where these are appropriate.

I. Quantification of emissions to air

a. Sampling data

To use sampling data to estimate emissions, information is required on both the flow rate and pollutant concentration. To determine annual emissions accurately, sampling for Emissions Inventory reporting should be performed under conditions representative of annual operations and, ideally, in accordance with methods or standards that we have approved.

Take care with relying on the results of one spot sample in order to report annual emissions, unless you are certain that the process conditions are representative of annual average operations. Where a process has a number of steady state conditions, it may be necessary to take samples under each operating condition and average the result according to the length of time the process operates at each condition. Similarly, where process conditions at the time of the spot sampling are uncertain, it may be necessary to take several samples and to average the results in order to provide the final annual emission estimate. Use good engineering judgement to select the most appropriate sampling time and data to use. You need to be able to justify the sampling programme selected.

Sampling as part of a permit condition may require that the monitoring be undertaken at maximum load (that is, higher than annual operating conditions) and this should be taken into account in the annual emission estimates. When in doubt, the proposed sampling protocols should be confirmed with us.

To estimate annual emissions from sampling data, the first step is to multiply the measured emission concentrations by the volumetric flow rates of the emission source at the time of the test. Assuming that representative sampling has been undertaken, these emission rates are then aggregated together for the annual operating period. More information on how mass emissions can be calculated from pollutant concentration data and volumetric flow rates is highlighted in the box below (taken from TGN M2):

Mass Emissions and Volumetric Flow Calculations

To convert a concentration to a mass emission, it is necessary to know the volume flow rate of gas discharged from the stack.

Stack gas volume flow rate ($\text{m}^3 \text{s}^{-1}$) = velocity of stack gas (m s^{-1}) x cross-sectional area of stack (m^2)

Mass emission rate (mg s^{-1}) = concentration measured (mg m^{-3}) x stack gas volume flow rate ($\text{m}^3 \text{s}^{-1}$)

Mass emissions (mg) = Mass emission rate (mg s^{-1}) x time period (s)

Note 1: volume flow rate and concentration must be at the same reference conditions.

Note 2: measurement uncertainties are not subtracted from mass emission results.

Normally, when continuous monitoring is used, the half-hourly or hourly mass emission is calculated from the half-hourly or hourly average concentration and the average stack gas volume flow rate. The concentration and flow rate should be at the same reference conditions. These values can be summed over longer periods, such as, monthly or annually. Larger mass units, such as kg, tonnes or kilo tonnes, are used for these longer time periods.

For combustion plants that do not have continuous monitoring (typically < 100 MW), the annual total stack gas volume can be calculated from annual fuel consumption (see Annex E of EN ISO 16911-1 – velocity and volume flow rate). The annual mass emission is determined from the annual average measured pollutant concentration multiplied by the annual stack gas volume. It is good practice to verify the calculation by measuring the stack gas volume flow rate using either a velocity or tracer injection method, according to EN ISO 16911-1.

Take care to ensure that the emission concentration and flow rate are compatible. For example, normalised emission concentrations should be multiplied by normalised volumetric flow rates or actual, measured emission concentrations multiplied by actual, measured volumetric flow rates. Normalised emission rates are quoted in terms of a standard oxygen concentration, and are usually dry gas, at a temperature of 273K and a pressure of 101.3 kPa. It is always good practice to confirm the basis of measured data.

Sampled emission concentrations are also often reported in parts per million (ppm). In order to estimate annual emissions, these need to be converted to mg/m^3 at the emission temperature at which the volumetric flow rate is measured. Formulae for converting ppm to mg/m^3 are contained in Section IV of this Appendix.

The following section shows how to calculate emissions based on stack sampling data expressed in mg/m^3 . An example involving PM_{10} emissions is included, although the same general methodology is applicable for the majority of the substances listed on the Emissions Inventory.

$$(1) E = C \times Q \times 0.0036 \times [\text{Op Hours}]$$

Where:

E = emission rate of pollutant in kg/yr

C = pollutant concentration (mg/m³)

Q = volumetric flow rate of the emission (m³/s)

0.0036 = the conversion factor from mg/s to kg/hr

Op hours = the operating hours of the activity per year

Where the pollutant concentration is consistent over the averaging period (i.e. one year), equation (1) can be written as:

$$(2) E = C \times M \times V \times 10^{-6}$$

Where:

E = emission rate of pollutant in kg/yr

C = average pollutant concentration (mg/m³)

M = mass of feedstock in one year (kg feedstock)

V = standard volume of flue gas per tonne of feedstock (m³/kg feedstock)

Example 1: PM₁₀ emissions using equation (1):

Operating hours = 24 hours/day, 280 days per year

PM₁₀ emission concentration = 20 mg/m³ (normalised to 273K, dry, 11% oxygen)

Emission volumetric flow rate = 10 m³/s (normalised to 273K, dry, 11% oxygen)

$$\begin{aligned} E &= C \times Q \times 0.0036 \times 24 \times 280 \\ &= 20 \times 10 \times 0.0036 \times 24 \times 280 \\ &= 4,838 \text{ kg/yr} \end{aligned}$$

The use of continuous emission monitoring systems (CEMS) is considered below. In essence, this follows the same principles as using spot sampling data.

b. Continuous emission monitoring systems (CEMS) data

Although CEMS can report real-time emissions over a variety of time periods automatically, it may be necessary to determine annual emissions manually from such data, especially for periods where data may be out of tolerance. In any case, where annual emissions are calculated within the software of a CEMS, it is good practice to check the data manually in order to ensure that the automatic calculations are accurate.

Confidence Intervals must not be subtracted from the average values generated from the raw emissions data, prior to calculation of annual mass emissions reporting to the Emissions Inventory (unless part of an over-riding written agreement with NRW).

Prior to using CEMS to determine emissions, we would prefer you to agree the methodology for collecting and averaging the data with us.

The basic equation for determining emissions is equation (1), adjusted for the appropriate time period of the measurement. It must be applied for each time period for which emission measurements are available in the year, following the guidance given in Section I a. Normally, the measurement time periods are the same, such that it is possible simply to multiply the average emission rate by the operating time per year to obtain the annual emission. However, it may be that the measurement time periods vary, and then equation (3) should be used:

$$E = \sum_1^n (E_i \times t)$$

Where:

E = emission rate of pollutant in kg/yr

E_i = emission rate of pollutant over time period t

t = time period for emission measurement

Example 2: SO₂ emissions calculated using equation (3)

Based on the average CEMS data for 6 days of a week. It is assumed that the process operates for 24 hours per day, 48 weeks per year and that the CEMS data are representative of annual operations.

E1 = 13.2 kg/hr	E4 = 12.2 kg/hr
E2 = 12.6 kg/hr	E5 = 14.0 kg/hr
E3 = 11.2 kg/hr	E6 = 13.4 kg/hr

$E = [(13.2 \times 24) + (12.6 \times 24) + (11.2 \times 24) + (12.2 \times 24) + (14 \times 24) + (13.4 \times 24)]$
kg/week x 48 weeks/year
= 88,243 kg/yr

c. Emission factors

Emission factors can be used to estimate emissions to the environment. In this note they relate the quantity of substances emitted from a source to some common activity associated with those emissions. General emission factors have been developed from a variety of sources, but this guidance draws upon UK information in particular.

Provided that unit operations remain consistent, representative monitoring data can be used to generate site specific emission factors. The emission factor will be the ratio of the measured or calculated pollutant emission to the process activity (e.g. per tonne of pulp produced). Site-specific emission factors should be verified periodically to ensure their continued validity, especially where raw material quality varies throughout the year.

Where an emission factor, or other release estimation technique, is not available for a particular substance you may review published information or use the emission factors referred to in this Note. However, care needs to be taken in selecting appropriate emission factors to ensure that the conditions under which the emission factor has been determined are representative of the site's operations.

Emission factors are usually expressed as the mass of a substance emitted multiplied by the unit mass, volume or duration of the activity emitting the substance.

Emission factors are used to estimate an activity's emissions by the general equation:

$$(4) \ E = [A \times \text{Op hours}] \times EF$$

Where:

E = emission rate of pollutant in kg/yr

A = activity rate of process, t/hr or m³/hr

Op hours = operating hours per year of activity, hr/yr

EF = controlled emission factor of pollutant per activity, kg/t or kg/m³

Within equation (4) it is important to note that EF is the emission factor for the pollutant released to atmosphere, that is, after the emission has been abated.

Depending on the availability of information, equation (4) can be rewritten as:

$$(5) \ E = M \times EF$$

Where:

E = emission rate of pollutant in kg/yr

M = activity rate in terms of mass of product produced in the year (t/yr)

EF = controlled emission factor of pollutant per activity, (kg/t of product)

The following example shows how to estimate annual emissions using equation (4).

Example 3: Air dried unbleached production of paper pulp:

Estimating SO₂ emissions from a recovery system (typically includes recovery furnace, evaporator, acid fortification tower, scrubbers) per tonne of air dried unbleached pulp produced serves as an example of the use of emission factors. It is assumed that the pulping mill operates for 8000 hours per year and that 5 tonnes of pulp is produced per hour during the reporting year. The SO₂ emission factor (assuming scrubber control) is assumed to be 4.5 kg of SO₂ per tonne of air-dried unbleached pulp produced.

A = 5 tonnes per hour
Op hours = 8,000 hr/yr
EF = 4.5 kg/tonne

$$E = 5 \times 8,000 \times 4.5 \\ = 180,000 \text{ kg/yr}$$

Emission factors developed from measurements for a specific location can sometimes be used to estimate emissions at other sites provided that the processes are comparable in size and operation. As previously mentioned, where there is any doubt it is advisable to have an emission factor reviewed and approved by us prior to its use for Emissions Inventory submissions.

In the case of new or modified processes, initial emission factors can be obtained from manufacturer's data with sampling undertaken during commissioning to confirm the assumed values.

d. Carbon dioxide factors

If you are not a participant in the EU EUTS, you can use the emission factors for CO₂ described here: <https://www.gov.uk/guidance/energy-efficiency-standards-for-industrial-plants-to-get-environmental-permits> (Use the same guidance as for sites in England).

If you are a participant in the EU ETS, the European Commission has established guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to European Directive 2003/87/EC (Emissions Trading Scheme (EU ETS)).

https://ec.europa.eu/clima/policies/ets/monitoring_en

Guidance specific to UK members of the scheme can be found here:

<https://www.gov.uk/guidance/participating-in-the-eu-ets>

e. Carbon dioxide excluding biomass

Carbon dioxide emissions minus carbon dioxide from qualifying renewable fuel sources must also be reported.

The combustion of biofuels and materials is considered to be carbon neutral as, providing there is no long-term decline in the total carbon embodied in standing biomass, this activity does not significantly add to atmospheric carbon concentrations. Therefore, national level Greenhouse Gas inventories under the IPCC guidelines exclude carbon dioxide emissions from the combustion of biofuels and materials.

f. Dioxins and Furans

Where your permit requires you to monitor for emissions of dioxins and furans to air we will need you to report these emissions as both I-TEQ and WHO-TEQ to the Emissions Inventory. Your permit will explain how to calculate the Toxic Equivalence Concentration (TEQ) using Toxic Equivalence Factors (TEF). There are 17 relevant congeners listed in your permit. You do not need to include any other congeners in the sum of emissions.

Use the WHO-TEF for Humans/mammals to calculate the sum of emissions for the WHO-TEQ.

II. Quantification of emissions to water

The usual method for determining emissions to water is to use direct measurement. You may use other release estimation techniques, particularly mass balances or site-specific emission factors, where these are appropriate and agreed in your permit.

a. Direct measurement techniques

These are periodic or continuous monitoring techniques to measure the concentration of a substance in the water discharge and the flow rate. Sampling requirements will be set out in your EPR permit and it is important to note that no additional sampling and monitoring is required solely for the purposes of reporting to the Emissions Inventory.

Measurement of flow and pollutant concentration needs to be carried out at the same time. You must also ensure that measurements are taken at times which show the full range of emissions discharges under the different operating conditions of your process.

Take particular care when relying on the results of one spot sample in order to report annual emissions unless you can be certain that the process conditions are representative.

If you store effluent and release it at specified times, for example releases to tidal watercourses, samples should be taken at varying times of the discharge.

Measurement techniques will also be specified in your permit, including MCERTS requirements for flow monitoring.

b. Mass Balance techniques

If your permit includes mass balance techniques to estimate emissions you must ensure that all the factors used in your calculations remain correct. You will need to agree the techniques you are using with us, and we may require direct measurement of emissions from some of the water pathways to verify the calculations

c. Emission factors

Use of emission factors for estimating emissions will be agreed in your permit. They may be sector specific or site specific and relate the mass of emission to the amount of product or to an operating period. You must ensure that the emission factor you are using remains appropriate for the emissions you are reporting.

d. Subtracting the background load

If water is collected at the site of the installation from a neighbouring river, lake or sea for use as process or cooling water, the amount of a substance already in the water can be subtracted from the amount released from the site back into the same waterbody.

You should not subtract any background load resulting from the use of extracted groundwater, drinking water, or water from a different river catchment as this adds to the pollutant load in the receiving water body.

When subtracting the background load, it may also be necessary to take account of the fact that evaporation of water from the process will lead to an increase in the pollutant concentration. This can be done by using the following equation:

$$(6) \text{ PC} = \text{OC} - [\text{IC} \times \text{VF}]$$

Where:

PC = the pollutant emission concentration from the process, mg/l

OC = the measured pollutant concentration in the discharge, mg/l

IC = the measured pollutant concentration in the feedwater, mg/l

VF = the ratio of volume of water entering the process to volume of water discharged

e. Calculating the mass emission

To calculate the mass emission to water, multiply the concentration of the substance by the flow rate and the number of hours that the discharge occurs over the year. Take care with the units when making this calculation. Concentration is usually reported in mg/m³; flow in l/sec or m³/hour, and you need to report the total mass in kilograms.

There is information about how to calculate the mass emission where results are below the limit of detection in section 4.4 of this guidance.

For emission points fitted with continuous monitors, calculations of mass emissions from a particular discharge point can be made automatically. For cooling water it may also be necessary to adjust the measured data to take account of input pollutant concentrations as described above, and it is good practice to check automatic calculations manually to ensure that they are accurate.

Add together all the emissions of each specified substance to get the total release to controlled water, and similarly add all the releases to wastewater (off-site sewer), and report these in the relevant part of the inventory.

III. Reporting basis

Certain substances on the Emissions Inventory return are required to be reported as the main constituent, for example, 'Nitrogen oxides (NO and NO₂) as NO₂'. When a conversion needs to be made, the emission concentration or emission rate should be multiplied by the molar mass of the 'reported as' substance, and divided by the molar mass of the emitted substance. This is illustrated in the following example.

Example 4: Assume a discharge concentration of NO is 50 mg/m³. Using the molar masses of NO and NO₂, the equivalent discharge concentration of NO₂ can be determined.

Molar mass of NO = 30

Molar mass of NO₂ = 46

Concentration of NO as NO₂ = $50 \times 46 / 30$
= 76.7 mg/m³

The mass of NO₂ equivalent released can then be determined in accordance with equation (1).

IV. Converting emissions - ppm to mg/m³ and vice versa

The conversion between ppm and mg/m³ for air emissions is dependent on both the molar mass of the substance and the temperature and pressure at which the conversion is made. The assumption is that the pollutant behaves as an ideal gas and as such, 1 mole of the substance occupies 22.4 litres at standard temperature (273K) and pressure (101.3 kPa). This is consistent with normalised concentrations and it is, therefore, not normally necessary to take account of the temperature or pressure difference in the conversion. When converting ppm to mg/m³ under actual discharge conditions it is important to take account of these factors.

Converting air emissions

To convert from ppm to mg/m³ the following formula should be used:

$$\text{mg/m}^3 = \text{ppm} \times (\text{MM}/22.4) \times (273/\text{T}) \times (\text{P}/101.3)$$

Where:

MM is the molar mass of the substance (in grams)

T is the temperature at which the conversion is to be made (Kelvin)

P is the pressure at which the conversion is to be made (kPa)

To convert from mg/m³ to ppm use the following formula:

$$\text{ppm} = \text{mg/m}^3 \times (22.4/\text{MM}) \times (\text{T}/273) \times (101.3/\text{P})$$

Converting water emissions

The conversion between ppm and mg/l for water is straightforward in that it is normally assumed that water has a density of 1000 kg/m³.

On this basis, 1 ppm = 1 mg/l = 1 g/m³ = 1 mg/kg.