



Scottish Pollutant Release Inventory reporting

Pollution Prevention and Control Act 1999
The Pollution Prevention and Control (Scotland) Regulations 2000 No. 323,
Regulation 26 (2)

Incineration Activities Guidance Note

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1 Introduction

This Guidance Note provides information to assist you in preparing submissions to the Scottish Pollutant Release Inventory (SPRI). It has been developed through a process of consultation between industry stakeholders and ourselves. It is part of a range of non-statutory guidance and tools produced to assist in the completion of the annual SPRI return. Information on the range of guidance notes is available on the SPRI website¹ <http://www.sepa.org.uk/spri/index>.

By providing a series of guidance notes, we seek to ease the burden on industry and to raise the quality of SPRI data. In addition, the increasing use of SPRI data in policy-making and for comparisons on a sector and national basis has led to a need for increased consistency in SPRI data and an improved understanding of uncertainty.

1.1 Scope of the guidance note

This Note covers activities that are regulated as Incineration and Co-incineration of Waste activities under the Pollution Prevention and Control regime. Included within the scope are Part A (1) listed activities regulated under Section 5.1 (paragraphs a-f) of the PPC Regulations² as amended by the Waste Incineration (Scotland) Regulations SSI 2003/170³. Scottish Pollutant Release Inventory guidance for co-incineration installations such as combustion (e.g. power stations) & cement plants is covered in the appropriate sector note.

For the purposes of this note, activities can be broadly separated into two categories; WID⁴ (Waste Incineration Directive) and non-WID activities. Plants excluded from WID include those burning only vegetable waste from agriculture and forestry, wood waste, animal carcasses and radioactive waste amongst others. These excluded plants are not subject to the WID's mandatory monitoring requirements if it was demonstrated in the application that it was not BAT so to do. Essentially, the WID incinerators covered in this note are; Municipal Waste Incinerators (MWI), Clinical Waste Incinerators (CWI), Hazardous (Chemical) Waste Incinerators (HWI), Sewage Sludge Incinerators (SSI), Drum Incinerators (DI) and Animal Remains Incinerators.

Note that you are not required to include any emissions due to historic activities (for example, from contaminated land) in your SPRI return. Emissions reported need only relate to operations of the permitted activity. If you wish to include additional emissions or are unable to separate them it is acceptable to do so.

1.2 Background to the Scottish Pollutant Release Inventory (SPRI)

The Scottish Pollutant Release Inventory (SPRI) was created in 2004 to gather information on emissions from industrial activities. Each relevant industrial activity is required to report annual mass emissions of a number of specified substances released to air, controlled waters and land, transferred off-site in wastewater, and wastes transferred off-site. These data are held on our Scottish Pollutant Release Inventory database and are available to the public via the Internet.

The information held within the SPRI is becoming increasingly important to meet a number of obligations:

- To provide clear public information about industrial pollution;
- To ensure focused and efficient industrial regulation;
- To provide the Government and ourselves with the means to meet national and international environmental reporting requirements.

Following the guidance in this note, in conjunction with the General SPRI Guidance Note, will ensure that you meet the reporting requirements of the European Pollutant Release and Transfer Register (E-PRTR) Regulation and associated guidance (see web link below). This includes a more prescriptive indication of methods of measurement and calculation and a requirement to report certain releases to land. Data on transboundary shipments of hazardous waste taking place during 2007 and during each subsequent year must also be reported to meet the E-PRTR requirements. Further information on the E-PRTR is available on the EPER website⁵ <http://eper.cec.eu.int/eper/>.

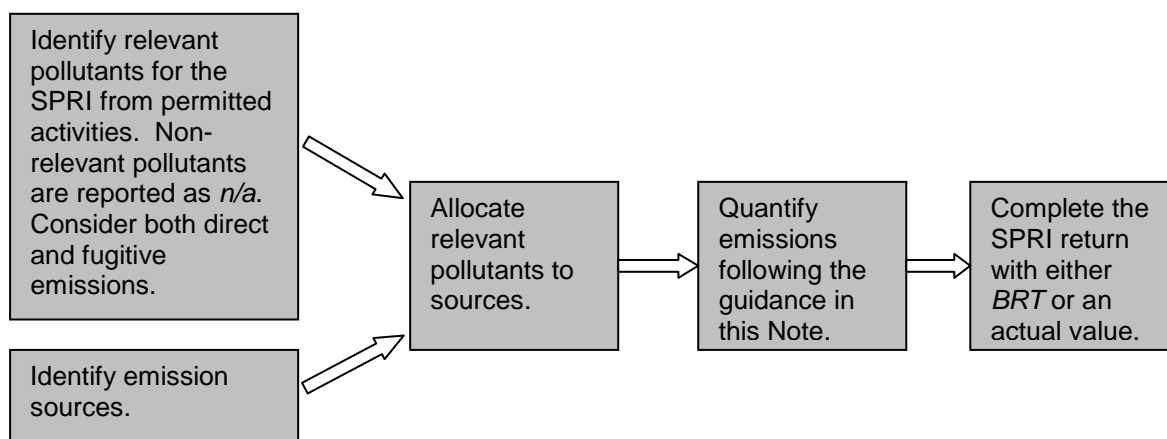
Reporting thresholds for the SPRI were assigned to all substances when the PI was set up. These are based on the need to capture nationally significant emissions and to restrict the burden of monitoring and reporting for industry. Where no emission of the substance occurred in the reporting year to that medium, this should be entered on the reporting form as *n/a* (not applicable). Where the annual emission has been assessed and found to be below the indicated annual reporting threshold, this should be entered as *BRT* (below reporting threshold).

1.3 General methodology

The SPRI reporting process for emissions to air & 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 SPRI return

These steps are described in the following flowchart. The process is described in more detail in Sections 2 and 3 of this Note.



The identification of relevant pollutants and emission sources is interrelated in that the pollutants emitted from each emission point may vary. Consideration also needs to be given to fugitive emission sources.

For obvious reasons, a SPRI return needs to be made retrospectively. However, in order to quantify emissions, information is needed which may best be gathered during the operational year. In reviewing the Release Estimation Techniques (RETs) presented in this Note, you should therefore also consider how and when the required information is to be obtained and put in place procedures to that effect.

1.4 Release estimation techniques (RETs)

This Note provides information on RETs for the SPRI substances relevant to this industry sector. Emphasis has been placed on providing information on the most common emissions from the sector. However, the absence of an RET for a substance in this Note does not imply that an emission should not be reported to the SPRI. The obligation remains to report on all relevant emissions.

In general, there are four types of RETs that may be used to evaluate emissions:

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

The above is not intended to imply that methodologies based on measurement are necessarily superior to those based on calculation or mass balance. Depending on the particular site, pollutant or process, each of the above techniques may be the most appropriate to use. 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.

However, there are cases where mandatory RETs exist, such as when reporting emissions under EU Directives or in accordance with authorisation or permit conditions. Examples of this are reporting requirements under the LCPD (2001/80/EC)⁶ and the European Emissions Trading Scheme (2003/87/EC) for greenhouse gases⁷. For consistency, you should also consider extending the use of such methods to additional parts of the installation that are not subject to the mandatory requirement, but that have SPRI reporting obligations.

In the absence of a mandatory methodology, you should use methods that have been agreed with us for your industrial sector, where available.

In the absence of mandatory or industry methodologies, site specific data in the form of monitored emission concentrations or mass balance techniques should be used where appropriate. Measured emission concentrations should be ideally based on data obtained using appropriately certified equipment, and/or accredited services. Continuous monitoring data should normally be used in preference to periodically sampled data. Sections 2.3.1 and 2.3.2 contain guidance on the use of sampling data for determination of emissions to air.

Where emission factors are used, preference should be given to the use of site-specific emission factors over those developed from other representative plant. However, in order to develop a site-specific emission factor, it is necessary to relate the level of emissions to an activity within the process. This is normally obtained from sampling data, or can be obtained from manufacturer's information or by calculation.

Although emissions are not prioritised in terms of environmental impact within the SPRI, some emissions from an installation will have more impact on the environment than others. You should therefore concentrate efforts and use the most accurate RETs on those emissions that have associated emission limit values in a permit or authorisation, and also those greatest relative to the SPRI reporting threshold values.

See Table 1.1 below for a summary of our generally preferred RETs for incineration activities:

Table 1.1 RET preferences

Preference	Release estimation technique availability	Notes
1	CEMs data	Calculate release based on daily CEMs average and daily average flow, integrated over year. [Note: based on raw/as measured data without subtraction of confidence intervals].
2	Periodic monitoring (with abatement) data.	Calculate release based on average of periodic samples and annual flow.
3	Periodic monitoring (without abatement) data.	Calculate release based on mass balance or emission factors, and as in 2 above. Report higher value.
4	No monitoring data.	Calculate release based on mass balance or emission factors.
5	Alternative agreed technique.	For any deviation from the above arrangements, agree an appropriate technique with the Agency.

The RETs presented in this Note relate principally to representative operating conditions. However, it is important to recognise that emissions resulting from significant operating deviations (e.g. failure of abatement plant) and/or accidental events (e.g. 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 amount of substances released as vapour. For all spills, the additional emission is the net emission, i.e. the quantity of the SPRI reportable substance spilled, less the quantity recovered or consumed during clean up operations.

1.5 Uncertainty

Currently, SPRI reporting **does not** require an estimate of the level of uncertainty to be submitted with a return. However, we consider that it is important for you to be aware of the issues concerning uncertainty and their relevance to the SPRI since this may become a requirement in the future.

The level of uncertainty of a determination is important in judging whether a change in reported emissions is significant or not. For example, if the level of reported emissions from one year to the next increases by 10%, this may not be a real increase if the level of uncertainty in the measurement is 20%. In this case, two different values are reported but the actual emissions could be the same.

The guidance given in this Note is aimed at reducing the variability and uncertainty in emission determination.

1.6 Access to further information

This Note does not provide detailed information on suggested measurement and monitoring techniques as this is dealt with extensively in other guidance documents that we publish. References to monitoring guidance and other sources of reference information are included in Section 5 of this document.

1.7 Disclosing information you provide

The General SPRI Guidance Note⁸ provides information relating to commercial confidentiality.

1.8 Feedback

In order to improve the quality of our guidance, we would like to receive feedback from you on your experiences in using this Note. Such feedback will be taken into account in the preparation of other guidance notes in this series, and in the updating of this document.

Feedback should be submitted to the SPRI team by phone or email:

Telephone: 01349-860321

Email: spriadministration@sepa.org.uk

2 Emissions to air

Incineration installations subject to WID are normally required to be continuously monitored for NO_x (provided that emission limit values are set), total particulate matter, CO, TOC, HCl, HF and SO₂. Under certain circumstances, continuous monitoring of HF, HCl and SO₂ may not be required and periodic monitoring can be substituted. The specific requirements for continuous or periodic monitoring are laid down in the PPC permit. The permit also specifies frequencies for periodic monitoring for heavy metals, dioxins and furans, dioxin-like PCBs and PAHs. The frequencies required by the WID are the minimum frequencies for such periodic measurements, but the permit may specify higher frequencies. Additionally, the PPC permit may set additional site specific monitoring requirements depending upon the local circumstances, which may include, where SNCR is in operation, N₂O and/or NH₃ releases depending on the reductant used.

2.1 Relevant pollutants

As indicated in Section 1.3, the first task is to identify the pollutants that need to be included in the SPRI return. The **main** air emissions from waste incineration activities are shown in Table 2.1. The table should be taken as a **guide** only, and you should verify that there are no other pollutants emitted from your installation. See Annex 1 for a summary of currently used RETs and guidance for a more comprehensive list of potential releases of substances to air from various sources.

Table 2.1 Main air pollutants emitted by incineration^(Note 1) activities and their main sources

Main air pollutants	Main sources
Cd	Flue gas in MSW incinerators from batteries, accumulators, paints and plastics. Hazardous wastes including effluent treatment sludges and drummed waste from metal plating works.
CO	Flue gas as a result of incomplete combustion of waste. e.g. if spontaneously evaporating or rapid-burning substances are present, or when combustion gas mixing with the supplied oxygen is poor.
CO ₂	Flue gas as a result of complete combustion of organic material. Between 0.7 and 1.7 tonnes of CO ₂ is generated per tonne of MSW combusted.
Dioxins & furans	Flue gas as a result of re-combination reaction of carbon, oxygen and chlorine. Also found in boiler ash, bottom ash, fly ash & sorbents.
HCl	Flue gas from wastes containing chlorinated organic compounds or chlorides.
HF	Flue gas from fluorinated plastic or fluorinated textiles in MSW and a variety of fluorinated compounds in HWI.
Hg	Flue gas from MSW containing batteries, thermometers, dental amalgam, fluorescent tubes or mercury switches. In HWI from coking plant tars, waste from chlorine alkaline electrolysis, caustic oil sludge from refineries and other chemicals containing mercury. Also found in bottom ash, fly ash & sorbents. In SSI, Hg from sewage (especially dental amalgam).
Metals (Heavy metals & compounds other than Hg and Cd) Sb, As, Pb, Cr, Cu, Mn, Ni, V, Sn,	Flue gas as particulate matter usually as metal oxides and chlorides. Also found in bottom ash, fly ash & sorbent.
NH ₃	Flue gas where SNCR is used and NH ₃ is used as a reducing agent. This arises through overdosing.
NO _x	Flue gas as both thermal and fuel NO _x . In MSW incinerators the proportion of thermal NO _x is very relevant with each type of grate having an inherent background NO _x level. It is often more significant than fuel NO _x .
N ₂ O	Principally from SNCR. Modern MSW incinerators have low combustion-originated N ₂ O but, depending on reagent, significant emissions resulting from SNCR.

Main air pollutants	Main sources
PAHs	Flue gas as products of incomplete combustion. Also found in bottom ash, fly ash & sorbents.
Dioxin like PCBs	Flue gas from most municipal waste streams and some industrial wastes. Higher concentrations in some hazardous waste streams. Also found in bottom ash and APC residues.
Particulate matter (including PM ₁₀)	Flue gas as fine ash from the incineration process entrained in the gas flow. Also fugitive releases of dust from waste storage areas.
SO ₂	Flue gas where sulphur is present in the waste stream. Common sources of sulphur in some waste streams are: waste paper; plaster board (calcium sulphate), and sewage sludges.
VOCs	Flue gas from incineration of organic waste. Also fugitive releases from waste storage areas.

Note 1 – The term incineration includes hazardous waste, clinical waste, municipal, animal carcass and sewage sludge incineration

2.2 Emission sources

2.2.1 Point source emissions

These emissions are exhausted via a stack or vent, i.e. a single point source into the atmosphere. Abatement equipment, e.g. scrubbing units, fabric filters (bag house) can be incorporated into the exhaust system prior to discharge to atmosphere. Point source (main stack) emissions are usually the most significant emission source (in terms of annual mass releases) for combustion activities taking place within a variety of furnace types at incineration facilities.

2.2.2 Fugitive emissions

Fugitive emissions are those that are not released from a point source such as a stack.

Fugitive dust and VOC emissions will be minimised where combustion, flue gas treatment processes and plant in general (including storage areas) operate at negative pressure.

Some examples of the potential sources of fugitive emissions to air are:

- the loading and unloading of transport containers;
- storage areas (e.g. bays, stockpiles, etc);
- transferring material between vessels (e.g. silos, volatile liquids such as SLF);
- conveyor systems;
- pipework and ductwork systems (e.g. pumps, valves, flanges);
- abatement equipment by-pass;
- accidental loss of containment from failed plant and equipment;
- oil & ammonia storage tanks
- poor building containment and extraction
- use of poorly sealed waste charging systems

Only fugitive emissions that leave the installation need to be reported to the SPRI. Whilst contained spills would therefore not need to be reported, you should report vapour emissions that may have dispersed.

2.3 Quantification of emissions

2.3.1 Sampling data

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

Care should be taken 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. Good engineering judgement should be used in order to select the most appropriate sampling time and data to use. You should 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 (i.e. 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 by us.

In order to estimate annual emissions from sampling data, the first step is to multiply the measured emission concentrations by the volumetric flowrates 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.

Care should be taken to ensure that the emission concentration and flowrate are compatible, e.g. normalised emission concentrations should be multiplied by normalised volumetric flowrates or actual, measured emission concentrations multiplied by actual, measured volumetric flowrates. 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. Formulae for conversion between normalised and actual emission concentrations are contained in Appendix A of this Note.

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 flowrate is measured. Formulae for converting ppm to mg/m^3 are contained in Appendix B.

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 SPRI.

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

Where:

E	=	emission rate of pollutant in kg/yr
C	=	pollutant concentration (mg/m^3)
Q	=	volumetric flowrate of the emission (m^3/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:

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

Where: E = emission rate of pollutant in kg/yr
 C = average pollutant concentration (mg/m³)
 M = mass of waste feedstock burnt in one year (kg dry waste feedstock)
 V = standard volume of flue gas per tonne of waste feedstock (m³/kg dry waste feedstock)

Example 1

The following example is for 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 flowrate = 10 m³/s (normalised to 273K, dry, 11% oxygen)

$$\begin{aligned} E &= C \times Q \times 0.0036 \times 24 \times 280 \\ &= 20 \times 10 \times 0.0036 \times 24 \times 280 \\ &= 4,838 \text{ kg/yr} \\ &= 4.8 \text{ te/yr} \end{aligned}$$

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

2.3.2 Using continuous emission monitoring systems (CEMS) data

The Waste Incineration Directive⁴ (WID) requires that where CEMs have to be used, you should use CEMS data that are from appropriately calibrated instrumentation operating within stated tolerances (according to CEN standards where available or ISO/national standards where they are not). Although CEMS can report real-time emissions over a variety of time periods automatically, it may be necessary to manually determine annual emissions 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 manually check the data in order to ensure that the automatic calculations are accurate.

The WID and LCPD directives require subtraction of Confidence Intervals (as specified in the appropriate directive) from CEM average values, to provide "validated" averages that are compared against the given emission limit values for compliance purposes. This is acceptable for relatively short term average periods, but not long term periods (such as a whole year and SPRI returns) when positive and negative errors (random errors) would be increasingly expected to cancel each other out. Therefore, Confidence Intervals must **not** be subtracted from the average values generated from the raw emissions data, prior to calculation of annual mass emissions (unless part of an over-riding written agreement with us).

Prior to using CEMS to determine emissions, it is preferable 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 2.3.1. Normally, the measurement time periods are the same, such that it is possible to simply 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.

$$E = \sum_1^n (E_i \times t) \quad (3)$$

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
n = number of time periods in the year

Example 2

This example shows how SO₂ emissions can be calculated using Equation (3) based on the average CEMS data for 6 days of a week. In the case of the example, it is assumed that the process operates for 24 hours per day, 48 weeks per year and that the CEMS data is representative of annual operations.

$$E_1 = 13.2 \text{ kg/hr}$$

$$E_2 = 12.6 \text{ kg/hr}$$

$$E_3 = 11.2 \text{ kg/hr}$$

$$E_4 = 12.2 \text{ kg/hr}$$

$$E_5 = 14.0 \text{ kg/hr}$$

$$E_6 = 13.4 \text{ kg/hr}$$

$$E = [(13.2 \times 24) + (12.6 \times 24) + (11.2 \times 24) + (12.2 \times 24) + (14 \times 24) + (13.4 \times 24)] \times 48 \text{ kg/yr}$$

$$= \mathbf{88,243 \text{ kg/yr}}$$

2.3.3 Emission factors

(a) General

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. waste feedstock flow rate). Site-specific emission factors should be periodically verified to ensure their continued validity, especially where waste feedstock quality varies throughout the year. Where different waste feedstocks are used, the emission when using each waste feedstock separately should be determined, and the results added together.

Where an emission factor or other RET is not available for a particular substance, then you may review published information or use the emission factors listed 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 sites' operations.

Emission factors are usually expressed as the weight of a substance emitted multiplied by the unit mass, volume, distance, or duration of the activity emitting the substance. In some cases, and particularly in the case of SO₂, the emission factor is based on waste feedstock analysis data (see Section 2.3.4).

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

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

Where: E = emission rate of pollutant in kg/yr
A = activity rate of process, te/hr or m³/hr
Op hours = operating hours per year of activity, hr/yr
EF = controlled emission factor of pollutant per activity, kg/te or kg/m³

Within Equation 4 it is important to note that EF is the emission factor for the pollutant released to atmosphere, i.e. after the emission has been abated.

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

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

Where: E = emission rate of pollutant in kg/yr
M = activity rate in terms of mass of waste feedstock burnt in the year (te/yr)
EF = controlled emission factor of pollutant per activity, (te/te dry waste feedstock)

The following examples show how to estimate annual emissions using Equation 4.

Example 3 (Sewage Sludge Incinerator)

Estimating (NO_x) emissions per tonne of sewage sludge waste combusted serves as an example of the use of emission factors. It is assumed that the incinerator plant operates for 8400 hours per year and that 5 tonnes of sewage sludge waste is burnt per hour during the reporting year. The NO_x uncontrolled emission factor given is assumed to be 0.88 kg of NO_x per tonne of sewage sludge burnt (fluidised bed).

A = 5 tonnes per hour
Op hours = 8,400 hr/yr
EF = 0.88 kg/tonne

E = 5 x 8,400 x 0.88
= 36,960 kg/yr
= **37 te/yr**

Example 4 (Wood Waste Incinerator)

Estimating total particulate (PM) emissions per tonne of wood waste combusted. It is assumed that the incinerator plant operates for 1500 hours per year and that 3 tonnes of wood waste is burnt per hour during the reporting year. The uncontrolled PM emission factor given is assumed to be 6.5 kg of PM per tonne of wood burnt.

A = 3 tonnes per hour
Op hours = 1,500 hr/yr
EF = 6.5 kg/tonne

E = 3 x 1,500 x 6.5
= 29,250 kg/yr
= **29 te/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 SPRI submissions.

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

(b) Carbon dioxide factors

In January 2004 a set of guidelines was produced for the monitoring and reporting of greenhouse gas emissions pursuant to European Directive 2003/87/EC establishing the European Union Emissions Trading Scheme (EU ETS)⁷. The European guidance sets out the approved methodology for estimating CO₂ emissions based on emissions from regular operations and abnormal events, including start-up and shut-down and emergency situations over the reporting period.

Incinerators are currently exempt from EU ETS reporting requirements. However, the methodology can be used to estimate carbon dioxide emissions from incinerators.

Under the EU ETS guidelines, estimation of CO₂ emissions is based on the following formula.

$$E_{CO_2} = A_e \times EF_{CO_2} \times OF_{CO_2} \quad (6)$$

Where:

E_{CO_2}	= emission of CO ₂ , te/yr
A_e	= activity rate (either in terms of annual energy consumption, TJ/yr, or mass/volume consumption, te/yr or m ³ /yr)
EF_{CO_2}	= emission factor of CO ₂ , (teCO ₂ /TJ, or teCO ₂ /te or teCO ₂ /m ³)
OF_{CO_2}	= oxidation factor

The oxidation factor takes into account the fact that when energy is consumed not all of the carbon in the feedstock oxidises to CO₂. The oxidation factor expresses the proportion of carbon in the feedstock that is oxidised to CO₂.

In the absence of other information, an oxidation factor of 0.99 can be applied for all solid fuel combustion, and a factor of 0.995 for all other fuels.

In some cases the emission factor may already take into account the proportion of carbon in the waste feedstock that is oxidised, and you should verify if this is the case. If so, the oxidation factor in Equation 6 is equal to 1.

It is possible to use an emission factor based on the amount of feedstock used in energy terms, or mass/volume, in essence Equation 5.

The EU ETS provides specific guidance regarding the determination of activity-specific emission factors for defined fuels. In the absence of activity-specific factors, general emission factors for the combustion of various fossil fuels are provided in the EU ETS guidance.

By contrast to combustion sources of CO₂ emissions, the EU ETS allows process emissions (emissions of CO₂ from non-combustion activities) to be derived from activity data based on raw material inputs, throughputs and outputs. The basic calculation equation remains multiplication of activity data by appropriate emission factors, but use of conversion factors (CFs) in place of oxidation factors.

Biomass is considered to be CO₂ neutral in terms of the EU ETS, but the mass of CO₂ emitted from its combustion or use is a SPRI reporting requirement. The proportion of the total CO₂ attributable to biomass should then be pointed out in the qualification box of the SPRI reporting form.

The EU ETS allows CO₂ emissions to be determined by two methodologies; a calculation methodology or a measurement methodology. However, where a measurement methodology is used, a requirement exists to verify the measured emissions by calculation. In both cases however, it is likely that measurements of fuel burned or material flow will be available and these can be used for the determination of other emission quantities when combined with appropriate emission factors.

Annex II of the EU ETS Directive monitoring reporting guidelines covers combustion activities.

2.3.4 Waste feedstock analysis and process stream data

The use of waste feedstock analysis and process stream data to determine emissions is similar to the use of emission factors.

For MSW incineration, analysis of fuel is not used for calculation of emissions. Either analysis is not carried out, is too variable, is too unreliable or cannot be related to emissions.

The basic equation used, for example, in waste feedstock analysis emission calculations is:

$$E = Q_f \times [\text{Op hours}] \times [\text{PC}_f/100] \times (\text{MW}_p / \text{EW}_f) \quad (7)$$

Where:

E	=	emission of pollutant, kg/yr
Q_f	=	waste feedstock use (kg/hr)
PC_f	=	pollutant concentration in the waste feedstock (%)
Op hrs	=	operating hours per year, hr/yr
MW_p	=	molecular weight of pollutant as emitted after combustion
EW_f	=	elemental weight of pollutant as present in waste feedstock

Equation 7 is the method usually used for calculating SO_2 emissions where it is normally assumed that all of the sulphur in the waste feedstock is converted to SO_2 .

Where the pollutant concentration in the waste feedstock is consistent over the averaging period (i.e. one year), equation 7 can be written as:

$$E = M \times [\text{PC}_f/100] \times (\text{MW}_p / \text{EW}_f) \quad (8)$$

Where:

E	=	emission rate of pollutant in kg/yr
M	=	mass of waste feedstock burnt in one year (kg/yr)
PC_f	=	pollutant concentration in the waste feedstock (%)
MW_p	=	molecular weight of pollutant as emitted after combustion
EW_f	=	elemental weight of pollutant as present in waste feedstock

Example 5

This example shows how SO_2 emissions can be calculated from oil combustion, based on analysis results and feedstock flow information. It is assumed that the facility operates burning waste oil for 1500 hours per year and that abatement of SO_2 does not occur.

Q_f	=	2000 kg/hr
PC_f	=	1.17%
MW_p	=	64
EW_f	=	32
Op hours	=	1500 hr/yr
E	=	$Q_f \times \text{PC}_f \times (\text{MW}_p / \text{EW}_f) \times [\text{Op hours}]$
	=	$[(2000) \times (1.17 / 100) \times (64/32) \times 1500] \text{ kg/yr}$
	=	$7.0 \times 10^4 \text{ kg/year}$

Equation 7 can also be used for volatile elements such as fluorine and chlorine as well as trace metallic pollutants, although some of these species are retained in the plant, either in the ash or in abatement equipment and appropriate retention factors applied.

When using Equation 7 or Equation 8, you should be aware that the amount of pollutants present in the waste feedstock or process stream can vary significantly.

2.3.5 Fugitive emissions

Methodologies and factors used to determine fugitive emissions are referenced in Annex 1.

2.4 Completion of the SPRI return

2.4.1 Reporting basis

Certain substances on the SPRI return are required to be reported as the main constituent, e.g. '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 molecular weight of the 'reported as' substance, and divided by the molecular weight of the emitted substance. This is illustrated in the following example.

Example 6

Assume a discharge concentration of NO is 50 mg/m³. Using the molecular weights of NO and NO₂, the equivalent discharge concentration of NO₂ can be determined.

MW of NO	=	30
MW of NO ₂	=	46
Concentration of NO as NO ₂	=	50 x 46 / 30
	=	76.7 mg/m ³

The mass of NO₂ released can then be determined in accordance with Equation 1.

Further guidance on reporting emissions, including dioxin and other organic substance congeners is given in the general SPRI guidance document⁸.

2.4.2 Limits of detection (LOD)

If the best available information indicates that a substance is not released from your process, you should report a *n/a* return for that substance. However, a measurement that indicates that a listed substance is below the LOD does not necessarily mean that the substance is not present, and a non-zero return needs to be made if you consider that the substance is present but not (currently) detectable by measurement. The problem arises as to how to determine the emission if all that is known is that the substance is present and it is measured at some value below the LOD.

There is no straightforward answer to this problem and in some cases it may be better to use another RET such as mass balance rather than measurement, especially if emission flow rates are very high. Where another RET is not an option, the following methodology should be used in order to provide a consistent approach (unless an over-riding methodology has been agreed with us, e.g. for a particular substance or process). Where multiple measurements for a substance are all below the LOD and there is no other reason to believe that the substance is present, then the measurement should be taken as zero for that emission point. Where there is reason to believe that a substance is present, the measurement should be taken as ½ LOD.

Where some measurements are above the LOD and some are below, then those above the LOD should be taken as the measured values unless you can demonstrate to us that the measurements are false, and the readings below the LOD should be taken as equal to ½ LOD. In both cases, the concentration measurements need to be multiplied by the flowrate at the time of the measurement in order to determine the mass emission (following the guidance contained in this Note).

In all cases where measurement is used, it should be based on the most accurate or appropriate methodology readily available involving the lowest LOD.

2.4.3 If no emission factors or RETs are available

If an emission factor or other emission estimation technique is not available then you should contact us.

2.4.4 Units

In completing the SPRI return, care should be taken with the units of the substances reported. A checklist of unit prefixes is included in Appendix B to aid in this process.

3 Emissions to water

Emissions of substances to water can be either direct to controlled waters or indirectly following transfer to off-site effluent treatment plant.

Guidance on what constitutes an emission or a transfer is contained in the general SPRI Guidance document⁸.

3.1 Relevant pollutants & emission sources

Water discharges from incineration processes arise from the air abatement equipment (e.g. wet scrubbers), storm water, cooling water, boiler blow-down, incoming waste handling areas, ash and other residue handling areas, accidental emissions of raw materials, products or waste materials, fire fighting and from on-site effluent treatment. Table 3.1 illustrates the main pollutants emitted to water and their main sources. Suspended solids are not a SPRI reportable substance⁵. However, the table should be taken as a **guide** only, and you should verify that there are no other substances emitted from the process, including in association with suspended particulate. See Annex 1 for methodologies used to determine emissions to water.

Table 3.1 Main water pollutants generated by incineration activities

Main water pollutants	Main sources
Dioxins & Furans	Scrubber liquor, releases from ash quenching
Ethylene dichloride	Scrubber liquor, releases from ash quenching
Metals	Waste storage, scrubber liquor, releases from ash quenching
PAHs	Scrubber liquor, releases from ash quenching
Suspended solids	Raw material preparation, storage & handling, scrubber liquor, releases from ash quenching
TOC	Waste storage, scrubber liquor, releases from ash quenching

N.B. At some installations waste water will pass through an on-site effluent treatment plant prior to discharge into controlled waters.

The resulting discharge of the above substances depends on the 'in process' preventative measures (good housekeeping, re-use) and the presence and technical standards of waste water treatment facilities.

Notwithstanding the above, you should consider all emission sources to water and characterise the flows and emission concentrations from each source.

3.2 Quantification of emissions

There is less choice in the techniques to use for the determination of emissions to water than for emissions to air. The most appropriate method is to use direct measurement. However, you may use other RETs, particularly mass balances or site-specific emission factors where these are appropriate. Mass balances can often be used when emissions to water are very complex and difficult to quantify with other approaches. However, a mass balance calculation is still likely to require direct measurement of emissions from some of the water pathways in order to verify the calculations. Site-specific emission factors are determined from the ratio of the measured or calculated pollutant emission to the water discharge flowrate.

Within this Note, advice is given on the use of direct measurement techniques as these are likely to be applicable to the majority of Operators.

Using the direct measurement technique requires information on both the flowrate and pollutant concentration. Measurement of flows and pollutant concentrations should be undertaken at the same time during representative operating conditions. Particular care should be taken with 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. Where a process has a number of operating conditions, it may be necessary to take samples at each 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, then it may be necessary to take several samples and the results averaged in order to provide the final annual emission estimate.

The frequency of sampling will depend on the variability of the data. Initially, it may be necessary to take several samples and average the results to yield an annual result. If, however, the results indicate that a concentration and flow are reasonably constant, then the frequency of sampling may be reduced to a practical minimum of once per year. You should be able to justify the sampling regime selected and this may be supported by a history of previous measurements. The sampling requirements will usually be set out in the PPC permit and it is important to note that no additional sampling and monitoring is required solely for the purposes of reporting to the SPRI.

The background load of a reportable substance in water may be taken into account. For example, if water is collected at the site of the installation from a neighbouring river, lake or sea for use as process or cooling water which is afterwards released from the site of the installation into the same river, lake or sea, the "release" caused by the background load of that substance can be subtracted from the total release of the installation. The measurements of pollutants in collected inlet water and in released outlet water must be carried out in a way that ensures that they are representative of the conditions occurring over the reporting period. If the additional load results from the use of extracted groundwater or drinking-water, it should not be subtracted since it increases the load of the pollutant in the river, lake or sea.

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:

$$PC = (OC - [IC \times VF]) \quad (9)$$

Where: PC = the pollutant emission concentration due to 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 extracted to volume of water discharged

In order to estimate the mass emission to water, the appropriate pollutant concentration is then multiplied by the flowrate for that particular discharge point. These representative discharge rates are then aggregated together based on the time for which the water is discharged at that rate. The estimated mass emissions from all discharge points to either controlled waters or in wastewater transfers should then be summed for each individual pollutant for each reporting medium.

For emission points fitted with continuous monitors, calculations of mass emissions from a particular discharge point can be made automatically. However, 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 manually check automatic calculations to ensure that they are accurate.

Example 7 below shows how to estimate annual mass flow of a substance from cooling water discharges taking into account water evaporation in the plant.

Example 7

Suppose the chromium discharge concentration $[OC_{cr}]$ and annual volume flows from three separate discharge points are found to be:

$[OC_{cr}]_1$	=	$2.2 \times 10^{-3} \text{ mg/m}^3$	V_1	=	$4.2 \times 10^6 \text{ m}^3$
$[OC_{cr}]_2$	=	$1.2 \times 10^{-3} \text{ mg/m}^3$	V_2	=	$36 \times 10^6 \text{ m}^3$
$[OC_{cr}]_3$	=	$4.5 \times 10^{-3} \text{ mg/m}^3$	V_3	=	$21 \times 10^6 \text{ m}^3$
Chromium inlet concentration $[IC_{cr}]$	=	$0.12 \times 10^{-3} \text{ mg/m}^3$			
Volume of water extracted during testing period	=	$15,000 \text{ m}^3$			
Volume of water discharged during testing period	=	$14,300 \text{ m}^3$			
The volume factor	=	$15,000/14,300 = 1.05$			

From Equation 9 above, the following average process concentrations are therefore:

$$[PC]_1 = \{2.2 \times 10^{-3} - [0.12 \times 10^{-3} \times 1.05]\} = 2.07 \times 10^{-3} \text{ mg/m}^3$$

$$[PC]_2 = \{1.2 \times 10^{-3} - [0.12 \times 10^{-3} \times 1.05]\} = 1.07 \times 10^{-3} \text{ mg/m}^3$$

$$[PC]_3 = \{4.5 \times 10^{-3} - [0.12 \times 10^{-3} \times 1.05]\} = 4.37 \times 10^{-3} \text{ mg/m}^3$$

$$\begin{aligned} \text{Total annual chromium mass emission} &= \{[PC]_1 \times V_1\} + \{[PC]_2 \times V_2\} + \{[PC]_3 \times V_3\} \\ &= \{2.07 \times 10^{-3} \times 4.2 \times 10^6\} + \{1.07 \times 10^{-3} \times 36 \times 10^6\} + \{4.37 \times 10^{-3} \times 21 \times 10^6\} \text{ mg} \\ &= 139\text{g which is below the reporting threshold} \end{aligned}$$

3.3 Completion of the SPRI return

3.3.1 Substances reported 'as'

Certain substances on the SPRI return are required to be reported as the main constituent, e.g. 'Chlorides – total as Cl'. For instances when a conversion needs to be made, the emission concentration should be multiplied by the molecular weight of the main constituent and divided by the total molecular weight of the substance. This is illustrated in the following example.

Further guidance on reporting emissions of specific compounds is given in the general SPRI Guidance document⁸.

Example 8

Let the measured concentration of sodium chloride be 50 mg/l and the total volume released be 1,000 m³

Relative Atomic Mass of sodium	=	23
Relative Atomic Mass of chlorine	=	35
Molecular Weight of sodium chloride	=	58

$$\begin{aligned} \text{Concentration of sodium chloride as chloride} &= 50 \times 35 / 58 \\ &= 30.2 \text{ mg/l} = 30.2 \text{ g/m}^3 \end{aligned}$$

The mass of chloride released is $(30.2 \times 10^{-3}) \times 1000 = 30.2 \text{ kg}$ which is below the reporting threshold

3.3.2 Limits of detection

If the best available information indicates that a substance is not released from your process, you should report a *n/a* return for that substance. However, a measurement that indicates that a listed substance is below the LOD does not necessarily mean that the substance is not present, and a non-zero return needs to be made if you consider that the substance is present but not (currently) detectable by measurement. The problem arises as to how to determine the emission if all that is known is that the substance is present and it is measured at some value below the LOD.

There is no straightforward answer to this problem and in some cases it may be better to use another RET such as mass balance rather than measurement, especially if emission flow rates are very high. Where another RET is not an option, the following methodology should be used in order to provide a consistent approach (unless an over-riding methodology has been agreed with us, e.g. for a particular substance or process). Where multiple measurements for a substance are all below the LOD and there is no other reason to believe that the substance is present, then the measurement should be taken as zero for that emission point. Where there is reason to believe that a substance is present, the measurement should be taken as $\frac{1}{2}$ LOD.

Where some measurements are above the LOD and some are below, then those above the LOD should be taken as the measured values unless you can demonstrate to us that the measurements are false, and the readings below the LOD should be taken as equal to $\frac{1}{2}$ LOD. In both cases, the concentration measurements need to be multiplied by the flowrate at the time of the measurement in order to determine the mass emission (following the guidance contained in this Note).

In all cases where measurement is used, it should be based on the most accurate or appropriate methodology readily available involving the lowest LOD.

3.3.3 If no emission factors or other RETs are available

If an emission factor or other emission estimation technique is not available then you should contact us.

3.3.4 Units

In completing the SPRI return, care should be taken with the units of the substances reported. A checklist of unit prefixes is included in Appendix B to aid in this process.

4 Off-site waste transfers

4.1 Introduction

Reporting to the SPRI consists of the annual mass (tonnage) of waste arising from process-related activities and transferred off site. Wastes must be classified by the European Waste Catalogue (EWC) 6-digit code(s) and by the relevant Waste Framework Directive disposal or recovery code(s) (D&R).

There is no reporting threshold for hazardous wastes, which are indicated by an asterisk in the EWC. For all other EWC/D&R code combinations, a reporting threshold of 5 tonnes applies.

Any transfer of waste off-site to a third party is covered by the Duty of Care provisions of the Environmental Protection Act 1990. This includes the requirement to describe the waste and record the quantity. You should therefore use data generated in compliance with Duty of Care requirements to complete the SPRI return. The only additional information that is required in reporting off-site waste transfers to the SPRI is the appropriate Waste Framework Directive D&R code.

4.2 Relevant wastes

In general the waste streams from incineration facilities comprise:

- Bottom ash (approx. 25% by weight and 10% by volume of input for a modern Municipal Waste Incinerator MWI), (EWC 19 01 011 – where bottom ash contains dangerous substances and 19 01 12 where it does not)
- Fly ash (EWC 19 01 13 where fly ash contains dangerous substances and 19 01 14 where it does not)
- Air pollution control residues (commonly combined with fly ash and then approx. 2.5% by weight of waste input for a modern MWI)
- Rejected feedstock wastes (chemical or physical incompatibility e.g. large objects)
- Recovered waste fractions e.g. steel and aluminium extracted from ash. (EWC 19 01 02 ferrous materials removed from bottom ash)

(EWC codes are given in brackets where known).

4.3 Quantification of emissions

In completing the SPRI return, 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 SPRI return. However, waste transferred to third parties (even if stored on your site), should be reported.

4.4 Transboundary shipments of hazardous waste

The annual quantities of any transboundary hazardous waste shipments taking place during 2007 and during each subsequent year must be reported to the SPRI. Separate guidance on how to do this will be issued during 2007.

5 References and further information

- 1 Scottish Pollutant Release Inventory web site.
www.sepa.org.uk/spri/index/
- 2 The Pollution Prevention and Control Regulations (Scotland) SSI 2000 No. 323. [Scottish Statutory Instrument 2000 No. 323](#)
- 3 The Waste Incineration Regulations (Scotland) 2003. SSI 2003 No. 170.
- 4 The Waste Incineration Directive (2000/76/EC).
- 5 EPER web site. <http://eper.cec.eu.int/eper/>
- 6 Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001. Limitation of emissions of certain pollutants into the air from large combustion plants.
- 7 EU Emissions Trading Scheme.
Commission Decision of 29 January 2004 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC
<http://www.defra.gov.uk/environment/climatechange/trading/eu/permits/index.htm>
- 8 SEPA. Scottish Pollutant Release Inventory reporting guidance note.
http://www.sepa.org.uk/pdf/spri/spri_general_guidance.pdf

Appendix A - Normalisation of emission concentrations

In many cases, pollutant emission concentrations to air are reported as normalised concentrations, the actual measured emission concentration having been adjusted to a normalised temperature (273K), oxygen, pressure and/or water vapour concentration. In calculating mass emissions to air, it is important that either the actual release concentration is multiplied by the actual volumetric flowrate, or the normalised concentration is multiplied by the normalised volumetric flowrate. In many cases, emission concentrations and volumetric flowrates are quoted in different ways, and you should ensure that the measurements are multiplied together on a consistent basis.

The following equations can be used to correct measured concentrations and flowrates for temperature, oxygen, pressure and water vapour content. It should be noted that the equations for correcting concentrations and volumetric flowrates are simple inversions of each other.

Concentrations

To correct for moisture concentration to dry (0% oxygen)

$$C_d = C_m \times (100/(100 - \%H_2O))$$

Where C_d is the dry concentration
 C_m is the measured concentration
 $\%H_2O$ is the measured water vapour percentage

To correct the % oxygen to dry basis (if required – may already be measured dry)

$$O_{2(dry)} = O_{2m} \times (100/(100 - \%H_2O))$$

Where $O_{2(dry)}$ is the dry oxygen percentage
 O_{2m} is the measured oxygen percentage

To correct to normalised oxygen concentration

$$C_{corr} = C_d \times (20.9 - O_{2norm})/(20.9 - O_{2(dry)})$$

Where C_{corr} is the corrected concentration for oxygen concentration
 O_{2norm} is the stated normalised oxygen percentage

To correct for temperature

$$C_{normT} = C_{corr} \times ((273 + T_m)/273)$$

Where C_{normT} is the normalised concentration for temperature
 T_m is the measured temperature in degrees centigrade

To correct for pressure

$$C_{norm} = C_{normT} \times (101.3/P_m)$$

Where C_{norm} is the normalised concentration
 P_m is the measured pressure in kPa

Volumetric flowrates

To correct for moisture concentration to dry (0% oxygen)

$$Q_d = Q_m \times ((100 - \%H_2O)/100)$$

Where Q_d is the dry volumetric flowrate
 Q_m is the measured volumetric flowrate

%H₂O is the measured water vapour percentage

To correct the % oxygen to dry basis (if required – may already be measured dry)

$$O_{2(\text{dry})} = O_{2m} \times (100 / (100 - \%H_2O))$$

Where $O_{2(\text{dry})}$ is the dry oxygen percentage
 O_{2m} is the measured oxygen percentage

To correct to normalised oxygen concentration

$$Q_{\text{corr}} = Q_d \times (20.9 - O_{2(\text{dry})}) / (20.9 - O_{2\text{norm}})$$

Where Q_{corr} is the corrected volumetric flowrate for oxygen concentration
 $O_{2\text{norm}}$ is the stated normalised oxygen percentage

To correct for temperature

$$Q_{\text{normT}} = Q_{\text{corr}} \times (273 / (273 + T_m))$$

Where Q_{normT} is the normalised volumetric flowrate for temperature
 T_m is the measured temperature in degrees centigrade

To correct for pressure

$$C_{\text{norm}} = C_{\text{normT}} \times (P_m / 101.3)$$

Where C_{norm} is the normalised volumetric flowrate
 P_m is the measured pressure in kPa

Appendix B - Conversion factors

ppm to mg/m³ - air

The conversion between ppm and mg/m³ is dependent on both the molecular weight of the substance and the temperature 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. However, when converting ppm to mg/m³ at actual discharge conditions, it is important to take account of the necessary factors.

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

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

Where MW is the molecular weight of the substance (in grams)
 T is the temperature at which the conversion is to be made (degrees Kelvin)
 P is the pressure at which the conversion is to be made (kPa)

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

$$\text{ppm} = \text{mg/m}^3 \times (22.4/\text{MW}) \times (\text{T}/273) \times (1013/\text{P})$$

ppm to mg/l – Water

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.

Metric prefixes

The following prefixes are given for the metric system as an easy reference guide.

Factor by which unit is multiplied	Prefix	Symbol
10 ²⁴	yotta	Y
10 ²¹	zetta	Z
10 ¹⁸	exa	E
10 ¹⁵	peta	P
10 ¹²	tera	T
10 ⁹	giga	G
10 ⁶	mega	M
10 ³	kilo	k
10 ²	hecto	h
10	deca	da
10 ⁻¹	deci	d
10 ⁻²	centi	c
10 ⁻³	milli	m
10 ⁻⁶	micro	μ
10 ⁻⁹	nano	n
10 ⁻¹²	pico	p
10 ⁻¹⁵	femto	f
10 ⁻¹⁸	atto	a
10 ⁻²¹	zepto	z
10 ⁻²⁴	yocto	y

Appendix C - Glossary

ACI	Animal Carcass Incineration
APC	Air Pollution Control
B(a)P	Benzo(a)pyrene
BAT	Best Available Techniques
BRT	Below Reporting Threshold
CEMS	Continuous Emission Monitoring System
COD	Chemical Oxygen Demand
CWI	Clinical Waste Incineration
DI	Drum Incineration
EU ETS	European Union Emissions Trading Scheme
E-PRTR	European Pollutant Release and Transfer Register
ESP	Electrostatic Precipitator
EWC	European Waste Catalogue
HWI	Hazardous Waste Incineration
IPC	Integrated Pollution Control
IPPC	Integrated Pollution Prevention & Control
I-TEQ	International Toxicity Equivalents of Dioxins
LCPD	Large Combustion Plant Directive
LOD	Limit of Detection
MCERTS	(Environment Agency's) Monitoring Certification Scheme
MSW	Municipal Solid Waste
NO _x	Nitrogen Oxides (mixture of NO and NO ₂)
NMVOCS	Non-Methane Volatile Organic Compounds
PAHs	Polycyclic Aromatic Hydrocarbons
PCDDs	Polychlorinated Dibenzodioxins
PCDF	Polychlorinated Dibenzofurans
PM ₁₀	Particulate Matter (< 10µm aerodynamic diameter)
PM _{2.5}	Particulate Matter (< 2.5µm aerodynamic diameter)
PPC	Pollution Prevention & Control
ppm	Parts per million
RET	Release Estimation Technique
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
SO ₂	Sulphur Dioxide
SSI	Sewage Sludge Incineration
TOC	Total Organic Carbon
TPM	Total Particulate Matter
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WHO	World Health Organisation
WHO TEQ	WHO Toxicity Equivalents of Dioxins
WID	Waste Incineration Directive

Annex 1 – Incineration source factors

This Annex is designed to be an aid for compiling Scottish Pollutant Release Inventory (SPRI) submissions from incineration processes, and covers the major categories of emission sources; combustion emissions, fugitive emissions, wastewater etc. It also includes emission factors where applicable.

The table below addresses all the pollutants which we consider potentially emitted from typical incineration processes. For pollutants not contained within this table a return of not applicable, *n/a*, is in most cases to be expected, to indicate that this pollutant is not knowingly discharged by the site.

Emissions to Air

Determinand	Threshold	Method (see note 1)	Emission source	Literature reference	Factors and guidance
Benzene	1 t	C	Waste Combustion		
Benzo(a)pyrene	0.001 t	M	Waste Combustion	BS ISO 11338	BS ISO 11338 for extractive monitoring
Butadiene	0.1 t	C	Waste Combustion		
CO	100 t	M	Waste Combustion	CEN/ISO/ MCERTS	Continuous and periodic monitoring carried out for all incinerators covered by WID. BS EN14181 for CEMs. Standard Reference Method BS EN15058. (ISO12039 formerly relevant)
		C	MSW Combustion	Environment Agency (2000)	0.197 kg/t of MSW combusted
		C	SSW Combustion	USEPA 1995	1.1 kg/t of SSW combusted (fluidised bed)
				USEPA 1995	15.5 kg/t of SSW combusted (multiple hearth)
C	CW Combustion	USEPA 1995	1.48 kg/t of CW combusted (controlled air)		
CO ₂	10,000 t	C	Waste Combustion	EU ETS M&R Methodology (2004/156/EC)	Although incinerators are not subject to the EU ETS requirements the EU ETS methodology is considered best practice.
CH ₄ (see note 2)	10 t	C	MSW Combustion	Environment Agency (1997)	0.0008 kg/t of MSW combusted
		C	SSW Combustion	USEPA 1995	0.39 kg/t of SSW combusted in multiple hearth (controlled)
Dioxins & Furans	1 x 10 ⁻⁸ t	M	Waste Combustion	BS EN1948	Periodic monitoring required for WID incinerators.

Determinand	Threshold	Method (see note 1)	Emission source	Literature reference	Factors and guidance
HCl	10 t	M	Waste Combustion	MCERTS/BS EN	BS EN14181 for CEMs and BS EN1911 (or demonstrated equivalent) for periodic monitoring carried out for all incinerators covered by WID
		C	MSW Combustion	USEPA 1996	3.2 Kg/t of MSW combusted
		C	SSW Combustion	USEPA 1995	0.05 Kg/t of SSW combusted on fluidised bed (controlled)
		C	CW Combustion	USEPA 1995	16.8 Kg/t of CW combusted (uncontrolled)
Fluorine and inorganic compounds – as HF	1t	M	Waste Combustion	ISO/USEPA	BS EN14181 for CEMs and USEPA Method 26A for periodic monitoring. Not all WID incinerators are required to monitor HF continuously.
NH ₃	1 t	M	SNCR nitrogen oxide abatement	MCERTS certified equipment	Continuous or periodic monitoring may be required depending upon BAT assessment. US EPA Method 26. VDI 2461 or ASTM D6348-03 potentially relevant to periodic monitoring.
NMVOCs	10 t	M	Waste Combustion	MCERTS/BS EN 12619	CEM and extractive monitoring required under WID. BS EN14181 for CEMS.
		C	MSW Combustion	Environment Agency (2000)	0.0308 kg/t of MSW combusted
		C	SSW Combustion	USEPA 1995	0.84 kg/t of SSW combusted in multiple hearth (uncontrolled)
		C	Fugitive VOC Releases		
NO _x	100 t	M	Waste Combustion	CEN/ISO/MCERTS	Continuous monitoring carried out for all incinerators covered by WID. BS EN14181. Standard Reference Method BS EN14792. (BS ISO 10849 for CEM & BS ISO 11564/ISO 10849 for extractive monitoring. Of former relevance)

Determinand	Threshold	Method (see note 1)	Emission source	Literature reference	Factors and guidance
		C	MSW Combustion	Environment Agency (2000)	1.37 kg/t of MSW combusted
		C	SSW Combustion	USEPA 1995	2.5 kg/t of SSW combusted in multiple hearth (uncontrolled)
		C	SSW Combustion	USEPA 1995	0.88 kg/t of SSW combusted in fluidised bed (uncontrolled)
		C	CW Combustion	USEPA 1995	1.78 kg/t of CW combusted in controlled air (uncontrolled)
N ₂ O (see note 3)	10 t	M	Waste Combustion		Extractive monitoring required for WID. (ASTM D6348-03, ISO 10849, VDI2469-1)
		C	MSW combustion	IPCC (2000)	0.03 kg/t of MSW combusted
		C	SSW combustion	IPCC (2000)	0.8 kg/t of SSW combusted
PAHs (see note 4)	0.05 t	M	Waste Combustion	BS ISO	BS ISO11338 for extractive monitoring
PCBs	0.0001 t	M	Waste Combustion	CEN/BS EN	BS EN1948 for dioxin like PCBs extractive monitoring.
Total Particulate Matter	10 t	M	Waste Combustion	BS ISO/BS EN	Continuous monitoring carried out for all incinerators covered by WID. BS EN13284-2 for CEMs and BS EN13284-1 SRM.
		C	MSW Combustion	USEPA 1996	12.6 kg/t of MSW combusted (uncontrolled)
		C	SSW Combustion	USEPA 1995	233 kg/t of SSW combusted (uncontrolled)
		C	CW Combustion	USEPA 1995	2.33 kg/t of CW combusted (uncontrolled)
PM ₁₀ (also PM _{2.5})	1 t	C	MSW Combustion	(Environment Agency 2000)	0.022 kg/t of MSW combusted
		C	SSW Combustion		0.075 kg/t of SSW combusted
		C	CW Combustion	CORINAIR (1999)	0.27 kg/t of CW combusted
SO _x	100 t	M	Waste Combustion	CEN/ISO/MCERTS	BS EN14181/BS 6069 (ISO 7935) for CEMs and BS EN14791 (SRM). BS ISO11632/BS ISO 6069 alternatives for extractive monitoring.

Determinand	Threshold	Method (see note 1)	Emission source	Literature reference	Factors and guidance
		C	MSW Combustion	(Environment Agency 2000)	0.076 kg/t of MSW combusted
		C	SSW Combustion	USEPA 1995	2.3 kg/t of SSW combusted in multiple hearth (venturi scrubber)
		C	SSW Combustion	USEPA 1995	0.15 kg/t of SSW combusted in fluidised bed (uncontrolled)
		C	CW Combustion	USEPA 1995	1.09 kg/t of CW combusted in controlled air (uncontrolled)
Metals					
As	0.001 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Cd	0.001 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Cu	0.01 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Cr	0.01 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Hg	0.001 t	M	Waste Combustion	BS EN	BS EN13211 for extractive monitoring (or in series with other metals by BS EN14385 subject to adaptation).
Mn	0.01 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Ni	0.01 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Pb	0.1 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Sb	0.001 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
V	0.01 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring.
Zn	0.1 t	M	Waste Combustion	BS EN	BS EN14385 for extractive monitoring ^(see note 5) .

Notes:

1. In method column M=measurement, C=calculation, E=estimation (engineering judgement).
2. Option exists for methane emissions to be included in future phases of the EU ETS – estimation methodologies may warrant re-evaluation when EU monitoring and reporting decisions are published
3. Option exists for N₂O emissions to be included in future phases of the EU ETS – estimation methodologies may warrant re-evaluation when EU monitoring and reporting decisions are published.
4. From 2006 the SPRI requires reporting of the annual emissions of listed individual PAH compounds (with individual reporting thresholds) rather than a PAH total.
5. Although not specifically validated for zinc. BS EN14385 will be applicable in most cases (see Environment Agency “Metals” Method Implementation Document).

Releases to Controlled Waters and Transfers in Wastewater

Wherever possible data should be net of incoming cooling water quality, however where this would result in a negative return (i.e. removal of pollutants from incoming waters) a *n/a* return should be made unless alternative local arrangements have been made with us.

The list of reference methods is not exhaustive, other analytical methods may be appropriate

Determinand	Threshold	Method	Emissions Source	Literature Reference	Factors and Guidance
As	0.005 t	M	Effluent Treatment Facilities	BS EN ISO 11969	Monthly flow proportional sampling
Cd	0.001 t	M	Effluent Treatment Facilities	BS EN ISO 17294	Monthly flow proportional sampling
Chlorides (as total Cl)	2000 t	M	Effluent Treatment Facilities	Chloride in Waters. Sewage and Effluents 1981 SCA blue book.	
Chloroform	0.005 t	M	Effluent Treatment Facilities	BS EN ISO 10301	
Cr	0.02 t	M	Effluent Treatment Facilities	BS EN ISO 11885 BS EN ISO 17294	Monthly flow proportional sampling
Cu	0.02 t	M	Effluent Treatment Facilities	BS EN ISO 11885 BS EN ISO 17294	Monthly flow proportional sampling
Ethylene dichloride	0.01 t	M	Effluent Treatment Facilities	BS EN ISO 10301	
Hg	0.0001 t	M	Effluent Treatment Facilities	BS EN 13506	Monthly flow proportional sampling
Naphthalene	0.001 t	M	Effluent Treatment Facilities	BS ISO 17993 USEPA Method 0610	

Determinand	Threshold	Method	Emissions Source	Literature Reference	Factors and Guidance
Ni	0.02 t	M	Effluent Treatment Facilities	BS EN ISO 11885 BS EN ISO 17294	Monthly flow proportional sampling
PAHs*	0.001 t	M	Effluent Treatment Facilities	BS ISO 17993 USEPA method 0610	
Pb	0.02 t	M	Effluent Treatment Facilities	BS EN ISO 11885 BS EN ISO 17294	Monthly flow proportional sampling
PCBs	1×10^{-6} t	M	Effluent Treatment Facilities	USEPA methods 0680, 1668	
TOC	50 t	M	Effluent Treatment Facilities		Continuous monitoring
Tributyl Tin	5×10^{-6} t	M	Effluent Treatment Facilities	BS ISO 18073:2004	
Zinc	0.1 t	M	Effluent Treatment Facilities	BS EN ISO 11885 BS EN ISO 17294	Monthly flow proportional sampling

* Benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(123-cd)pyrene