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VMRVP01 - Waste activities during the voluntary MRV-only period

Technical guidance

Revised October 2026

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1 Overview

This document provides guidance to operators of energy from waste (EfW) and waste incineration facilities on the activities they will carry out under the voluntary monitoring, reporting and verification (MRV)-only period. This guidance provides:

- an introduction to aspects of MRV, taking existing technical guidance and tailoring it for waste operators to make it more accessible
- signposting where to find more detailed technical guidance in existing UK ETS guidance publications
- new technical guidance for the voluntary MRV-only period concerning the additional quarterly reporting requirement for waste operators

The Environment Agency's 'How to participate' guidance sets out how to apply for a Voluntary Monitoring Plan (VMP) and the commitments that apply during the voluntary MRV-only period. These include commitments to monitor and report emissions from relevant activities. Monitoring should be in accordance with your VMP and **the Monitoring and Reporting Regulation 2018** (**MRR**), while reporting should be in accordance with the MRR.

The MRR refers to Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 as given effect by the Greenhouse Gas Emissions Trading Scheme Order 2020 (the Order) and subject to modifications in Schedule 4 to the Order.

The MRR has no legal effect for the voluntary MRV-only period, but operators should monitor and report in line with it to understand the requirements ahead of inclusion of the waste sector in the UK ETS. However, there are a limited number of changes to the MRR which are needed to apply it to waste activities. These are set out in the Annex to this guidance. Whenever reference is made to the MRR and to Articles in the MRR in this guidance, this means the MRR as it applies for the purposes of the UK ETS, together with the changes in the Annex.

Operators are advised to work through this guidance document in the first instance. There are also several existing UK ETS technical guidance documents that relate to the MRR that may assist waste operators during the voluntary MRV-only period. These are as follows (with hyperlinks provided):

- UKETS01 MRR – General guidance for installations
- UKETS02 MRR/FAR – Uncertainty assessments for installations
- UKETS03 MRR – Reporting biomass in installations

- UKETS04 MRR - Data flow activities and control system
- UKETS07 MRR – Sampling and analysis

Please note, there is also UK ETS guidance scheduled to be published in due course which, once available, might also assist waste operators during the voluntary MRV-only period. These are as follows:

- UKETS05 MRR – Making conservative estimates and data gaps
- UKETS06 MRR – Use of continuous emissions measurement systems (CEMS)

Please contact your regulator for waste-specific CEMS guidance that has been previously shared from the Environment Agency ETS Waste Helpdesk.

2 The voluntary MRV period

The UK Emissions Trading Scheme (UK ETS) came into operation on 1 January 2021. The scheme is a key part of the UK's approach to addressing climate change, setting a limit on greenhouse gas emissions from the sectors covered and ensuring an appropriate price is applied to them. The scheme is run by the UK ETS Authority (the Authority), and is comprised of the UK Government, Scottish Government, Welsh Government and the Department of Agriculture, Environment and Rural Affairs for Northern Ireland.

In May 2024, the Authority published a technical consultation on expanding the UK ETS to the waste sector. This followed an earlier consultation and Authority response published in March 2022 and June 2023, respectively.

The Authority published an interim response to the technical consultation on 21 July 2025. This response confirmed that a Waste Activities Voluntary Monitoring Reporting and Verification (prior to inclusion in the UK ETS) period (the voluntary MRV-only period) will start on 1 January 2026. The voluntary MRV-only period is now underway, with Operators able to apply for their voluntary monitoring plan through Manage your Emissions Trading Scheme (METS) platform.

The Authority has made the following decisions in relation to a voluntary MRV-only period as set out in the interim response to the consultation:

1. The voluntary MRV-only period commenced on 1 January 2026, enabling operators and customers to better understand participation in the scheme, and support further policy development by the Authority ahead of inclusion of the waste sector in the UK ETS.
2. Participation in the MRV-only period is voluntary, and therefore there will be no legal obligation to participate and no penalty for non-participation. This is to enable the Authority to test different approaches to MRV before legislating for the inclusion of the waste sector in the UK ETS.
3. Participants will have access to regulator support during the voluntary MRV-only period without incurring onboarding or regulator upkeep costs. Voluntary participation is strongly encouraged.
4. Data from the voluntary MRV-only period will be shared with regulators and the Authority. Taking part in the voluntary MRV-only period will allow operators to provide data in relation to their installation which can be used to support the finalisation of policy decisions, including in relation to MRV methodologies and the pass through of UK ETS costs from waste incinerators to their customers. The

voluntary MRV-only period will apply to combustion and process emissions from energy from waste (EfW) and waste incineration processes.

5. For the purposes of the voluntary MRV-only period, the inclusion threshold for waste incineration will be based on the small waste incineration plant (SWIP) throughput threshold, which is defined in the Environmental Permitting Regulations (England and Wales) 2016. This means that installations incinerating non-hazardous waste with a capacity exceeding 3 tonnes an hour, or, incinerating hazardous waste with a capacity exceeding 10 tonnes a day, will be in scope of the voluntary MRV-only period. Clinical waste incinerators and clinical waste treated at non-specialist facilities will be included in the voluntary MRV-only period. The voluntary MRV-only period will allow the Authority to better understand the impacts of including clinical waste, and the Authority will reassess this position ahead of the inclusion of the waste sector in the UK ETS.
6. High temperature incinerators that primarily process non-clinical hazardous waste will be exempt from the voluntary MRV-only period.
7. The Authority will use an integrated monitoring approach, which will combine Carbon-14 (C-14) and emissions factors.

As noted in the interim response, the voluntary MRV-only period will inform elements of the ongoing policy decision making process relating to the details of the statutory scheme which will apply in relation to the waste sector when it is included in the UK ETS. Therefore, the requirements for operators during the MRV-only period may be different to the requirements when the sector is included in the UK ETS. The Authority will set out final policy decisions in that regard in a subsequent Authority response as soon as reasonably practicable.

This guidance explains the activities covered by the voluntary MRV-only period and who should participate. It will help operators of waste incineration, and EfW installations understand how to monitor and report greenhouse gas emissions. This guidance may be updated at any point during the voluntary MRV-only period: where this happens, participants will be notified. Note that references to numbered sections will link to sections in this guidance document unless otherwise stated.

The Environment Agency guidance – ‘Waste Activities Voluntary Monitoring Reporting and Verification (prior to inclusion in the UK ETS): How to Participate’ - gives further detail about the commitments during the voluntary MRV-only period and how to meet those commitments. Please contact your regulator for a copy.

The EU Emissions Trading System will apply in Northern Ireland (NI) under the terms of Article 9 and Annex 4 to the Windsor Framework (formerly the Northern Ireland Protocol) in respect of energy from waste installations. Any queries with respect to this position

should be directed to the Department of Agriculture, Environment and Rural Affairs (DAERA) in NI, at developETS@daera-ni.gov.uk.

3 Waste activities and operators

Monitoring, Reporting and Verification (MRV) is the process by which operators track, record, and validate their greenhouse gas emissions. The process should be **robust, transparent, consistent and accurate** (these terms are defined in more detail in section 5).

3.1 Eligibility for the voluntary MRV-only period

The activities included in the voluntary MRV-only period are both of the following:

- incineration of non-hazardous waste with a capacity greater than 3 tonnes of waste per hour; and
- incineration of hazardous waste with a capacity greater than 10 tonnes of waste per day.

Hazardous waste incineration installations that are not eligible to participate in the voluntary MRV-only period:

- any installation that is demonstrably capable of operating at a temperature of 1,100 °C for 2 seconds and whose annual waste input (assessed over the previous calendar year) comprises:
    - at least 80% hazardous waste; and
    - no more than 20% healthcare waste (hazardous and/or non-hazardous); and
    - no more than 1% hazardous waste wood

Please refer to the 'How to Participate' guidance for detailed information about the voluntary MRV-only period commitments.

3.2 Definitions

For the purposes of the voluntary MRV-only period, the following definitions are used.

Waste means anything that:

- is waste within the meaning of Article 3(1) of the Waste Framework Directive, as read with Articles 5 and 6 of that Directive, and
- is not excluded from the scope of that Directive by Article 2(1)(d) of that Directive.

Hazardous waste means:

- in relation to an installation in Northern Ireland or UK coastal waters adjacent to Northern Ireland, hazardous waste for the purposes of regulation 6 of the Hazardous Waste Regulations (Northern Ireland) 2005
- in relation to an installation in Scotland or UK coastal waters adjacent to Scotland, special waste within the meaning of regulation 2 of the Special Waste Regulations 1996
- in relation to an installation in Wales or UK coastal waters adjacent to Wales, hazardous waste for the purposes of regulation 6 of the Hazardous Waste (Wales) Regulations 2005
- in any other case, hazardous waste for the purposes of regulation 6 of the Hazardous Waste (England and Wales) Regulations 2005.

Non-hazardous waste means waste which is not hazardous waste (as defined above).

Healthcare waste means waste categorised under Chapter 18 of the List of Wastes and includes waste categorised under the codes 20 01 31 (cytotoxic & cytostatic medicines) & 20 01 32 (other medicines).

Hazardous waste wood means waste categorised under any of the following List of Wastes codes:

- 03 01 04 (sawdust, shavings, cuttings, wood, particle board and veneer containing hazardous substances)
- 17 02 04 (glass, plastic and wood containing or contaminated with hazardous substances)
- 19 12 06 (wood containing hazardous substances)
- 20 01 37 (wood containing hazardous substances).

Incineration means oxidation of waste as well as other thermal treatment processes, such as pyrolysis, gasification or plasma process if the substances resulting from the treatment are subsequently incinerated.

List of Wastes means the list of wastes established by Commission Decision 2000/532/EC of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste[1] and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste.[2]

The '**operator**', for the purposes of the voluntary period, is the person or entity that has sufficient control over the operation of an installation and its emissions. The person or

[1] https://eur-lex.europa.eu/eli/dec/2000/532/oj/eng
[2] https://eur-lex.europa.eu/eli/dec/2000/532/oj/eng

entity must have the authority and ability to make sure that it follows the monitoring methodology as set out in the Voluntary Monitoring Plan (VMP).

To assess whether a person or entity has sufficient control and the authority or ability to follow the VMP, the following criteria will be considered – the person or entity:

- has day-to-day control of the installation or relevant activity, including the manner and rate of operation
- has the authority to instruct staff to follow the VMP
- controls, monitors and reports emissions
- decides who holds important staff positions and has incompetent staff removed, if required
- makes investment and financial decisions that affect the installation's performance or how the site operates
- makes sure that operations are controlled in an emergency

Each situation will be considered on its facts. It is not necessary for all these criteria to be met for a person or entity to be considered the operator of an installation.

4 Definitions relevant to MRV

Monitoring, reporting, and verification (MRV) is the process by which operators track, record, and validate their greenhouse gas emissions. The process should be **robust**, **transparent**, **consistent**, and **accurate** (these terms are defined in more detail in section 5).

The following definitions explain the MRV-related terms that are used throughout this guidance:

Calculation factors: calculation factors are key parameters of any monitoring plan based on a calculation methodology and include:

- Emission Factor (EF)
- Net Calorific Value (NCV)
- Oxidation Factor (OxF)
- Biomass Fraction (BF)
- Carbon Content (CC).

Continuous emission measurement: a set of operations to determine the value of a quantity by means of periodic measurements, applying either measurements in the stack or extractive procedures with a measuring instrument located close to the stack, whilst excluding measurement methodologies based on collecting individual samples from the stack.

Emission point: the point from where greenhouse gas emissions are released from the installation e.g. main stack, boiler flue, etc.

Emission source: an emission source is defined as "*A separately identifiable part of an installation or a process within an installation, from which relevant greenhouse gases are emitted...*" (from Article 3(5) of the MRR). For waste activities, an emission source will be a physical unit from which emissions are released e.g. an incinerator, standby generator, fire pump, etc. Any part of the facility where the combustion reaction occurs and relevant greenhouse gases are emitted will be an emission source

Measurement point: a measurement point is defined as "*the emission source for which continuous emission measurement systems (CEMS) are used for emission measurement, or the cross-section of a pipeline system for which the CO_2 flow is determined using continuous measurement systems*" (Article 3(43) of the MRR). This

refers to the point where the probe (in the waste gas duct) takes measurements and/or samples.

Source stream: a source stream is defined as "*a specific fuel type, raw material or product giving rise to emissions of relevant greenhouse gases at one or more emission sources as a result of its consumption or production; a specific fuel type, raw material or product containing carbon and included in the calculation of greenhouse gas emissions using a mass-balance methodology*" (Article 3(4) of the MRR). Relevant source streams for waste incineration and EfW sites will include waste feedstock, any ancillary fuel used during start-up of the incinerator, other small sources around the site and carbon containing materials used for flue gas scrubbing e.g. urea, lime or sodium bicarbonate.

5 The Voluntary Monitoring Plan (VMP)

The approved VMP is the most important document for every installation participating in the voluntary MRV-only period. The VMP serves as a manual for the operator's tasks, and it should be written in a way that allows all relevant parties, particularly new staff and the regulator, to understand how an installation's emissions are monitored. Additionally, it is a guide for any verifier (if appointed) against which they will verify the operator's emission report.

A monitoring plan (which forms part of the VMP) for the waste sector will likely include the following:

- source streams, emission sources, emissions points, measuring devices
- data collection methods (metering data, invoices, etc.)
- stack emissions sampling, additional fuel sampling e.g. continuous emissions measurement systems (CEMS) equipment or C-14 sampling equipment
- laboratory analyses of stack samples (C-14 sample analysis)
- maintenance and calibration of meters
- description of calculations and formulae used
- control activities (e.g. four eyes principle for data collection)
- data archiving (including protection against manipulation)
- regular identification of improvement possibilities.

The VMP and any subsequent changes to it should be approved by the regulator. Further information on applying for and making changes to the VMP can be found in the 'How to Participate' guidance.

The underlying principles governing the development of a VMP are as follows:

- **Completeness**: all relevant emission sources and source streams should be included.
- **Consistency and comparability**: time series data should be consistent over time, unless improvements to monitoring have been made. Any changes to the VMP should be approved by the regulator.
- **Transparency**: data collection, compilation, and calculation processes should be transparent. This means that the data and the methods for collecting and using them (the whole data flow) should be clearly documented. Relevant information

should be securely stored and retained, allowing sufficient access by authorised third parties (verifier, regulator).

- **Accuracy**: operators should ensure that data are accurate, i.e. neither systematically nor knowingly inaccurate. Operators should aim for the highest achievable accuracy and exercise due diligence. 'Highest achievable' means it is technically feasible and 'without incurring unreasonable costs'.
- **Integrity of the methodology and of the emissions report**: this principle is at the core of any MRV system. Essentially, the data generated by the MRV system and the processes in place to support the data capture, must be of high integrity, or 'robust'. The MRR explicitly mentions it and adds the following:
    - the monitoring methodology and the management of data should allow the verifier to achieve "reasonable assurance" on the emissions report, i.e. the monitoring should withstand extensive testing
    - data should be free from material misstatements and avoid bias
    - data should provide a credible and balanced account of an installation's emissions
    - when looking for greater accuracy, operators may balance the benefit against additional costs, such that attempts to achieve greater accuracy are proportionate. Operators should aim for 'highest achievable accuracy, unless this is technically not feasible or would lead to unreasonable costs.'
- **Continuous improvement**: the operator should regularly check whether the VMP can be improved.

It is recommended that Operators consult section 4.2 'A 13-step approach for creating a monitoring plan' in the guidance document 'UKETS01 MRR – General guidance for installations' when devising their VMP.

5.1 Procedures

To avoid a lengthy and complex VMP, some monitoring activities, particularly those that may change frequently, are not documented in detail in the VMP. Such activities should be detailed instead in 'written procedures'" which are referred to in the VMP and complement the VMP. The operator should describe the procedure in the VMP and include an appropriate level of detail so the regulator can understand the content of the procedure. Operators should make all procedures available for the purpose of verification (Article 12(2) of the MRR) and should provide these to the regulator upon request.

The following should be detailed in written procedures rather than included within the VMP:

- managing responsibilities and competency of personnel
- data flow and control procedures (see below)
- quality assurance measures
- estimation method for substitution data in case of data gaps (these should be approved by the regulator)
- regular review of the monitoring plan for its appropriateness (including uncertainty assessment, where relevant, which should be approved by the regulator)
- a sampling plan,[3] if applicable, and a procedure for revising the sampling plan, if relevant (the sampling plans should be approved by the regulator)
- procedures for methods of analyses, if applicable
- procedure for demonstrating evidence for equivalence to EN ISO/IEC 17025 accreditation of laboratories, if relevant
- procedures for using measurement-based methodologies (see section 8.1, including for corroborating calculations and for subtracting biomass emissions)

For further information on how to set out and describe procedures, please see Article 12 of the MRR and section 4.6 of 'UKETS01 MRR – General guidance for installations

5.2 Data flow and control system

When monitoring emissions, operators should ensure that data are produced, collected, processed and stored in a controlled way. The operator should list the responsible person for the data at every stage, from collection through analysis to reporting. These 'data flow' activities are covered in the management procedure section of the VMP. A data flow diagram is a useful tool for analysing and creating data flow procedures. Examples of data flow activities include reading from instruments, sending samples to the laboratory and receiving the results, aggregating data, calculating the emissions from various parameters, and storing all relevant information for later use.

As data flow activities involve multiple steps, e.g. manual data handling or using different IT systems, there is potential for mistakes. To mitigate these risks, the operator should establish an effective control system (Article 59 of the MRR) that includes the following:

- a risk assessment
- control activities for mitigating the risks identified.

[3] The plan should include the methodologies for preparation of samples, including information on responsibilities, locations, frequencies and quantities and methodologies for the storage and transport of samples (Article 33 of the MRR).

‘Risks’ should account for the likelihood of an incident happening and its impact on emissions. The risks relate to the probability of a misstatement (data omission or error) and the degree to which such an error would affect the annual reportable emissions.

5.2.1 Risk assessment

When carrying out a risk assessment, the operator should analyse each part of the data flow for the whole installation to identify any risk of errors occurring. The risk can be assessed qualitatively (low, medium, high) and the potential reasons for an error should be recorded, e.g. paper copies of datasheets transported from one department to another could be lost or copy and paste errors occurring in datasheets.

Mitigation measures to control each risk should be identified, recorded and implemented, e.g. sending data electronically and storing a paper copy in the original department, search for duplicates or data gaps in spreadsheets, a control check by an independent person (‘four eyes principle’).

The operator should re-evaluate the risks with mitigation measures in place until the remaining risks are assessed as being “low” and the operator is confident that they can produce an annual emissions report free from errors that would make a material difference to their annual emissions calculation.

5.2.2 Control activities

All control activities should be described in written procedures and referenced in the VMP. The results of the risk assessment (including appropriate mitigation measures) should be submitted to the regulator for checking. Operators should establish and maintain written procedures relating to control activities for at the least the following (Article 59(3) of the MRR):

- quality assurance of the measurement equipment
- quality assurance of the information technology system used for data flow activities, including process control computer technology
- segregation of duties in data flow activities and control activities and management of necessary competencies
- internal reviews and data validation
- corrections and corrective action
- control of out-sourced processes
- keeping records and documentation including managing document versions.

Note that installations with low emissions - i.e. less than 25,000 tCO_2 equivalent (CO_2e) - are exempt from including a risk assessment when submitting a VMP for the regulator to check (Article 47(3) of the MRR). However, operators should still undertake a risk assessment to avoid under or over reporting emissions.

Detailed guidance on undertaking risk assessments, including an exemplar risk assessment, can be found in guidance document 'UKETS04 MRR - Data flow activities and control system.

6 Categorisation of installations, source streams and emission sources

One of the main principles of UK ETS that is also appropriate during the voluntary MRV-only period is that the greater the emissions, the more accurately they need to be measured. Monitoring costs should therefore be proportionate to the number of emissions. Operators can avoid unreasonable financial and administrative effort when the benefit of more robust monitoring is marginal.

6.1 Installation categories

To determine the monitoring effort required, the operator should classify the installation according to its estimated average annual emissions (see Table 1 below):

Table 1. Installation categories based on annual average emissions

Installation Category	Annual Average Fossil Emissions
A (low emitter)	< 25,000 tCO_2e
A	≤ 50,000 tCO_2e
B	> 50,000 ≤ 500,000 tCO_2e
C	> 500,000 tCO_2e

When estimating average annual emissions, the operator should exclude emissions from biomass but include CO_2 transferred out of the installation (for example to a carbon capture facility or CO_2 transport network).

6.1.1 Installations with low emissions

Installations which on average emit less than 25,000 tCO_2e per year are classified as 'installations with low emissions'. **Installations with low emissions can apply simplifications to their monitoring requirements to reduce administration effort**.

6.2 Source streams

A source stream[4] refers to all the inputs and outputs that should be monitored when using a **calculation-based approach** (see section 8.2). A list of likely source streams for waste operators is listed below:

- waste – further delineation of possible source streams such as:
  - municipal solid waste (MSW)
  - clinical waste
  - hazardous waste
  - commercial and industrial waste
  - solid recovered fuel (SRF)
  - refuse derived fuel (RDF)
- other fuels, such as natural gas, gas oil or Hydrogenated Vegetable Oil (HVO) used to fire small domestic boilers and heaters or during start-up of incinerators
- carbonates, such as urea, lime or sodium bicarbonate, used in flue gas scrubbing.

For clarity, methane and N2O are not relevant GHGs

For the purposes of the voluntary MRV-only period:

- operators using a calculation-based approach will initially be asked to use a high-level default emissions factor for their waste activities, pending the expected development of more specific emissions factors
- operators using a measurement-based approach for their waste incineration activities during the voluntary MRV-only period, please see section 7.3.

Emissions from source streams that contribute the most to the overall emissions of the installation should be determined more accurately than those that don't. The operator should classify all source streams by comparing emissions of each source stream to the total emissions of the installation as follows:

- Determine the total emissions by summing emissions from all source streams and emission sources (excluding emissions from biogenic sources but include transferred CO_2).
- List all source streams and sort in descending order (lowest emissions last)
- Select source streams which will be classified as '**minor**', '**de-minimis**' or '**marginal**' (see Table 2) which will have lower accuracy requirements.

[4] Refer to Section 4 for definition of a source stream.

Table 2. Thresholds for classifying minor, de-minimis and marginal source streams when using a calculation-based approach to determine emissions.

Source Stream Category	Tonnes (t) of fossil CO_2 per year
Minor source streams	• jointly account for <5,000 t, or • jointly account for <10% of total emissions, up to a maximum of 100,000 t, whichever is greater.
De-minimis source streams	• jointly account for <1,000 t, or • jointly account for <2% of total emissions, up to a maximum of 20,000 t, whichever is greater.
Marginal source streams	• jointly account for <10 t

All other sources streams should be classified as **major source streams**.

6.3 Emission sources

The term 'emission source'[5] is used when categorising emissions quantified using a measurement-based methodology i.e. when CO_2 is measured in the stack using CEMS. The emission source is the combustion line, with the stack as the emission point. An operator may classify emission sources as 'minor' when they meet the criteria set out in Table 3. All other emission sources should be classified as **major emission sources**.

Table 3. Thresholds for classifying a minor emission source when using a measurement-based approach to determine emissions

Source Stream Category	Fossil CO_2 per year
Minor emission source	• <5,000 t or • <10% of total emissions, up to a maximum of 100,000 t (whichever is greater)

[5] Refer to Section 4 for definition of an emission source.

7 Monitoring approach

During the voluntary MRV-only period, operators should monitor their emissions as follows:

- category B and category C (see Table 1) facilities should monitor emissions using a measurement-based approach i.e. CEMS and Carbon-14 (C-14) equipment, unless they can demonstrate to regulators that this is technically infeasible or would incur unreasonable costs.
- category A or category A low emitter (see Table 1) facilities should carry out CEMS and C-14 monitoring but may request the approval of regulators to use emissions factors (a calculation-based approach using the standard methodology).
- uncertainty standards will apply both to the CEMS (CO_2) and C-14 (fossil %) monitoring. Operators should meet **separate** minimum standards of accuracy for CO_2 monitoring through CEMS, and measurement of the percentage of fossil CO_2 through C-14 but **will not be required to meet an overall uncertainty standard for both technologies combined.**
- during the voluntary MRV-only period, facilities using a calculation-based approach will be able to use conservative default emissions factors developed by the Authority. The voluntary MRV-only period will be used to codevelop more granular emissions factors with stakeholders.
- during the voluntary MRV-only period, operators are requested to report additional data to the Authority to enable the testing and improvement of representative emissions factors. This will be in addition to annual reporting of emissions. Further detail is given in Section 13.

7.1 The measurement-based approach

The Authority expects that most operators will use a measurement-based approach, unless they emit 50,000 t fossil CO_2 or less, and can demonstrate this expectation is not possible or not proportionate to their facility, or they emit more than 50,000 t fossil CO_2, but less than 500,000 t fossil CO_2 and can demonstrate to regulators that this is technically infeasible or would incur unreasonable costs.

In this approach, the operator measures the greenhouse gas emissions in the installation's off-gas stack. This is a useful approach when mixed materials, such as waste, are combusted and when sampling and analysis of the feedstock pre-combustion is infeasible, as shown in Figure 1 below.

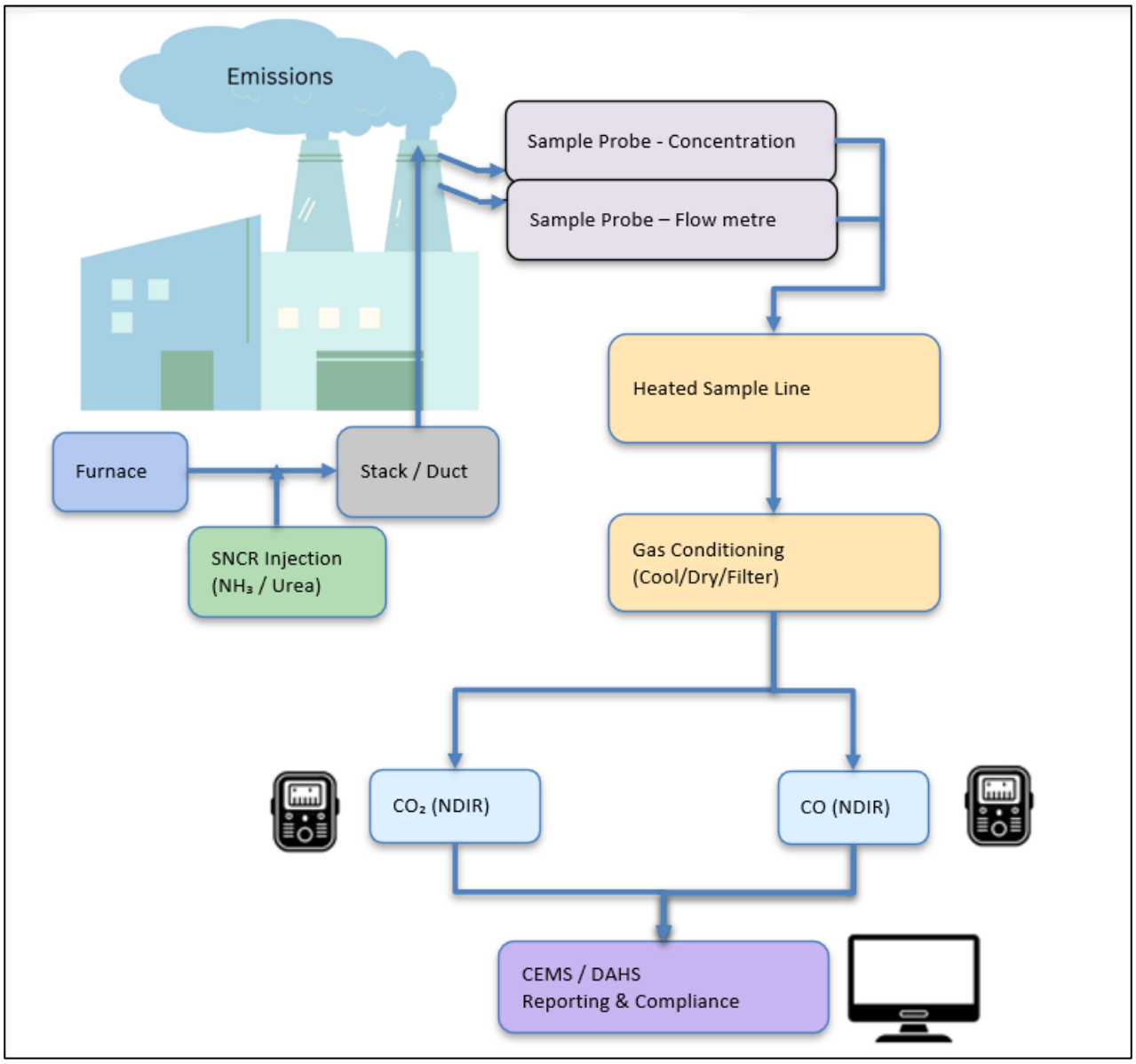


Figure 1. Schematic of a continuous emission measurement system (CEMS)

CEMS[6] always require two elements:

- measurement of the CO_2 concentration[7]
- volumetric flow of the gas stream where the measurement takes place.

[6] 'Continuous emission measurement' means determining the value of a quantity using periodic measurements, applying either measurements in the stack or extractive procedures with a measuring instrument located close to the stack, whilst excluding measurement methodologies based on collecting individual samples from the stack.
[7] Additional corrections may be needed, e.g. for moisture content.

In addition to these two elements, CEMS typically also captures CO, and the emissions from any SNCR additives and support fuels, if relevant.

Operators should determine emissions hourly, using hourly averages for each parameter (e.g. concentrations and flue gas flow rate). However, should an operator be able to generate data over shorter periods without additional cost,[8] then the operator should use those periods to determine their annual emissions. All hourly (or less) values are summed to provide the total emissions from that emission point (the stack) over the reporting period. When several stacks at the same installation are monitored, then the operator should aggregate data for each stack separately and then sum them to provide total emissions[9] calculated using a measurement-based approach over the reporting period. Operators should refer to section 11 which provides further information on the measurement-based approach and section 11.2 "Missing Data" for a discussion on how to approach reporting emissions during start-up and shut-down.

7.1.1 CO_2 stemming from biomass

Operators should subtract emissions stemming from biogenic sources when determining total emissions using the measurement-based approach. Operators should use the C-14 monitoring method using radiocarbon analyses of samples taken from the flue gas (based on BSI EN ISO 13833) to determine the % biogenic carbon in the flue gas. The minimum frequency of analyses is once per month or every 50,000 tonnes of total CO_2, whichever is more frequent. When continuously sampling the flue gas stream, the operator should apply EN 15259 (Air quality — Measurement of stationary source emissions — Requirements for measurement sections and sites and for the measurement objective, plan and report).

7.2 The calculation-based approach

As set out in the interim Authority response, most installations are expected to monitor emissions from waste incineration using the measurement-based approach. However, installations that either emit 50,000 t fossil CO_2 or less or can demonstrate that a measurement approach is not possible or proportionate to their facility, can use the standard methodology to calculate their emissions from waste incinerated.

Additionally, the standard methodology is likely to be appropriate for larger emitters with emissions from combustion or other processes that are not released through the main stacks in which the CEMs are installed.

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[8] Many measurement systems automatically generate half-hourly values. In such cases, the half hourly values should be used.

[9] "Total" here means total emissions determined using CEMS. Where relevant, emissions from the same installation determined by other approaches should be added to total emissions monitored using CEMS to provide the total reportable emissions for a specific reporting period.

Instead of measuring CO_2 emitted using CEMs installed in the stack, operators calculate their emissions using activity data (e.g. amount of fuel or feedstock consumed) multiplied by an emission factor and an oxidation factor,[10] as shown in Figure 2 below.

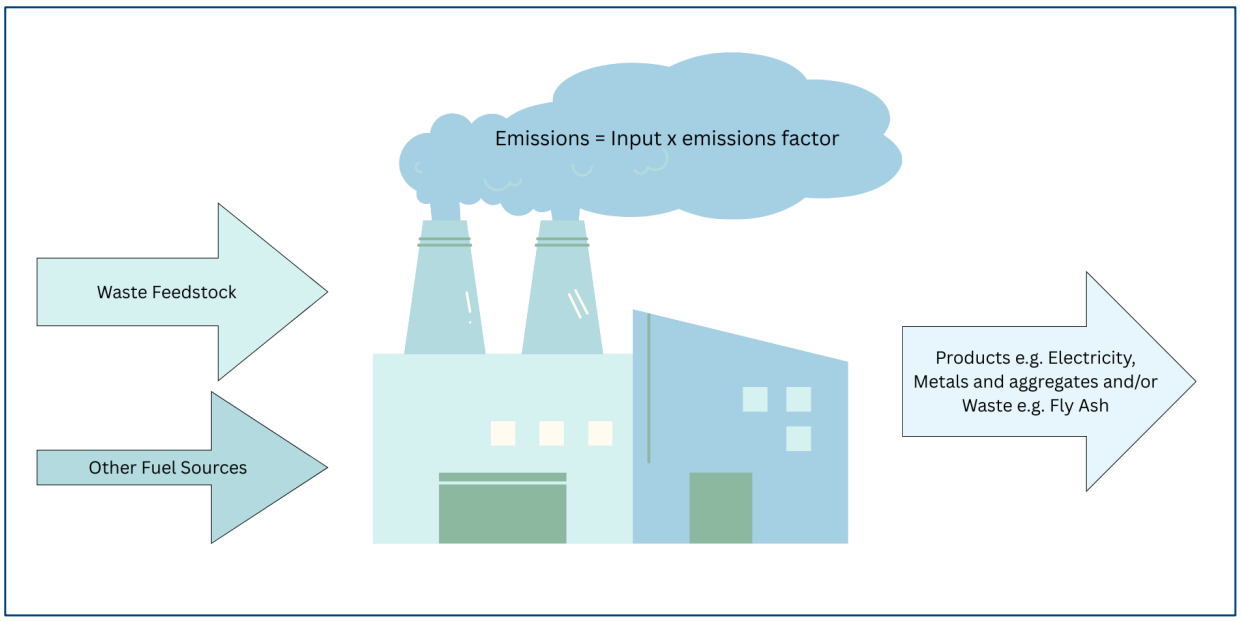


Figure 2. The standard methodology for calculating emissions for the waste sector

When using a calculation-based approach, the following formulae are used to calculate **combustion emissions**:

$$Em = AD \times EF \times OxF$$

Where:

Em.... emissions [tCO_2]

AD.... activity data [terajoule (TJ), t or Nm^3]

EF.... emission factor [tCO_2/TJ, tCO_2/t or tCO_2/Nm^3]

OxF... oxidation factor [dimensionless]

Activity data for waste feedstocks will be tonnes and the EF will be tCO_2/t.

Additionally, operators will likely use other fuels to heat buildings and offices, for example, or during startup operations of the incinerator. Operators should also report emissions from these fuels. For gaseous fuels, the relevant unit for AD is usually normal

[10] An oxidation factor is used in case of incomplete combustion.

metres^3 [Nm^3] and for liquid fuels, it is likely kg or t. Operators should pay attention to units of measurement and ensure that appropriate unit conversions are completed.

For gaseous or liquid fuels, activity data should be expressed as net calorific value as follows:

$$AD = FQ \times NCV$$

Where:

FQ..... fuel quantity [t or Nm^3]

NCV... net calorific value [TJ/t or TJ/Nm^3]

7.2.1 Biogenic fraction

Emissions from the biogenic fraction of the waste feedstock will be 'zero-rated', i.e. the emission factor will be set to zero.

This 'zero-rating' applies for accounting purposes only, as CO_2 is still emitted from the installation. To ensure emissions are transparent, when zero-rating biomass, the emission factor should be determined from the preliminary emission factor and the biomass (zero-rated) fraction of the feedstock as follows:

$$EF = EF_{pre} \times (1 - BF)$$

Where:

EF..... emission factor [tCO_2]

EF_{pre}... preliminary emission factor (i.e. according to Article 3(36) of the MRR, "*assumed total emission factor of a fuel or material based on the carbon content of its biomass fraction and its fossil fraction before multiplying it by the fossil fraction to produce the emission factor*")

BF..... biomass fraction[11] [dimensionless]

7.2.2 Flue gas scrubbing

Operators will likely use flue gas scrubbing to remove pollutants from exhaust gases and should ensure that they include emissions from scrubbing in their annual report. These emissions are not generated by means of combustion, but rather they are the result of a process. Common scrubbers used in EfW plants are lime and sodium bicarbonate

[11] The zero-rated fraction is composed of zero-rated biomass fraction.

($NaHCO_3$) which contain carbon[12]. Under the UK ETS, such emissions are referred to as process emissions and are calculated as follows:

$$Process\ emissions = material\ input \times EF \times CF$$

Where:

$material\ input \ldots$ tonnes of lime or of sodium bicarbonate (used for scrubbing)

$EF \ldots\ldots\ldots\ldots\ldots$ emission factor [tCO_2/t]

$CF \ldots\ldots\ldots\ldots\ldots$ conversion factor [dimensionless]

The conversion factor accounts for incomplete reaction i.e. when not all the carbon in the material is converted to CO_2.

Operators should refer to section 10.2 for information on where to find appropriate emission factors, net calorific values and other calculation factors.

Where operators are currently using non-carbon containing scrubbers, but switch to a carbon containing scrubber, they are required to update their VMP and provide details of how they intend to monitor emissions. In cases when emissions from scrubbers are captured in the main stack and monitored using CEMS, then the resulting emissions from the scrubber change would be captured.

[12] Some scrubbers are not relevant, such as NH4Oh (ammonium hydroxide) and $Ca(OH)_2$ (hydrated lime).

8 Tiers

During the voluntary MRV-only period, operators should meet distinct data quality levels (accuracy) depending on the amount of CO_2 emitted from different source streams. These data quality levels are called 'tiers' and are detailed below.

Lower tiers represent methods with less exacting requirements and less accuracy than higher tiers. Higher tiers are considered more costly to meet than lower tiers (e.g. due to more expensive measuring equipment). Therefore, lower tiers are appropriate for lower emissions, i.e. for minor, de-minimis and marginal source streams and for smaller installations, ensuring a cost-effective approach.

Note that in many cases, the tier corresponds to a required level of measurement uncertainty (Annexes II, IV and VIII to the MRR) which is covered in more detail in section 9. In other cases, the tier corresponds to a specific methodology or default value e.g. an emission factor published by the Authority.

8.1 Selecting the correct tier

8.1.1 Measurement-based approach

Operators should apply the highest tier for emission sources in category B and C installations during the voluntary MRV-only period. Tier 2 may be used by category A installations. A summary of tiers for measurement-based approaches is set out in Table 4. When the operator demonstrates that it is technically infeasible to meet the tier, a lower tier may be applied as follows:

- one tier lower in case of category C installations
- one or two tiers lower in case of category B and A installations
- Tier 1 is always the lowest possible tier.

Each tier corresponds to an uncertainty threshold as follows: ± 10% (Tier 1), ± 7.5% (Tier 2), ± 5% (Tier 3) and ± 2.5% (Tier 4). Further information on uncertainty is provided in section 9 and section 11.

Under the full UK ETS scheme, the Operator can demonstrate that the cost of meeting the tier is unreasonable, and with agreement from the regulator, apply a lower tier. Under voluntary MRV-only period, unreasonable cost assessments are not required.

Table 4. Summary of minimum tiers for measurement-based approaches and the relevant Article of the MRR

(Note that operators should use higher tiers when this can be achieved 'without additional effort').

Fossil Emissions (tCO_2)	Installation Category	Emission Source Category - Minor <5,000t or <10% (max 100,000t)	Emission Source Category - Major
>500,000	C	Tier 4 Annex VIII, Table 1	Tier 4 Annex VIII, Table 1
>50,000 to ≤500,000	B	Tier 4 Annex VIII, Table 1	Tier 4 Annex VIII, Table 1
≤ 50,000	A	Tier 2 Annex VIII, Table 2	Tier 2 Annex VIII, Table 2
<25,000	A Low Emitter	Tier 1 Article 47(6)	Tier 1 Article 47(6)

Further guidance on standards and uncertainties for C-14 and CEMS for waste installations using measurement-based approaches will be made available in due course, these will be shared with Operators, but please also contact your Regulator for copies. Ongoing work will investigate the technical feasibility of meeting the uncertainty thresholds detailed in the relevant articles of the MRR. The Authority may set waste-sector specific uncertainty requirements, when the sector is included in the UK ETS, based on the outcome of uncertainty assessment within the voluntary MRV-only period and future work.

8.1.2 Calculation-based approach

Annex II of the MRR defines the tiers for all parameters. The overarching expectation is that operators should apply the highest tier defined for each parameter, particularly for major and minor source streams within category B and C installations. However, operators can bear in mind the following for major source streams:

- instead of the highest tiers defined, category A installations may apply at least the tiers specified in Annex V of the MRR for major source streams (see Table 5).

- regardless of the installation category, Annex V tiers can be applied to the calculation factors for commercial standard fuels[13] (see Table 5).
- where the operator demonstrates to the satisfaction of the regulator that applying the expected tier leads to unreasonable costs or is technically not feasible (see section 8.2), the operator may apply the following tier to major source streams:
    - one tier lower in case of category C installations
    - one or two tiers lower in case of category B and A installations

  Tier 1 is always the lowest possible tier.
- where the tiers in Annex V are still technically not feasible or involve unreasonable costs, the regulator may allow the operator to apply an even lower tier (with a minimum of tier 1). The operator should however agree a suitable plan for necessary improvement with the regulator, which for the purposes of the voluntary MRV-only period would be entered into on a voluntary basis.

Table 5. Minimum tiers for calculation-based methodologies for category A installations and calculation factors for commercial standard fuels used by category B and C installations (Article 26(1)(a) and Annex V to the MRR)

Source stream	Activity data - amount of fuel / material	Activity data - Net calorific value	Emission factor	Oxidation factor	Conversion factor
Commercial standard fuels e.g. gas oil	2	2a	2a	1	N/A
Other gaseous and liquid fuels e.g. natural gas	2	2a	2a	1	N/A
Solid fuels e.g. waste feedstock	1	2a	2a	1	N/A
Scrubbing (carbonate)	1	N/A	1	N/A	1

[13] Article 3(32) defines: 'commercial standard fuel' means the internationally standardised commercial fuels that exhibit a 95% confidence interval of not more than 1% for their specified calorific value, including gas oil, light fuel oil, gasoline, lamp oil, kerosene, ethane, propane, butane, jet kerosene (jet A1 or jet A), jet gasoline (jet B) and aviation gasoline (AvGas).

Operators may apply lower tiers for minor source streams. The operator should select the highest tier that is technically feasible, without incurring unreasonable costs, with a minimum of tier 1.

Operators are expected to apply tiers equal to or higher than 1 for de-minimis or marginal source streams where this can be achieved 'without additional effort' (i.e. without significant costs). However, when this is not possible, the operator may apply a conservative[14] estimation method (a 'no-tier method'). The operator should describe this method in the monitoring plan.

The following apply to calculation factors:

- the operator of any installation may apply tier 1 for oxidation and conversion factors (i.e. setting the factor to a value of 100%)
- the NCV of fuels is not required to calculate emissions in certain cases, for example when the emission factor is tCO_2 per tonne of fuel or material (as is the case for waste), but it should be reported for consistency reasons.

The tiers for calculation-based approaches are summarised in Table 6 below. For tier requirements for marginal source streams, refer to de-minimis source streams. Note that an operator should use higher tiers when this can be achieved 'without additional effort'.

Table 6. Summary of minimum tiers for calculation approaches and the relevant Article of the MRR

Emissions (tCO_2)	Installation category	Parameter	Source stream category **- De-minimis** <1,000t or <2% (max 20,000t)	Source stream category **- Minor** <5,000t or <10% (max 100,000t)	Source stream category **- Major**
>500,000	C	Activity Data	No Tier *Article 26(3)*	Tier 4 *Article 26(1)(b)*	Tier 4 *Article 26(1)(b)*
>500,000	C	Calculation Factors	No Tier *Article 26(3)*	Tier 3 *Article 26(1)(b)* OR Tier 2a (commercial standard fuels only) *Article 26(1)(a)*	Tier 3 *Article 26(1)(b)* OR Tier 2a (commercial standard fuels only) *Article 26(1)(a)*
>50,000 to ≤500,000	B	Activity Data	No Tier *Article 26(3)*	Tier 4 *Article 26(1)(b)*	Tier 4 *Article 26(1)(b)*

[14] "Conservative" means that the method should not lead to underestimation of the emissions.

Emissions (tCO_2)	Installation category	Parameter	Source stream category **- De-minimis** <1,000t or <2% (max 20,000t)	Source stream category **- Minor** <5,000t or <10% (max 100,000t)	Source stream category **- Major**
>50,000 to ≤500,000	B	Calculation Factors	No Tier *Article 26(3)*	Tier 3 *Article 26(1)(b)* OR Tier 2a (commercial standard fuels only) *Article 26(1)(a)*	Tier 3 *Article 26(1)(b)* OR Tier 2a (commercial standard fuels only) *Article 26(1)(a)*
≤ 50,000	A	Activity Data	No Tier *Article 26(3)*	Tier 2 OR Tier 1 (solid fuels) *Article 26(1)(a)*	Tier 2 OR Tier 1 (solid fuels) *Article 26(1)(a)*
≤ 50,000	A	Calculation Factors	No Tier *Article 26(3)*	Tier 2a *Article 26(1)(a)*	Tier 2a *Article 26(1)(a)*
<25,000	A - Low Emitter	Activity Data	No Tier *Article 26(3)*	Tier 1 *Article 47(6)*	Tier 1 *Article 47(6)*
<25,000	A - Low Emitter	Calculation Factors	No Tier *Article 26(3)*	Tier 1 *Article 47(6)*	Tier 1 *Article 47(6)*

For the purposes of the voluntary MRV-only period, operators using calculation-based approaches should report using a high-level default emissions factor set out by the Authority (tier 2a), with final policy on emissions-factor based approaches still under development. Note that this applies to waste source streams only. Operators should use the table above to determine the required tier for other source streams including fuels and process emissions.

8.2 Reasons for deviation from expected tiers: unreasonable costs and technical infeasibility

Cost effectiveness is an important concept in the UK ETS. Operators may derogate from an expected tier, if applying the tier would lead to unreasonable costs. To assess whether costs for a specific measure are reasonable, the operator should carry out a cost-benefit analysis. Costs are considered unreasonable if the costs exceed the benefit (Article 18 of the MRR). The operator should provide appropriate evidence of these costs. Equipment costs should be assessed using a depreciation period appropriate for the economic lifetime of the equipment. Regulators provide a tool for assessing unreasonable costs and operators are advised to contact their regulator for a copy. For further details on the methodology for assessing unreasonable costs, please see 'UKETS01 MRR - General guidance for installations'.

Similar deviations may be applicable if a measure is technically not feasible. Technical feasibility is not a question of cost-benefit, but whether the operator is able to achieve a certain tier. Operators may provide a justification when claiming a measure is not technically feasible. The justification should demonstrate that the operator does not have the appropriate resources to meet the specific requirement within the required time. Appropriate resources include the availability of essential techniques and technology.

9 Uncertainty

When assessing the quality of data in the UK ETS, measurement uncertainty is a key factor. Any measurement, even in the finest national measurement laboratories, has some doubt associated with it, and this 'doubt' is referred to as 'uncertainty'. When using the term 'uncertainty', we acknowledge that no measurement can ever be perfect.

When preparing a report of their total emissions for a given year, operators combine many measurements across a range of different parameters. Therefore, uncertainties should be reduced as much as possible, and operators should demonstrate that they can meet specific tiers which are generally related to uncertainties.

9.1 Uncertainty assessments

In many cases the tier levels, set out in the previous section, correspond to a level of measurement uncertainty which is expressed as the 'maximum permissible uncertainty' over a reporting period. The operator should demonstrate that the measurement uncertainty meets the uncertainty of the tier by submitting an uncertainty assessment in line with Article 12(1)(a) of the MRR. Note that installations with low emissions are exempt from this requirement.

The uncertainty assessment should contain the following information:

- evidence of the uncertainty for activity data, for example waste tonnages or fuel consumed (Annex II to the MRR)
- evidence of the uncertainty for measurement-based methodologies (Annex VIII to the MRR).

For activity data e.g. tonnes of waste or fuel, the assessment should cover the following in line with Article 28(2):

- specified uncertainty of the applicable measuring instruments
- uncertainty associated with calibration
- uncertainty associated with an instrument's use
- uncertainty related to determining stocks at the start/end of the year, if relevant as follows:
    - fuel or material quantities are determined based on batch measurements rather than continual metering, i.e. mostly when invoices are used

- storage facilities can contain at least 5% of the annually used fuel or material
- the installation is not an installation with low emissions

In many cases, operators can use the simplified uncertainty assessments below.

9.2 Simplifications

As detailed above, a full uncertainty assessment should include uncertainty from many different sources, including errors due to imprecision (this is a meter's uncertainty as specified by the manufacturer for use in an appropriate environment, and certain conditions for installation, such as length of straight piping before and after a flow meter) and inaccuracy (e.g. caused by ageing or corrosion of the instrument, which may result in a drift) as well as meter calibration and all other possible influencing parameters. In practice a full uncertainty assessment is very demanding and would result in unreasonable costs for many operators. The MRR, therefore, provides several pragmatic simplifications:

Maximum Permissible Error (MPE) *in service*: this measure may be used if the measuring instruments are installed appropriately as per the manufacturer's instructions and in a suitable environment for use. The MPE in service is the overall uncertainty of the measuring instrument and is usually specified by the manufacturer. When no information is available, the operator may use the uncertainty from the calibration, multiplied by a conservative adjustment factor which accounts for the higher uncertainty when the instrument is 'in service'.

National Legal Metrological Control: When the operator demonstrates to the satisfaction of the regulator that a measuring instrument is subject to national legal metrological control, the MPE in service allowed by the metrological control legislation may be taken as the uncertainty value, without providing further evidence.

Installation with low emissions: such installations are exempt from providing an uncertainty assessment, when activity data is based on purchase records (Article 47(4) and (5) of the MRR).

Further information on uncertainty in UK ETS, including worked examples, can be found in 'UKETS02 MRR/FAR – Uncertainty assessments for installations'

9.3 Uncertainty assessments for measurement-based approaches

Operators should consult EN 14181 which contains information about quality assurance procedures (Quality Assurance Level - QAL 2 and 3) to minimise uncertainty, as well as

guidelines on how to determine uncertainties. Guidance for QAL 1 can be found in EN ISO 14956. As a minimum, quality assurance checks, including parallel measurements with standard reference methods, should be performed once a year by competent staff.

To calculate average hourly or half hourly CO_2 emissions using CEMs, operators should measure the concentration of CO_2 and the flue gas flow. Note that values for the concentration and the flue gas flow should be consistent and relate to the same conditions, e.g. to dry flue gas at standard conditions.

Therefore, the uncertainty associated with CO_2 concentration measurement should be combined with the uncertainty associated with flue gas flow measurement as follows:

$$U_{av\ hourly\ emissions} = \sqrt{U_{GHGconcentration}{}^2 + U_{flue\ gas\ flow}{}^2}$$

The uncertainty should correspond to a 95% confidence interval; operators should therefore multiply the combined standard uncertainty with a coverage factor of 2 to obtain the expanded uncertainty.

9.3.1 Uncertainty associated with measuring CO_2 concentration

Operators may assess the uncertainty associated with measuring CO_2 concentration using details from the QAL1. However, the QAL2 procedure (calibration and validation of the CEM) will provide the most appropriate uncertainty figure associated with measuring CO_2 concentration *in situ*.

9.3.2 Uncertainty associated with flue gas flow

The type of uncertainty assessment will depend on how the operator has chosen to determine flue gas flow. There are two options as follows (Article 43(5) of the MRR):

1. Calculation using a mass balance, accounting for all significant input parameters, including at least input material loads, input airflow and process efficiency, as well as output parameters including at least the product output, O_2, SO_2 and NOx concentration
2. Continuous flow measurement at a representative point.

In the case of 1, the uncertainty related to the flue gas flow will be calculated using error propagation, considering at least the input and output parameters of the mass balance. Operators can find guidance on how to perform such calculations in Annex II, section 8.2 of 'UKETS02 MRR/FAR - Uncertainty assessments for installations'.

However, it is most likely that operators will choose to use option 2. In this case, the operator should assess the degree to which the measurement point(s) are representative of the whole flue gas stream using the provisions in EN 15259 (similar to assessing

representative points for the concentration profile in the flue gas). ISO 16911-2:2013 describes specific requirements for automated measuring system flow monitoring including conditions and criteria for the choice, mounting, commissioning and calibration of equipment.

To help operators calculate the uncertainty associated with their CEMs and C-14 measurements, the regulator will provide a template into which the operator will input relevant data. The template is designed to guide operators and ensure that all the necessary parameters are collected. The template will calculate the uncertainties associated with their measurements automatically.

10 Calculation-based approaches

This section expands on information in section 7.2. The main considerations when applying calculation-based approaches are as follows:

- monitoring activity data: amounts of fuel or feedstock should be monitored, with the required tier (dependent on installation and source stream category) corresponding to the metering uncertainty.
- determining calculation factors: operators may apply default values, or, if a higher tier is applied (dependent on installation and source stream category), calculation factors should be determined using sampling and analysis.

The waste feedstock would constitute one or more source stream(s). In line with the interim response, operators of larger installations (category B and C) should determine their emissions using a measurement-based approach, so we do not envisage sampling and analysis (Tier 3) to occur during the voluntary MRV-only period. Category A installations may apply the tier 2a default values (consistent with the UK's National Greenhouse Gas Inventory), however, they should adopt a measurement-based approach if they have CEMs in place, as this achieves the highest monitoring accuracy without any additional effort (they already have a measurement system in place). . Installations in category B and C which do not currently have CEMS and C-14 equipment installed should report using default factors until this equipment is ready to be used. The Authority will provide default emissions factors for waste incineration during the voluntary MRV-only period, with these found in Annex VI.

10.1 Monitoring activity data

The tiers for activity data of a fuel or feedstock (source stream) are defined as the maximum uncertainty threshold allowed over a reporting period (calendar year). The operator should submit an uncertainty assessment (see section 9) to the regulator to demonstrate whether the required tier is met. Installations with low emissions (for more details see section 6.1.1) are exempt from this requirement. Table 7 below provides the tier definitions for combustion of fuels or solid waste. A full list of all tier definitions is set out in Section 1 of Annex II to the MRR.

Table 7. Tier definitions for activity data of fuels or solid waste based on uncertainty

Tier	Definition
1	Amount of fuel or solid waste [t] over the reporting period is determined with a maximum uncertainty of **± 7.5 %**
2	Amount of fuel or solid waste [t] over the reporting period is determined with a maximum uncertainty of **± 5.0 %**
3	Amount of fuel or solid waste [t] over the reporting period is determined with a maximum uncertainty of **± 2.5 %**
4	Amount of fuel or solid waste [t] over the reporting period is determined with a maximum uncertainty of **± 1.5 %**

Note that the uncertainty refers to all sources of uncertainty, including uncertainty of instruments, calibration and environmental impacts, unless the simplifications listed in section 9.2 apply. Un-combusted waste at the beginning and end of the period should be accounted for when determining activity data over the reporting period.

10.1.1 Continual vs. batch metering

There are two ways in which activity data can be determined:

- based on continual metering at the installation (weighbridge / crane weights)
- based on aggregation of tonnage of waste (or fuel) delivered (batch metering) accounting for relevant stock changes.

Continual metering / weighing: in these circumstances the feedstock directly passes over the measuring instrument (e.g. weighbridge) before being fed into the greenhouse gas emitting process (incinerator). Similarly, when natural gas, used to fire boilers that produce heat and hot water for a building for example, flows into an installation, it passes through a meter before flowing to the boiler. The quantity of feedstock or fuel used over the reporting period (calendar year) is calculated using the following:

- the value at 23:59 on 31 December minus the value at 00:01 on 1st January of the same calendar year (e.g. in the case of gas meters)
- the sum of readings (e.g. every minute, hour or day) over the whole reporting period (e.g. in the case of weighbridges).

The uncertainty assessment should account for the uncertainty of the measuring device.

Batch metering: in these circumstances the feedstock or fuel delivery is determined using a material balance (Article 27(2) of the MRR):

$$Q = D + \left(F_{begin} - F_{end}\right) - E$$

Where:

Q……. quantity of fuel or feedstock used / processed over the reporting year

D……. fuel / feedstock delivered

E……. fuel / feedstock exported

F_{begin}.. stock of fuel / feed at the beginning of the reporting year

F_{end}…. stock of fuel / feed at the end of the reporting year

This method is usually applied when the operator uses invoices as the primary data source. The operator should describe how stocks are determined at the beginning and end of a reporting year in their monitoring plan. Additionally, the operator should account for uncertainties associated with determining stock changes in their uncertainty assessment.

Article 27(2) of the MRR allows two simplifications to the determination of stocks at the beginning and end of the reporting year:

1. When operators use fuel other than waste during operations, and where it is technically not feasible or would incur unreasonable costs to determine stock quantities by direct measurement, the operator may use an estimation method. Such situations may occur, for example, in tanks containing heavy fuel oil, where some solid fraction on top of the liquid oil prevents the exact metering of the surface level. Operators may consider the following:
    a. to use data from previous years correlated with output for the reporting period
    b. to use documented procedures and respective data in audited financial statements for the reporting period.
2. Theoretically, the stocks should be determined at midnight of 31 December every year, which may not be possible in practice. Therefore, operators may choose the next most appropriate day to separate a reporting year from the following one. Data should be reconciled accordingly to the calendar year required. The operator should clearly set out instructions for determining the beginning and end of a reporting period for each source stream and these should be applied consistently each year.

10.1.2 Operator’s instruments vs. supplier’s instruments

The operator may use instruments which are under the control of other parties (e.g. fuel suppliers) when this is justifiable. In the context of commercial transactions such as fuel

purchase, metering is usually by only one of the trade partners. The other partner may assume that the uncertainty associated with the measurement is reasonably low in cases when such measurements are governed by legal metrological control. Alternatively, requirements regarding quality assurance for instruments, including maintenance and calibration may be included in the purchase contracts. The control risk may be low where invoices are subject to an accounting department's controls.[15] However, the operator should confirm the uncertainty of the supplier's meter to assess whether they can meet the required tier. Suitable evidence should be added to the uncertainty assessment to demonstrate the applicable tier for the supplier's instrument.

Note that in some cases the measuring instrument is outside the control of the operator, but the reading for monitoring is carried out by the operator. In this case, the owner of the instrument should maintain, calibrate and adjust the instrument, and ultimately provide the uncertainty value, but the data readings may be directly checked by the operator. This situation frequently applies for natural gas meters owned by the gas supplier.

10.2 Calculation Factors

Calculation factors are an integral part of the monitoring plan when using a calculation-based methodology. The factors are outlined below:

- standard methodology for combustion of fuels / feedstock: emission factor (EF), net calorific value (NCV), oxidation factor (OxF) and biomass fraction
- mass balances: carbon content, biomass fraction and net calorific value

In line with Article 30(1) of the MRR, these factors may be determined by one of the following:

- as default values
- by laboratory analyses.

The applicable tier will determine which of these options an operator should use. Lower tiers allow for default values, e.g. for values which are kept constant throughout the years and updated only when more accurate data become available.

The highest tier corresponds to laboratory analysis, which is more demanding, but more accurate. The result of the analysis is valid only for the batch from which the sample has been taken, while a default value is a conservative value determined from large quantities of that fuel or feedstock. However, as all high emitting operators should use a measurement-based approach to measure their emissions, we do not envisage that

[15] Note that the operator should still include an appropriate risk mitigation measure in the UK ETS related control system. The risk assessment according to Article 59(2) of the MRR should include this risk as appropriate.

sampling and analysis of the waste stream for the purposes of calculating reportable emissions will occur during the voluntary MRV-only period.

Note that the operator should ensure that activity data and all calculation factors are used consistently. i.e. where a fuel's activity data (quantity) is determined in the wet state, the calculation factors should also refer to the wet state. Likewise, where analyses are carried out in the laboratory from the dry sample, the moisture should be accounted for appropriately, for determining calculation factors applicable for the wet material.

Additionally, operators should be careful to ensure all parameters used in an equation are in consistent units. Where the amount of fuel is determined per volume, also the NCV and/or emission factor should refer to volume rather than mass and vice versa.

10.2.1 Default values

Operators should document in the VMP any default values that they use, stating the actual figure. The only exception is where the default value changes on an annual basis, for example when the Authority updates and publishes the standard factors used in the National Greenhouse Gas Inventory each year. In these cases, the monitoring plan should contain the reference to the location (webpage, official journal, etc.) where the values are published, instead of the value itself (Article 31(2) of the MRR).

The required tier, which depends on the installation and source stream category, determines which type of default values the operator may use (see sections 2 to 4 of Annex II to the MRR). Table 8 provides a simplified overview of tier definitions relevant for the waste sector, with the following abbreviations are used: EF = emission factor, NCV = net calorific value, OxF = oxidation factor, CF = conversion factor, CC = carbon content, BF = biomass fraction.

Table 8. Tier definitions expected for calculation factors based on Annex II of the MRR

Source stream type	Factor	Tier	Tier definition
Combustion emissions EF[16]	NCV	1	• default value (standard factors listed in section 1 of Annex VI to the MRR), or • other constant values in accordance with point (e) of Article 31(1) of the MRR where no applicable value is contained in section 1 of Annex VI.
Combustion emissions EF	NCV	2a	National factors published by the Authority and used for the UK National Inventory submission to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). The Annex to this guidance contains a conservative national factor which will serve as the basis for calculation based MRV

[16] According to section 2.1 of Annex II of the MRR, the tiers defined shall relate to the preliminary emission factor, where a biomass fraction is determined for a mixed fuel or material.

Source stream type	Factor	Tier	Tier definition
			approaches for the purposes of the voluntary MRV-only period.
Combustion emissions EF	NCV	2b	• (EF only) established proxies (if applicable) such as fuel density measurements • (NCV only) the NCV for commercially traded fuels derived from purchasing records provided by the fuel supplier[17]
Combustion emissions EF	NCV	3	• Laboratory analyses in line with Articles 32 to 35 of the MRR (not expected for waste feedstock) or • (EF only) empirical correlation as per Tier 2b where the uncertainty does not exceed 1/3 of the required uncertainty for activity data
Combustion emissions	OxF	1	Default value OxF = 1
Combustion emissions	OxF	2	National factors published by the Authority and used for the National Inventory submission to the Secretariat of the UNFCCC.
Combustion emissions	OxF	3	Laboratory analyses (the operator shall derive activity-specific factors based on the carbon contents of ashes, effluents and other wastes and by-products, and other relevant incompletely oxidised gaseous forms of carbon emitted except CO).
Combustion emissions	BF	1	Default values in accordance with Article 31(1) of the MRR.
Combustion emissions	BF	2	An estimation method approved by the regulator and in accordance with Article 39(2) of the MRR.
Combustion emissions	BF	3	Laboratory analyses in accordance with the first sub-paragraph of Article 39(2) of the MRR and in accordance with Articles 32 to 35 of the MRR (not expected for waste feedstocks).

Lower emitting installations may use a conservative default factor developed by the Authority, for calculation factors for waste source streams during the initial phases of the voluntary MRV-only period. Such default factors are set out in the Annex to this guidance document.

For **other fuel source streams** used by **both high and low emitting installations**, the lowest tier corresponds to an internationally applicable default value (Intergovernmental Panel on Climate Change (IPCC) standard factor or similar as listed in Annex VI to the MRR). The second tier uses a national factor, which is used for the UK National Inventory under the UNFCCC. However, further types of default values or proxy methods are

[17] Such values must be derived based on accepted national or international standards

allowed if they are deemed equivalent by the regulator. The highest tier usually requires the factor to be determined by laboratory analyses. Further information is set out below:

Default values (Tier 1): either the standard factors listed in Annex VI (IPCC values) or other constant values in accordance with point (e) of Article 31(1) of the MRR: "*values based on analyses carried out in the past, where the operator can demonstrate to the satisfaction of the regulator that those values are representative for future batches of the same fuel or material*".

National factors (Tier 2): country-specific emission factors in accordance with points (b), (c) and (d) of Article 31(1) of the MRR, i.e. values used for the UK National Inventory, other values published by the regulator for more disaggregated fuel types, or other literature values which are agreed by the regulator, or values guaranteed by the supplier.[18]

Established proxies: these are methods based on empirical correlations as determined at least once per year in accordance with the requirements applicable for laboratory analyses. These rather complicated analyses are only carried out once per year; this tier is therefore considered a lower level than full analyses. The proxy correlations may be based on:

- density measurement of specific oils or gases, including those common to the refinery or steel industries, or
- net calorific value for specific coal types

Purchasing records: only in the case of commercially traded fuels can the NCV be derived from the purchasing records provided by the fuel supplier, provided it has been derived based on accepted national or international standards.

Laboratory analyses: see the following section for the specific requirements. This also includes the use of the 'established proxies', if applicable, and where the uncertainty of the empirical correlation does not exceed 1/3 of the uncertainty value associated with the applicable tier for activity data.

10.2.2 Laboratory analyses

When the MRR refers to determination 'in accordance with Article 32 to 35', this means that a parameter should be determined by (chemical) laboratory analyses, with the following provisions:

- the laboratory should be competent, with competency demonstrated by:

[18] Article 31(1)(d) of the MRR: "*values specified and guaranteed by the supplier of a fuel or material where the operator can demonstrate to the satisfaction of the regulator that the carbon content exhibits a 95% confidence interval of not more than 1%" – this is a similar approach as for "commercial standard fuels*" with 'commercial standard fuels' defined in Article 3(32).

    - an accreditation in accordance with EN ISO/IEC 17025, when the analysis method required is within the accreditation scope or
    - demonstrating that the criteria listed in Article 34(3) are satisfied which is considered equivalent to the requirements of EN ISO/IEC 17025. Note that this approach is allowed only when using an accredited laboratory is technically infeasible or leads to unreasonable costs.
- a sampling plan is developed by the operator to ensure that samples are **representative** of the fuel / feedstock (this is crucial for ensuring valid results). The sampling plan should be included within the written procedures and approved by the regulator.
- analysis methods should follow international or national standards, preferably EN standards.[19]

Note that laboratory analyses are required for the highest tier only for calculation factors. Low emitting installations may use "*any laboratory that is technically competent and able to generate technically valid results using the relevant analytical procedures and provides evidence for quality assurance measures as referred to in Article 34(3)*" according to Article 47.7 of the Commission Implementing Regulation (EU) 2018/2066.

Additionally, although we expect that operators will use either a measurement-based approach or high-level default factors as a fallback when equipment is not yet installed, we do not preclude sampling and analysis of waste feedstocks to support the MRV of reportable emissions during the voluntary MRV-only period.

More detailed guidance on topics related to laboratory analyses, sampling, frequency of analyses, equivalence to accreditation, etc. are set out in guidance document 'UKETS07 MRR – Sampling and Analysis'.

10.2.3 Emission factor (EF)

Article 3(13) of the MRR defines the emission factor to mean *"the average emission rate of a greenhouse gas relative to the activity data of a source stream assuming complete oxidation for combustion and complete conversion for all other chemical reactions.*"

Article 3(36) of the MRR relates to materials containing biomass and defines the preliminary emission factor as "*the assumed total emission factor of a fuel or material*

[19] When using standards, Article 32(1) of the MRR defines the following hierarchy: "*The operator shall ensure that any analyses, sampling, calibrations and validations for the determination of calculation factors are carried out by applying methods based on corresponding EN standards. Where such standards are not available, the methods shall be based on suitable ISO standards or national standards. Where no applicable published standards exist, suitable draft standards, industry best practice guidelines or other scientifically proven methodologies shall be used, limiting sampling and measurement bias*."

based on the carbon content of its biomass fraction and its fossil fraction before multiplying it by the fossil fraction to produce the emission factor".

Important Note: Where a biomass fraction is determined for a mixed fuel or material, as in waste feedstocks, the tiers defined shall relate to the preliminary emission factor.

Therefore, the required tier for a mixed fossil / biogenic feedstock should be determined based on total CO_2 emissions rather than only biogenic CO_2 emissions.

The emission factor is the stoichiometry-based factor used to convert the (fossil) carbon content of a material into the equivalent mass of (fossil) CO_2 assumed to be emitted. Adjustment for incomplete reactions is handled via the oxidation or conversion factor.

For combustion emissions, the emission factor is expressed in relation to the NCV of the fuel rather than its mass or volume. Thus, for fuels, the NCV should be determined and, depending on the tier, may require another analysis of the same sample.

However, for waste feedstocks, the regulator will allow the operator to use an emission factor expressed as tCO_2/t feedstock during the voluntary MRV-only period.

10.2.4 Net calorific value (NCV)

NCV is an important parameter when activity data of fuels is reported as energy content (this allows emission reports to be compared with energy statistics and National Inventories under the UNFCCC).

Note that although fuel activity data is calculated as *fuel quantity x NCV*, the tier definitions for activity data relate to fuel quantity only, with the NCV a separate parameter (calculation factor). Tiers are applicable to the parameter 'NCV' separately.

However, the NCV is not needed in the following situations:

- when emission factors are expressed as tCO_2/t of feedstock (as for waste source streams)
- when fuels are used as part of a mass balance

In these cases, the NCV will still need to be reported, but may be determined using a conservative estimate instead of using tiers.

10.2.5 Oxidation Factor (OxF)

The oxidation factor is the proportion of the fuel's total carbon content turned into CO_2 during the combustion process. It is used to account for incomplete reactions. It is determined based on laboratory analyses as follows:

$$OxF = 1 - \frac{C_{ash}}{C_{comb}}$$

Where:

OxF…. oxidation factor (dimensionless)

C_{ash}…. carbon contained in ash, soot and other non-oxidised forms of carbon (excluding carbon monoxide which is considered as molar equivalent of CO_2 emissions)

C_{comb}… total carbon combusted

Note that for all categories of installations and source streams, tier 1 is the minimum applicable tier. This is equivalent to *OxF* = 1 and is a conservative assumption.

11 Measurement-based approach: CEMS

To comply with monitoring obligations under the Industrial Emissions Directive (IED), most waste incinerators or EfW sites will already use CEMS to monitor air pollutants (NO_X, SO_X, etc). An operator may need to install CO_2 concentration and volumetric flow measurement, as well as CO concentration if they don't already monitor these parameters. Flue gases from waste incineration are subject to higher fluctuations compared to flue gases from combustion using standard fuels which may lead to higher measurement uncertainty. As with other methods, operators should carry out an appropriate uncertainty assessment (see section 9.1) to demonstrate the uncertainty achieved.

As described in section 7.1, CEMS always require two elements:

- measurement of the greenhouse gas concentration[20]
- volumetric flow of the gas stream where the measurement takes place.

In line with Article 43 of the MRR, emissions should be determined hourly, using hourly averages for each parameter (e.g. concentrations and flue gas flow rate). However, when an operator can generate data for shorter periods without additional cost,[21] then the operator should use those periods to determine their annual emissions. We expect that most installations are set up to record half-hourly averages.

The following section sets out the expectation for using a measurement-based approach, expanding on details provided in section 7.1.

The minimum tiers for a measurement-based approach are set out in section 1 of Annex VIII to the MRR (see table 9 below).

Table 9. Minimum tiers for CEMS including the maximum permissible uncertainties for the annual average hourly emissions

Emissions (tCO_2)	Installation Category	Emission source category - **Minor** <5,000t or <10% (max 100,000t)	Emission source category - **Major**
>500,000	C	**± 2.5%** [Tier 4]	**± 2.5%** [Tier 4]

[20] Additional corrections may be needed, e.g. for moisture content.
[21] Many measurement systems automatically generate half-hourly values. In such cases, the half hourly values should be used.

Emissions (tCO_2)	Installation Category	Emission source category **- Minor** <5,000t or <10% (max 100,000t)	Emission source category **- Major**
>50,000 to ≤500,000	B	**± 2.5%** [Tier 4]	**± 2.5%** [Tier 4]
≤ 50,000	A	**±7.5%** [Tier 2]	**±7.5%** [Tier 2]
<25,000	A Low Emitter	**±10%** [Tier 1]	**±10%** [Tier 1]

Flue gas flow should be determined using one of the following, in line with Article 43(5) of the MRR:

1. mass balance, accounting for all significant inputs and outputs, and at least the following: input material loads, input airflow and process efficiency, outputs and the concentration of oxygen (O_2), sulphur dioxide (SO_2) and nitrogen oxides (NO_X).
2. continuous flow measurement at a representative point applying the standard EN ISO 16911-2 ('Stationary source emissions – Manual and automatic determination of velocity and volume flow rate in ducts').

In the case of point 1 above, the uncertainty related to the flue gas flow should be calculated by error propagation taking at least the listed input and output parameters of the mass balance into account. Guidance on how to perform these calculations can be found in Section 8.2 of guidance document 'UKETS02 MRR/FAR - Uncertainty assessments for installations'.

However, it is likely that most operators will use option 2 to determine flue gas flow. In this case, assessing the representativeness of the measurement point(s) of the flue gas should be based on provisions in EN 15259 and is like assessing representative points for the concentration profile in the flue gas. The MRR lists EN ISO 16911-2 which follows the structure of EN 14181.

Peripheral measurements and calculations such as flue gas flow, oxygen and moisture are not covered by the QAL procedures of EN 14181 or EN 14956. Therefore, quality assurance of the flue gas flow is expected as follows:

- operators should ensure that all relevant measuring equipment is calibrated, adjusted and checked at regular intervals including prior to use, and checked against measurement standards traceable to international measurement standards, where available (Article 60(1) of the MRR).

- operators should prepare an appropriate procedure for quality assurance (Article 59(3)(a) of the MRR). However, in the case of point 1 above, the QAL procedures of EN 14181 can be applied for certain parameters such as NOx and SO_2. Operators should use EN ISO 16911-2 for flue gas flow.

The operator should treat carbon monoxide (CO) emitted to the atmosphere as the molar equivalent of CO_2 (Article 43(1) of the MRR).

11.1 Measurement equipment and standards

The operator should ensure that the measurement equipment is suitable for the environment in which it is to be used and it is regularly maintained and calibrated.

All relevant aspects of the continuous measurement system should be considered by the operator, including the location of the equipment, calibration, measurement, quality assurance and quality control.

Operators should apply EN 14181 (’Stationary source emissions – Quality assurance of automated measuring systems’) for quality assurance. This standard requires the following:

- QAL 1: Testing whether the CEMS meets the specified requirements. For this purpose, EN ISO 14956 (’Air quality. Evaluation of the suitability of a measurement procedure by comparison with a required uncertainty measurement’) and EN 15267-3 (’Air quality – Certification of automated measuring systems – Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary sources’) should be used
- QAL 2: Calibration and validation of the CEMS
- QAL 3: Ongoing quality assurance during operation
- AST: Annual surveillance test.

The standard requires that QAL 2 and AST are performed by accredited laboratories; QAL 3 is performed by the operator. The operator should ensure that the personnel carrying out the tests are competent. Note that the standard does not cover quality assurance of any data collection or processing system (i.e. IT systems). The operator should ensure appropriate quality assurance of those by separate means.

Further information including an overview of the QALs and more specific information about each one is available in guidance document ‘UKETS06 MRR – Use of continuous emissions measurement systems (CEMS)’.

Note that there are important differences between the application of CEMS for air pollutants and for greenhouse gases and these are set out in section 3.2.2.2. of guidance

document ‘UKETS06 MRR – Use of continuous emissions measurement systems (CEMS)’.

A full list of all relevant standards that operators should apply is available in section 14.

11.2 Missing data

Article 45 of the MRR sets out several options for operators when data are missing or lost, i.e. when valid hour or shorter reference periods are not available for one or more parameters:

- **When valid hour or shorter reference periods are not available for CO_2 concentration data**: the operator should calculate surrogate data[22] using the sum of an average concentration plus 2 x standard deviation. Note that when calculating the average concentration and its standard deviation, the operator should ensure that such data are representative of conditions at the time of the data gap.
- **When valid hour or shorter reference periods are not available for parameters other than concentration, e.g. flue gas flow**: the operator should calculate surrogate data values using a suitable mass balance model or an energy balance of the process and consider all aspects of the mass balance. The operator should validate the results using the remaining measured parameters, using data measured during similar conditions and over a similar time frame as the data gap.

When any part of the CEMS is out of operation for more than five consecutive days, operators should inform their regulator without undue delay (Article 45(1) of the MRR). The operator should submit their proposed data gap methodology to the regulator for checking (Article 66 of the MRR).

General guidance on methods to close data gaps will be found in guidance document ‘UKETS05 MRR - Making conservative estimates and data gaps’ once published.

Note that the data gap methodology above can be applied during start-up and shutdown when the CEMS data are invalid. However, if the operator is concerned that applying such a methodology may lead to a significant over-estimation of emissions during this time, then the operator can contact the regulator to propose an alternative approach. Note that any alternative approach should be agreed with the regulator.

Typically, a CEMS will need calibrating through zero and span checks every 2 to 6 weeks – this is standard industry practice. Many operators have duty and standby systems allowing them to switch between the two systems when one is down for maintenance or repair. This ensures that, in most cases, data collection continues as per the operator’s

[22] “surrogate” data are estimated data that will be substituted for missing data

monitoring plan. There is however the risk that both CEMS may be off-line at the same time, for example if the back-up CEMS was to fail. If less than 80% of data points are available for a reference period (usually half hourly), there would be a change to the operator's monitoring plan, and the operator should check whether a data gap has occurred.

If an operator uses a half hour reference period and cannot meet 80% of the max data points for that period, then so long as they can meet 80% of an hourly reference period they will meet the minimum requirements of the MRR (i.e. one hour reference period) and it is not a data gap.

It is advised that operators include this fall-back methodology in their monitoring plan in the approach description section. If the alternative reference period of an hour is not written into the monitoring plan, then following a change in reference period (from half hourly to hourly), the operator would need to notify their regulator of a deviation from their monitoring plan.

12 Biomass fraction

The MRR defines the biomass fraction to mean "*the ratio of carbon stemming from biomass to the total carbon content of a fuel or material, expressed as a fraction*".

In the case of municipal solid waste or other waste streams applicable to waste sector, the biomass fraction may be zero-rated.

The biomass fraction of a mixed source stream, for example municipal solid waste, is determined as follows subject to the required tier:

12.1 When using a calculation-based approach

As we expect that only low-emitting installations will use a calculation-based approach, operators should use a default value provided by the Authority, see Annex VI.

The following equations are used to calculate the total preliminary emissions and the emissions attributable to biomass:

1. **Total preliminary emissions**

$$Em_{pre(total)} = AD \times EF_{pre} \times OxF$$

Where:

$Em_{pre(total)}$… total preliminary emissions [tCO_2] i.e. the emissions without any zero-rating

AD…….. activity data (tonnes of waste or TJ of fuel)

EF_{pre}…….. preliminary emission factor [tCO_2/t]

OxF…… oxidation factor [dimensionless]

2. **Biomass emissions**

$$Em_{bio} = Em_{pre(total)} \times BF$$

Where:

Em_{bio}….. total preliminary emissions [tCO_2] i.e. the emissions without any zero-rating

BF…….. biomass fraction [dimensionless]

12.2 When using a measurement-based approach

Operators should determine separately any CO_2 stemming from biomass using the C-14 monitoring method, as set out in the interim Authority response, and subtract it from the total measured CO_2 emissions. C-14 methodology uses radiocarbon analyses of samples taken from the flue gas by continuous sampling (not continuous measurement). Operators should apply EN ISO 13833 (Stationary source emissions – Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide – Radiocarbon sampling and determination'). The minimum frequency of analyses is every 50,000 tonnes of total CO_2, but at least once a month.

12.3 The radiocarbon (C-14) method

This approach has been extensively used over the past 70 years to determine the ratio of biogenic and fossil carbon. The C-14 isotope is a radioactive isotope of carbon which is unstable, forms in the upper atmosphere, and decays over time. Living organisms take up C-14 and therefore biogenic and fossil carbon can be distinguished based on the amount of C-14 in a sample. Measuring the amount of C-14 in flue gas allows operators to determine the biogenic and fossil fractions of CO_2 emitted. This method does not involve measuring the concentration, but rather the ratio of biogenic CO_2 to total CO_2.

To determine the biogenic CO_2 fraction in flue gas involves the following:

- Representative sampling of CO_2
- Measuring the sampled C-14
- Calculating the biogenic CO_2 fraction in the flue gas emitted during the sampling period

12.3.1 Representative sampling of CO_2

The CO_2 in a representative stack gas sample is absorbed in an alkaline medium or transferred to a gas bag or lecture bottle and, after sampling, the CO_2 collected is prepared for C-14 analysis. The operator should carry out sampling in accordance with sampling and sampling strategies for continuous and intermittent measurements of stationary source emissions, for example, in ISO 10396 and EN 15259.

12.3.2 Grab gas samples

Operators should use accepted procedures for collecting gas in gas bags, canisters or gas bottles and should only use gas bags impenetrable to CO_2. Most aluminium-lined gas bags are suitable.

12.3.3 Absorption samples

When liquid or solid absorbers are used, the CO_2 is collected in a medium containing alkaline reagents. For sampling with liquids, alkaline solutions of, for example, 2 mol/l to

4 mol/l potassium hydroxide (KOH) or equivalent (sodium hydroxide, NaOH) are suitable. For solid CO_2 absorbers, commercial products are suitable. After collection of the samples, close the absorbers and ensure that they are gastight, to prevent the ingress of atmospheric CO_2.

12.3.4 C-14 measurement techniques

The C-14 content of the collected samples may be determined using either of the following:

- accelerated mass spectrometry (AMS)
- beta-ionisation (BI) measurement (gas proportional counter)
- liquid scintillation counting technique (LSC)

Depending on the C-14 analysis technique different amounts of sampled CO_2 are required, see Table 10 below:

Table 10. Minimum volume CO_2 required per C-14 analysis technique

C-14 measurement technique	Minimum volume of CO_2 required
AMS	0.004 litres
BI	2 – 10 litres
LSC	a few grams

Full details of the materials and equipment, analysis methodology, calculation of the results, quality assurance and quality control procedures are set out in BS EN ISO 13833:2013.

Further guidance on standards and uncertainties for C-14 and CEMS for waste incineration facilities using measurement-based approaches will be made available in due course.

13 Additional quarterly reporting requirement for waste operators

So that the Authority can make policy decisions regarding the use of more specific emissions factors, the Authority needs to gather and analyse relevant data from the waste sector.

As part of the voluntary MRV-only period, operators are being asked to submit quarterly waste and emissions data which will be analysed by the Authority. The analysis will focus on the relationships between the waste and emissions datasets and the extent to which accurate emission factors can be developed from the data submitted.

While the voluntary MRV-only period broadly mirrors the requirements of the full UK ETS, **quarterly reporting represents an additional data request for operators** that does not exist within UK ETS. Quarterly data reporting[23] began on 1 January 2026, with the first quarter ending on 31 March 2026. Each quarter is followed by a two-month reporting period, to account for any necessary data manipulation and the time-lag associated with receiving results of C-14 sampling.

This is a prescriptive excel template for data entry, focusing on alignment to existing reporting, whilst ensuring the correct data is gathered. The template is iterative and may be amended based on feedback received following each reporting period. However the data below are requested by default:

- description of waste input
- waste tonnage per individual waste type entering an installation
- waste tonnage per individual incineration/emissions stream
- raw C-14 data where measured
- raw CEMS data

Please note that this list is not exhaustive and is not intended to be restrictive either. Over time, it is expected that a clearer understanding of optimal data requirements will emerge and the template will become more defined and standardised. In the meantime, operators are invited to upload more specific data. The ‘free upload’ section within the reporting task in METS allows operators to tag and upload additional data i.e. entire CEMS .csv files, additional compositional sampling etc.

[23] The quarterly reporting template can be found here: https://www.gov.uk/government/publications/uk-ets-waste-quarterly-data-report-template

The objective of this additional data reporting process is to generate an evidence base, and provide the opportunity for sufficient objective analysis, such that the Authority has sufficient assurance to approve the use of more specific emission factors by operators. This objective can only be achieved by the comprehensive participation of operators in the additional data reporting process.

14 Measurement and monitoring standards

The following standards are required to apply CEMS in accordance with the MRR:

- EN 14181 (’Stationary source emissions – Quality assurance of automated measuring systems’) for quality assurance of the CEMS.
- EN 15259 (’ Air quality - Measurement of stationary source emissions – Requirements for the measurement sections and sites and for measurement objective, plan and report'): this standard describes how to achieve accurate and reliable results in emission testing, including in relation to sampling position.

To apply these standards correctly, further standards are important:

- EN ISO 14956 (’Air quality – Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty’): this is required because it is referenced by EN 14181. It describes the QAL 1 procedure, which is required by EN 14181.
- EN 15267-3 (’Air quality – Certification of automated measuring systems – Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary sources’): again, this standard is required for correctly carrying out the QAL 1 procedure. It should be noted that EN 15267-3 is an application of EN ISO 14956 and is now often used to define testing procedures for CEMS and the determination of uncertainties in the measurement.

For the determination of the flue gas flow, the following standards are important:

- EN ISO 16911 (’Stationary source emissions - Manual and automatic determination of velocity and volume flow rate in ducts’)
    - Part 1: Manual reference method (EN ISO 16911-1)
    - Part 2: Automated measuring systems (EN ISO 16911-2)

EN ISO 16911-2 applies EN 14181, EN 15267-3, EN ISO 14956 and EN 15259 as mandatory references.

Further helpful standards include the following:

- carbon dioxide and monoxide: ISO 12039 (’Stationary source emissions - Determination of carbon monoxide, carbon dioxide and oxygen - Automated methods’)

- moisture, as a peripheral measurement under EN 14181: standard EN 14790 (’Stationary source emissions - Determination of the water vapour in ducts’)
- nitrous oxide, for subsection B.2 of section 16 of Annex IV to the MRR: EN ISO 21258 (’Stationary source emissions - Determination of the mass concentration of dinitrogen monoxide (N2O) - reference method: Non-dispersive infrared method’)
- nitrogen dioxide, for Article 43(5)(a) of the MRR: EN 14792 (’Stationary source emissions - Determination of mass concentration of nitrogen oxides (NOx) - reference method: chemiluminescence’”)
- oxygen, for subsection B.4, section 16 of Annex IV to the MRR and as a peripheral measurement under EN 14181 and for Article 43(5), point (a): EN 14789 (‘Stationary source emission - Determination of volume concentration of oxygen (O2) - Reference method – Paramagnetism)
- sulphur dioxide, for Article 43(5)(a) of the MRR: EN 14791 (’Stationary source emissions - Determination of mass concentration of sulphur dioxide - reference method’)

15 Verification

The role of the verifier is to conduct independent assessments of emissions data submitted by operators. Verifiers will check the implementation of the VMP, performing substantive data testing and check specific monitoring and reporting issues such as the ongoing validity of information used to calculate uncertainty levels set out in the VMP.

Operators should consult the ‘How to Participate’ guidance – the section beginning ‘Appointing an independent verifier’ - for the steps required to appoint a verifier, the information that a verifier would need to see, and the site visit process. Whilst Operators do not need to appoint a verifier for the voluntary MRV-only period, verification of data for reporting will give Operators reassurance that their methodology is accurate and reporting practices sound, ahead of full ETS scheme.

Operators should ensure that if they appoint a verifier they are accredited for ’combustion of fuels in installations, without restrictions’ which falls under activity group 1b.

16 Annex

The MRR sets out the rules for the monitoring and reporting of greenhouse gas emissions in the UK ETS. **The large majority of these provisions are relevant for waste installations in the voluntary MRV-only period.** However, some changes are required to account for the specific monitoring requirements of the waste sector.

16.1 Changes to the MRR for the purpose of the voluntary MRV-only period

The MRR should be read as including the following changes:

16.1.1 Annex II: Tier definitions for calculation-based methodologies related to installations (Article 12(1) of the MRR)

Additional entry into Table 1: Tiers for activity data (maximum permissible uncertainty for each tier):

Activity/source stream type	Parameter to which the uncertainty is applied	Tier 1	Tier 2	Tier 3	Tier 4
Waste Incineration					
Waste (all types)	Amount of waste incinerated [t]	± 7.5%	± 5%	± 2.5%	± 1.5%

16.1.2 Annex IV: Activity-specific monitoring methodologies related to installations (Article 20(2) of the MRR)

Addition of section 25

25. INCINERATION OF HAZARDOUS WASTE WITH A CAPACITY >10 TONNES PER DAY OR INCINERATION OF NON-HAZARDOUS WASTE WITH A CAPACITY >3 TONNES PER HOUR

A. Scope

The operator shall monitor and report all CO_2 emissions from the incineration of hazardous waste or non-hazardous waste (as defined in the technical guidance) that are released in a combustion or other process.

Where emissions are released in a combustion, the scope is as set out in section 1 of this Annex with the addition of units specific to waste installations, such as, units used in thermal treatment processes.

B. Specific monitoring rules

Where emissions are released from a category B or C installation, as defined in Article 19(2)(b) and (c), a measurement-based methodology shall be applied in accordance with Article 41 to 46 of this Regulation. If a category A installation has a continuous emissions monitoring system in place, the operator shall adopt a measurement-based approach as this achieves the highest monitoring accuracy without any additional effort in accordance with Article 8.

For each emission source where a measurement-based methodology is applied, the operator shall consider the total annual emissions to be the sum of all hourly or half hourly emissions using equation 1 given in section 3 of Annex VIII.

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

C: Calculation of biomass fraction

When calculating the biomass fraction, operators shall apply Annex II section 2.4 which sets out the tiers relevant for the biomass fraction. To determine which tier is relevant for their installation, operators shall refer to Article 26.

For those operators that are required to meet Tier 3 (sampling and analysis), operators shall use the approach set out in Article 43(4)(a). If using C-14 analysis based on the above method, samples shall be continuously collected from the flue gas stream and be proportional to the gas flow. Analysis shall be conducted on monthly composite / cumulative samples over the year (12 per year).

16.1.3 Annex V: Minimum tier requirements for calculation-based methodologies involving category A installations and calculation factors for commercial standard fuels used by category B and C installations (Article 26(1) of the MRR)

Addition of entry into Table 1: Minimum tiers to be applied for calculation-based methodologies in the case of category A installations and in the case of calculation factors for commercial standard fuels for all installations in accordance with point (a) of Article 26(1):

	Activity data		Composition data			
Activity/Source stream type	Amount of fuel or material	Net Calorific Value	Emission Factor	Carbon Content	Oxidation Factor	Conversion Factor
Waste Incineration						
Waste (all types)	1	2a/2b	2a/2b	N/A	1	N/A

16.1.4 Annex VI: Reference values for calculation factors (Article 31(1)(a) of the MRR)

Addition of Section 4:

4. EMISSION FACTOR FOR WASTE INCINERATION[24]

Table 7

Fuel type description	Preliminary emissions factor (tCO_2/t waste)	Emission factor (tCO_2/t waste)	Biomass fraction (tCO_2/t waste)
Waste*	1.01	0.59*	0.43**

*please note that this excludes clinical waste

Note that the emission factor is a mean value (0.47) that have been derived using data from installations with total fossil emissions greater than 50,000 tCO_2 per annum. A standard deviation (0.13) has been added to make the emission factor conservative, to reflect the uncertainty associated with the emission factor and the need to ensure that

[24] Note that these factors will be revised over time and will be made available by the Authority.

emissions are not underreported.[25] This value is applicable only to the voluntary MRV-only period and is subject to change.

**Note that the biomass fraction is a mean value (0.54) that has been derived using data from installations with total fossil emissions greater than 50,000 t CO_2 per annum. A standard deviation (0.11) has been deducted to make the biomass fraction conservative, to reflect the uncertainty associated with the biomass fraction and the need to ensure that emissions are not underreported. This value is applicable only to the voluntary MRV-only period and is subject to change. The 'preliminary' emission factor is the emission factor that accounts for the total CO_2 released by the combustion of the fuel or conversion of the material, regardless of whether the CO_2 is stemming from fossil or biomass carbon.

[25] Note that the mean and standard deviation do not sum to the default factor due to rounding.

If you have questions, comments or general queries related to UK ETS policy, please contact: emissions.trading@energysecurity.gov.uk

If you have questions for your regulator, please find contact email addresses below

Nation	Regulator	Contact address
England	Environment Agency (EA)	ETSWaste@environment-agency.gov.uk
Scotland	Scottish Environment Protection Agency (SEPA)	emission.trading@sepa.org.uk
Wales	Natural Resources Wales (NRW)	GHGHelp@cyfoethnaturiolcymru.gov.uk
Northern Ireland	Northern Ireland Environment Agency (NIEA)	emissions.trading@daera-ni.gov.uk

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