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UKETS07 MRR – Sampling and analysis

Note

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1 Overview

This document provides guidance to operators of installations under the UK Emissions Trading Scheme (UK ETS) on the importance of sampling and analysis and how this topic is treated in the Monitoring and Reporting Regulation.

The relevant legislation in this area is:

- **the Greenhouse Gas Emissions Trading Scheme Order 2020 (The Order)** as amended from time to time <https://www.legislation.gov.uk/uksi/2020/1265/contents>
- **the Monitoring and Reporting Regulation (MRR)** ([Commission Implementing Regulation \(EU\) 2018/2066 of 19 December 2018](#)) on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (disregarding any amendments adopted after 11 November 2020) as given effect for the purpose of the UK ETS by article 24 of the Order, subject to the modifications made for that purpose from time to time
- **the Verification Regulation (VR)** ([Commission Implementing Regulation \(EU\) 2018/2067 of 19 December 2018](#)) on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council (disregarding any amendments adopted after 11 November 2020), as given effect for the purpose of the UK ETS by article 25 of the Order, subject to the modifications made for that purpose from time to time

2 Calculation factors – Principles

[This section is copied from section 6.2 of 'UKETS01 MRR - General guidance for installations'. It is included here for reasons of completeness and to allow this guidance to be read as a self-standing document.]

Besides the activity data, the “calculation factors” are important parts of any monitoring plan based on a calculation methodology. These factors are (as outlined in the context of the calculation formulae in section 3.3.1 and section 3.3.2 of UKETS01):

- in case of the standard methodology for combustion of fuels, or fuels used as process input: Emission factor, net calorific value (NCV), oxidation factor and biomass fraction
- in case of the standard methodology for process emissions (particularly for decomposition of carbonates): Emission factor and conversion factor
- for mass balances: Carbon content and (if applicable) biomass fraction and net calorific value.

According to Article 30(1) of the MRR, these factors can be determined by one of the following principles:

- as default values (see section 5.2.1 of UKETS01); or
- by laboratory analyses (see section 5.2.2 of UKETS01).

The applicable tier will determine which of these options is used. Lower tiers allow for default values, such as values which are kept constant throughout the years, and updated only when more accurate data becomes available. The highest tier defined for each parameter in the MRR is usually the laboratory analysis, which is more demanding but more accurate. The result of the analysis is valid for the very batch from which the sample has been taken, while a default value is usually an average or conservative value based on large quantities of that material (e.g. a UK-wide average as appears in the UK digest of energy statistics (DUKES)), while the analysis will be valid for only one batch of one coal type.

Important note: In all cases the operator must ensure that activity data and all calculation factors are used consistently. For example, where a fuel's quantity is determined in the wet state before entering the boiler, the calculation factors must also refer to the wet state. Where analyses are carried out in the laboratory from the dry sample, the moisture

must be accounted for appropriately, to determine the calculation factors applicable for the wet material.

Operators must also be careful not to mix up parameters of inconsistent units. Where the amount of fuel is determined per volume, also the NCV and/or emission factor must refer to volume rather than mass¹.

2.1 Default values

When an operator intends to use a default value for a calculation factor, the value of that factor must be documented in the monitoring plan. The only exception is where the default value or its information source changes on an annual basis. In principle, this is the case where the regulator regularly updates and publishes the standard factors used in the national greenhouse gas inventory. In such cases, the monitoring plan should contain the reference to the place (webpage, official journal, etc.) where these values are published, instead of the value itself (Article 31(2) of the MRR).

The applicable type of default values is determined by the applicable tier definition. Sections 2 to 4 of Annex II of the MRR give a general scheme for these definitions. The sector-specific monitoring methodologies in Annex IV further specify those tiers, or sometimes overrule the tier definitions with more specific ones. A complete listing of all tier definitions would significantly exceed the scope of this guidance. However, a simplified overview of tier definitions given by Annex II is presented in Table 1 below.

¹ See section 3.3.1 of UKETS01, in which conditions are mentioned under which the operator may use emission factors expressed as t CO₂/t fuel instead of t CO₂/TJ.

Table 1: Overview of the most important tier definitions for calculation factors, based on Annex II of the MRR

Source stream type	Factor	Tier	Tier definition
Combustion emissions	emission factor ²	1	Type I default values
		2a	Type II default values
		2b	Established proxies (if applicable)
		3	Laboratory analyses or empirical correlations
Combustion emissions	oxidation factor	1	Default value OF=1
		2	Type II default values
		3	Laboratory analyses
Combustion emissions and mass balance	net calorific value	1	Type I default values
		2a	Type II default values
		2b	Purchasing records (if applicable)
		3	Laboratory analyses
Combustion emissions, process emissions and mass balance	biomass fraction	1	Type I biomass fraction
		2	Type II biomass fraction
		3	Laboratory analyses
Process emissions (Method A: Input based)	emission factor	1	Type I default values
		2	Type II default values
		3	Laboratory analyses and stoichiometric values
Process emissions (Method B: Output based)	emission factor	1	Type I default values
		2	Type II default values
		3	Laboratory analyses & stoichiometric values
Process emissions (Methods A and B)	conversion factor	1	Default value CF=1
		2	Laboratory analyses & stoichiometric values
Mass balance source stream	carbon content	1	Type I default values
		2a	Type II default values
		2b	Established proxies (if applicable)
		3	Laboratory analyses or empirical correlations or stoichiometric values for pure chemical substances

² 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.

As can be seen from Table 1, the lowest tier usually applies an internationally applicable default value (IPCC standard factor or similar, as listed in Annex VI of the MRR). The second tier uses a national factor, which is in principle used for the national greenhouse gas inventory under the UNFCCC. However, further types of default values or proxy methods are allowed, which are deemed equivalent. The highest tier usually requires the factor to be determined by laboratory analyses.

The short descriptions of tier levels in Table 1 must be read in full text as follows:

- **type I default values:** Either standard factors listed in Annex VI (i.e. in principle IPCC values) or other constant values in accordance with point (e) of Article 31(1) of the MRR, i.e. analyses carried out in the past but still valid.³
- **type II default values:** 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 national greenhouse gas inventory,⁴ more values published by the regulator for more disaggregated fuel types, or other literature values which are agreed by the regulator,⁵ or values guaranteed by the supplier.
- **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 (see section 5.2.2 of UKETS01). However, these rather complicated analyses are only carried out once per year, therefore this tier is 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 case of commercially traded fuels, the net calorific value may 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:** In this case, the requirements discussed in section 5.2.2 of UKETS01 below are fully applicable. This also includes the use of the 'established

³ Article 31(1)(e) 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”. This is a considerable simplification for operators, who do not have to carry out regular analyses as described in section 5.2.2 of UKETS01.

⁴ Article 31(1)(b) of the MRR: “standard factors used by the UK for its national inventory submission to the Secretariat of the United Nations Framework Convention on Climate Change”.

⁵ Article 31(1)(c) of the MRR: “literature values agreed with the regulator, including standard factors published by the regulator, which are compatible with factors referred to in point (b), but representative of more disaggregated sources of fuel streams”.

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. Furthermore, the regulator may accept the use of the stoichiometric content of pure chemical substances as meeting the tier that would otherwise require laboratory analyses.

- **type I biomass fraction**⁶: One of the following methods is applied, which are considered equivalent:
 - Use of values published by the UK ETS Authority.
 - Use of values in accordance with Article 31(1), i.e. a "Type I/II default value".
- **type II biomass fraction**: Use of a value determined in accordance with the second subparagraph of Article 39(2) of the MRR, i.e. use an estimation method approved by the regulator. For fuels or materials originating from a production process with defined and traceable input streams, the operator may base such estimation on a mass balance of fossil and biomass carbon entering and leaving the process.
- **stoichiometrical values**: In principle these are allowed in the same way as other literature values, i.e. they must be agreed with the regulator and can therefore be considered "Type II default values". However, under certain conditions (the substance must be pure, the use of that value would be conservative, and the otherwise required laboratory analyses would lead to unreasonable costs), the regulator may approve that those values suffice to comply with the highest tier. This in turn reduces the cases where operators would have to submit an improvement report, as the higher tier thereby has been achieved.

2.2 Laboratory analyses

Where the MRR refers to determination "in accordance with Article 32 to 35", this means that a parameter must be determined by (chemical) laboratory analyses. The MRR imposes relatively strict rules for such analyses, to ensure a high-quality level of the results. In particular, the following points need consideration:

- the laboratory must demonstrate its competence. This is achieved by one of the following approaches:

⁶ Note that it is not discussed here how to determine whether the relevant sustainability and GHG savings criteria are met (if applicable). A short overview is given in section 5.3.5 of UKETS01. More information on the treatment of biomass issues in the UK ETS are given in guidance document 'UKETS03 MRR - Reporting biomass in installations'.

- an accreditation in accordance with EN ISO/IEC 17025, where the analysis method required is within the accreditation scope; or
 - demonstrating that the criteria listed in Article 34(3) of the MRR are satisfied. This is considered reasonably equivalent to the requirements of EN ISO/IEC 17025. Note that this approach is allowed only where use of an accredited laboratory is shown to be technically not feasible or involving unreasonable costs (see section 3.6 of UKETS01).
- the way samples are taken from the material or fuel to be analysed is considered crucial for receiving representative results. Therefore, operators must develop sampling plans in the form of written procedures (see section 4.5 of UKETS01) and get them approved by the regulator. Note that this also applies where the operator does not carry out the sampling but treats it as an outsourced process.
 - analyses methods must usually follow international or national standards. Preference is given to EN standards.⁷

Note that laboratory analyses are usually related to the highest tiers for calculation factors. Therefore, these rather demanding requirements are rarely applicable to smaller installations. Operators of installations with low emissions (see section 3.4.2 of UKETS01) 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)”. In fact, the minimum requirements would be that the laboratory demonstrates that it is technically competent and “capable of managing its personnel, procedures, documents and tasks in a reliable manner”, and that it demonstrates quality assurance measures for calibration and test results.⁸ However, it is in the operator’s interest to receive reliable results from the laboratory. Therefore, operators should strive to comply with the requirements of Article 34 of the MRR to the highest degree feasible.

Furthermore, it is important to note that the MRR in the activity-specific requirements of Annex IV allows the use of “industry best practice guidelines” for some lower tiers, where no default values are applicable. In such cases, where despite approval to apply lower tier methodology analyses are still required, it may not be appropriate or possible to apply

⁷ For the use of 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.”

⁸ Examples for such measures are given in Article 34(3) of the MRR, point (j): regular participation in proficiency testing schemes, applying analytical methods to certified reference materials, or inter-comparison with an accredited laboratory.

Articles 32 to 35 of the MRR in full. However, the regulator should deem the following as minimum requirements:

- where the use of an accredited laboratory is technically not feasible or would lead to unreasonable costs, the operator 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) of the MRR.
- the operator shall submit a sampling plan in accordance with Article 33 of the MRR.
- the operator shall determine the analysis of frequency in accordance with Article 35 of the MRR.

3 Sampling plan

3.1 Introduction to sampling

“Frequency of Sampling” versus “Frequency of Analyses”

The MRR refers to “Frequency of Analyses” in Article 35 (see [chapter 4](#)). Depending on the specific situation the resulting requirement in the approved monitoring plan for the operator may be e.g. that the minimum frequency of analyses of the emission factor of a certain source stream is four times a year.

The term “Frequency of Analyses” must not be confused with the “Frequency of Sampling”, i.e. the frequency of taking samples or increments from a batch or delivery of a fuel or material. In general, a lot more samples/increments than four must be taken over the year to obtain representative results. This Chapter only deals with the frequency of taking samples. The following example should help to clarify.

Example: A coal firing plant is burning 500,000 tonnes of coal a year. In accordance with Annex VII (also see [section 4.1](#)), the operator is required as a minimum to analyse every 20,000 tonnes of coal. This will at least result in 25 different laboratory samples that are analysed each year. The main objective of the sampling plan, which also includes the frequency of sampling, is to prepare (at least) 25 laboratory samples that are representative for each of the 20,000 tonne batches. In order to have representative laboratory samples more than just one sample/increment will have to be taken from each 20,000 tonne batch.

Sampling is a very important task whenever something is to be analysed in a laboratory. It is critical to develop and apply a reproducible methodology (the sampling plan) which ensures that the sample taken is representative of the whole batch or delivery from which the sample is taken. The sampling plan describes the overall aims and objectives; it includes specific and practical instructions on what is going to be sampled, how it will be sampled, at what frequency, what the sample will be analysed for and by whom. It covers all steps from drawing the sample until the sample is being analysed. An appropriate sampling plan provides transparency to all users and will not only improve the reliability of the results and the level of assurance; it may also help to reduce costs for analyses and verification.

The complexity of the sampling plan will largely depend on the degree of heterogeneity of the fuel or material. In general, it might be useful in complex cases to put some effort into the preparation of an elaborate sampling plan. However, it should also be noted that the use of highly heterogeneous materials is not a very common practice in UK ETS installations. Therefore, few installations will have to develop sophisticated sampling

plans. In many cases it may happen that sampling used for other purposes (such as quality or process control) can be used (as it is) without further adaptation, as the examples show.

The development of a sampling plan is explained in [section 3.3](#). Sampling is more complicated the more heterogeneous the material is. For a very homogeneous material (e.g. a liquid fuel which is homogenised in a tank by stirring) a simple sample of 50ml may well be representative for the whole 500 tonnes in the tank. At the other end of the spectrum, some waste fractions (e.g. electronic scrap) may consist of items each beyond 50kg mass, while a laboratory analysis usually needs only samples of some grams or even in some cases micrograms (μg).

The aim of every sampling exercise is that the final sample in the laboratory is as representative of the whole delivery period or batch of fuel or material as possible. It is a statistical exercise to determine how many “increments” (smaller samples which are combined into a bigger sample) must be picked from a batch, and how big the increments must be, to obtain a reasonably representative “composite sample”. The increments must be considerably bigger than the particle size, and the locations of sampling should be spread over the whole area to be sampled. The number of increments must be high enough to allow a meaningful average.

Example 1: An installation is burning clay delivered by storage tanks on trucks. To determine the properties of this source stream, e.g. the EF, each delivery is sampled and treated according to industry best practise.

Example 2: A power plant is firing coal. Sampling is done by an automatic sampler from the onsite coal stockpile. In both examples, the provision of a written procedure for the sampling plan may well be an exercise of documenting what is already being done in the past rather than implementing any new process steps.

Example 3: A cement clinker producing installation is exclusively firing petcoke. The operator intends to additionally burn waste tyres and other solid recovered fuels. In this case, the operator is well advised to carefully study relevant standard documents (see below) to prepare a transparent sampling plan accompanied by the underpinning procedure. The accredited laboratory that will be engaged for the analyses may also be consulted for the purpose of preparing an appropriate sampling approach.

Example: Figure 1 shows a population that consists of a physical mixture of two components that are different in the one material property of interest (indicated by the two different colours), e.g. the NCV. The average value of the property of the population is of interest. It is assumed that only increments sizes of 2x2 boxes (bold

frames) can be taken. This example should help the understanding that even rather simple cases require some effort to prepare an appropriate sampling plan providing representative results after analyses. Although in the population there are as many blue boxes as yellow ones, each 2x2 increment may contain different numbers of blue and yellow boxes. Due to this problem where, in practice, the material may not show visible differences, one of the main tasks of a sampling plan would be to determine the number of increments necessary to obtain sufficiently representative overall results (i.e. to have an equal number of blue and yellow boxes for analysis).

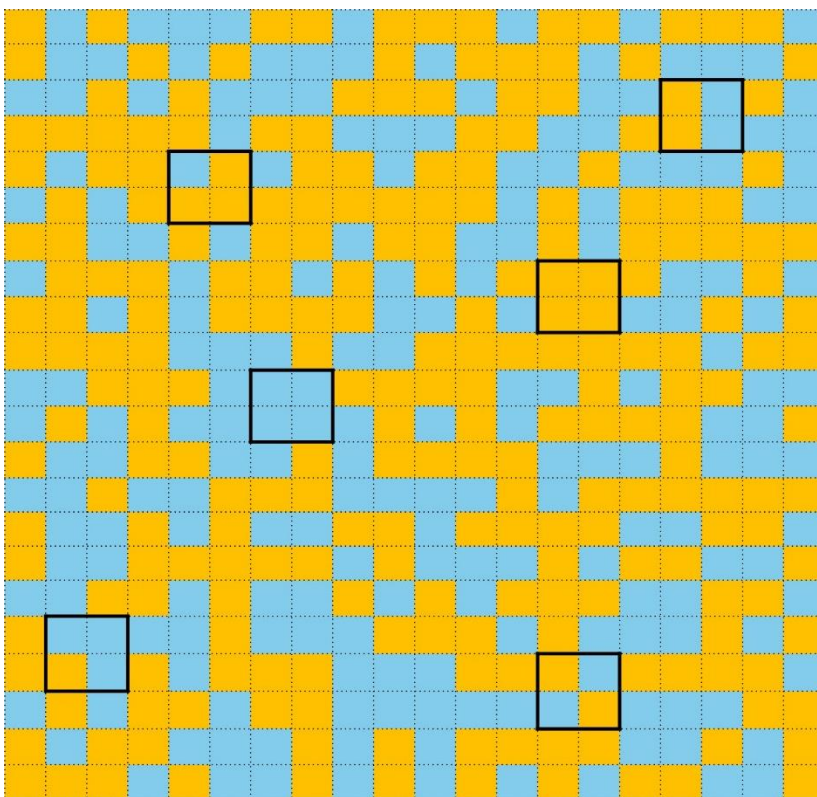


Figure 1: Example of a random two-component mixture with highly uniform particle size distribution. The bold squares illustrate possible samples to be taken.

Furthermore, sampling often requires several consecutive steps of picking increments from a pile, mixing these to a new sample, reducing the particle size, taking new (smaller) samples, mixing again and reducing the size etc., until a final laboratory sample can be obtained. As indicated at the beginning, this process needs more effort the more heterogeneous a material is and the bigger the individual particles are. Figure 2 shows an example of a flow chart to help understand the role of sampling in the determination of calculation factors. Figure 3 shows a more detailed example of a sampling plan.

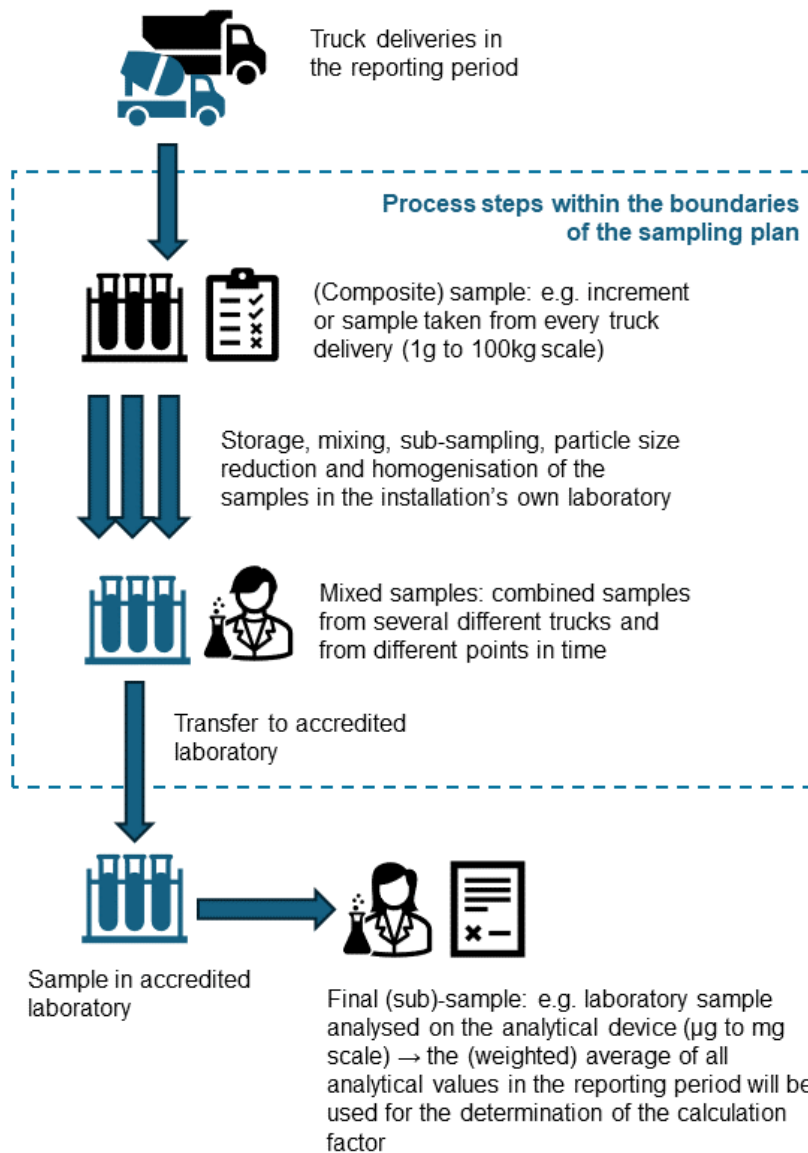


Figure 2: Example of a flow sheet for sampling and analyses

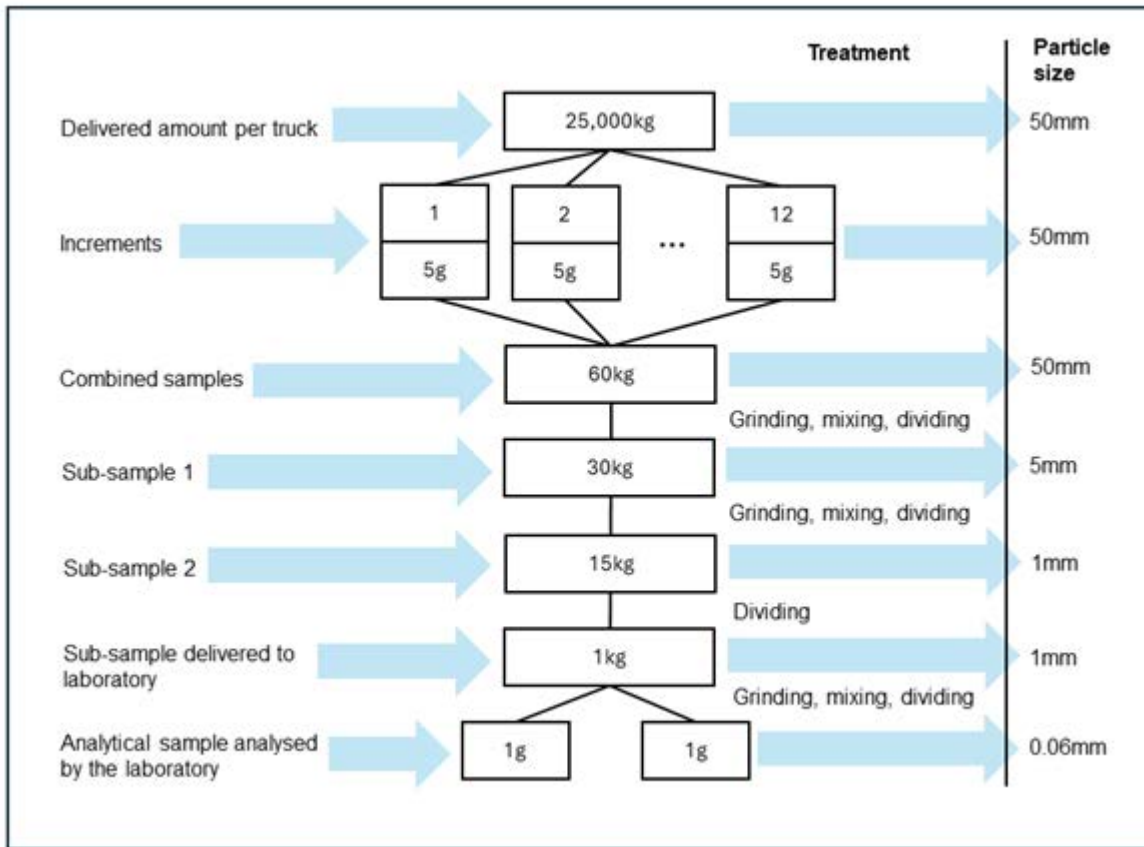


Figure 3. Example of a sampling plan flow sheet for the determination of the carbonate

Generally, all standards containing provisions for preparing sampling plans are suitable, particularly those related to the specific type of source stream, e.g. coal. The following standards and technical reports may be considered when preparing a sampling plan, particularly for more complex cases:

EN 932-1	Tests for general properties of aggregates - Part 1: Methods for sampling
EN ISO 10715	Natural gas - Sampling guidelines
ISO 13909-2	Hard coal and coke - Mechanical sampling - Part 2: Coal - Sampling from moving streams
EN 14899	Characterization of waste – Sampling of waste materials – Framework for the preparation and application of a sampling plan
CEN/TR 15310	Characterization of waste – Sampling of waste materials. This technical report consisting of five parts assists and supplements EN 14899
EN 15442	Solid recovered fuels – Methods for sampling

EN 15443	Solid recovered fuels – Methods for the preparation of the laboratory sample
EN 14778	Solid biofuels - Sampling

Some of these standards and technical reports focus on waste materials. However, solid waste materials are often very heterogeneous. Therefore, the approaches for preparing a sampling plan related to waste materials presented in the standards and technical reports can be considered to cover even the most complex non-waste cases as well. In the absence of a suitable standard for the specific fuel, considerable simplifications may be possible if the fuel or material is more homogeneous.

In some cases, analytical results may show that the heterogeneity of the fuel or material significantly deviates from the information on heterogeneity on which the original sampling plan for that specific fuel or material has been based. In such cases, Article 33(2) requires the operator to adapt the relevant elements of the sampling plan. Those adaptations shall be by agreement with the laboratory carrying out the analysis for the respective fuel or material ([see Chapter 5](#)) and subject to the approval of the regulator.

An example for a sampling plan template can be found in Annex I.

3.2 Sampling plan requirements of the MRR

For putting the above into practice in a practical and consistent manner, Article 33 of the MRR requires the operator to submit a sampling plan to the regulator for approval for each fuel or material for which calculation factors are to be determined by analyses. If only tiers using default values or purchasing records are applied for the determination of calculation factors, this requirement (and consequently this guidance document) is not relevant.

The sampling plan shall be in form of a written procedure containing the following information:

- methodologies for the preparation of samples
- responsibilities
- locations
- frequencies
- quantities
- methodology for the storage and transport of samples.

Furthermore, the MRR contains provisions that the sampling plan must be updated regularly if any changes of source streams or of the properties of source streams occur over time. This is achieved by requiring that the operator puts in place a procedure attached to the monitoring plan related to the revision of the appropriateness of the sampling plan.

The ultimate goal of a sampling plan in the MRR is to ensure that samples analysed are representative for the relevant batches and that the cumulated results allow for the determination of representative calculation factors, e.g. that sampling and analysis of the carbon content⁹ of a source stream is representative for that material over the whole reporting period.

In many cases, the requirement to have a sampling plan and an underpinning procedure in place does not impose any additional requirements to current practice at the installation. In any case, the MRR requires that relevant elements of the sampling plan shall be agreed with the laboratory carrying out the analysis for the respective fuel or material, and evidence of that agreement shall be included in the sampling plan. This is particularly relevant in cases of rather heterogeneous material having properties that vary spatially and temporally.

In some cases, sampling itself may be carried out by a third party, e.g. the fuel/material supplier. In such a case, it is still the operator's responsibility to demonstrate compliance with the requirements in the MRR for sampling plans. This may be achieved by obtaining information and evidence about the sampling plan by the third party¹⁰. In any event, the operator is responsible for correct sampling defined in an appropriate sampling plan in accordance with Article 33, regardless of whether sampling or analysis is carried out by the operator or by third parties.

3.2.1 Example of a relatively simple sampling plan procedure

Item according to Article 12(2)	Possible content (examples)
Title of the procedure	Sampling Plan for waste oil
Traceable and verifiable reference for identification of the procedure	ETS 01-SP

⁹ As pointed out in section 5.3.1 of guidance document 'UKETS01 MRR – General guidance for installations', the emission factor is based on the carbon content of a fuel or material. Carbon content is the primary object of analysis.

¹⁰ See [section 8.1](#)

Post or department responsible for implementing the procedure and the post or department responsible for the management of the related data (if different)	Head of either the waste department or the installation's laboratory ¹¹
Brief description of the procedure ¹²	<ul style="list-style-type: none"> • 1000 ml samples are taken from each truck's storage tank (about 250 trucks a year). • responsible person makes arrangement that sampling is supervised (weekly spot checks) by the responsible shift manager or a representative nominated by the manager. • samples are collected in tight bottles clearly marked with date and time, fuel supplier ID, and name of the person who took the sample. • samples are stored in room LA-007 of the laboratory (at room temperature). • when 10 samples have been collected, they are mixed and homogenised to give "a composite sample". This results in approximately 6 composite samples each quarter. • once per quarter the composite samples are sent to the accredited laboratory identified in the monitoring plan.
Location of relevant records and information	<p>Hardcopy: Laboratory Storage Room, shelf 27/9, Folder identified "ETS 01-SP".</p> <p>Electronically: "P:\ETS_MRV\Analyses\ETS_01-SP.xls"</p>
Name of the computerised system used, where applicable	N.A. (Normal network drives)
List of EN standards or other standards applied, where relevant	EN 14899

¹¹ Note that this is the installation's own laboratory and not the accredited laboratory used to carry out the analyses.

¹² This description is required to be sufficiently clear to allow the operator, the regulator, and the verifier to understand the essential parameters and operations performed.

3.3 Preparing a sampling plan

The following section outlines a step-by-step approach for preparing a sampling plan, including a brief description of the steps. This approach is taken from CEN/TR 15310-1.

1. Specify the objective of the Testing Programme

This should be a general statement on the overall purpose and an essential first step. However, it will usually be at a rather high-level and too non-specific to lead directly to detailed instructions for a sampling plan.

In most cases, this objective will simply be something like “to determine the average carbon content” or “to determine the average emission factor of a material over the whole reporting period”.

2. Develop the technical goals of the objective

(a) Define the population to be sampled

Population is a statistical term for defining the total volume of material or fuel about which information is required through sampling. In general, the population will refer to the total amount of material or fuel consumed within a reporting period. Sub-populations may, for example, be defined as single batches (e.g. each delivery, or as a volume as given by the analysis frequency in Annex VII of the MRR) or as fuel consumed each month in case of a continuous source stream.

(b) Assess variability

Variability can be distinguished between

- spatial variability - this term refers to the heterogeneity of a material depending on the location, e.g. the heterogeneity within one single batch.
- temporal variability - this term accounts for changes of properties over time, e.g. the variability of the net calorific values between a batch consumed in March and a batch consumed in November.

(c) Select the sampling approach

This can be distinguished between

- probabilistic sampling - this means that each element within the population to be assessed has an equal chance of being selected. This approach is therefore preferable to obtain representative results and eliminates one source for committing systematic errors.

- judgmental sampling - due to practical or costs reasons a probabilistic sampling is not always possible. Judgmental sampling will result in sampling sub-populations, e.g. due to technical reasons only samples from the top of a storage tank are being taken.

(d) Identify the scale

The scale defines the minimum quantity of material below which variations are judged to be unimportant.

(e) Choose the required statistical approach

The relevant statistical parameters will be the mean values as well as the standard deviation. Although only the mean value over the whole reporting value is to be reported and no specific uncertainty thresholds are mentioned in the MRR for those mean values, the deviation provides information about the appropriateness of the sampling plan to improve the level of assurance.

(f) Choose the desired reliability

Reliability refers to “bias”, “precision” and “confidence”. Choices must be made on the confidence level, and to the extent that random and systematic errors in sampling can be minimised.

3. Determine the practical instructions

(a) Choose the sampling pattern

The sampling pattern defines when, where and how samples are selected.

(b) Determine the increment/sample size

An increment is the amount of material that is obtained through one single sampling action. It is not analysed as an individual unit but is combined with other increments to form a composite sample. A simple “sample” is defined as a lot that is analysed individually. The increment/sample size should depend on properties like heterogeneity or particle size.

(c) Determine the use of composite or individual samples

This selection depends inter alia on costs and the statistical parameters. As in general the mean value will be of particular interest, usually composite samples will be used.

4. Determine required number of samples

This is a statistical exercise taking into account any standard deviations between increments, samples, composites etc. This point is relevant for the reliability of results but also for cost-efficiency.

After all relevant decisions have been made the sampling plan can be put down on paper. At least the following elements should be covered:

- who is responsible for each step?
- where and when are samples taken?
- how are the samples taken? For example, it might be necessary to first clean pipes where residues from previous samples might still be contained, etc.
- which instruments are used, if relevant? Describe automatic sampling equipment but also describe the tools for manual sampling. It might also be important how samples can be picked out from sufficiently deep within a pile that is several metres in height.
- how will the identity of the samples be ensured?
- how are the samples stored (dry, cool, dark, inert atmosphere, etc.)?
- how and when are increments combined?
- when are the samples analysed, are remaining samples stored after analysis, etc.?

As further help for the development of a sampling plan, Annex I of this document contains an example of a template for a sampling plan.

4 Frequency of analyses

According to Article 35 of the MRR the operator must consider the following options when determining the minimum frequency of analyses:

- applying the minimum frequency for relevant fuels and materials listed in Annex VII of the MRR (see Table 1 below)
- analysis frequencies different from those listed in that table may be allowed where the operator demonstrates one of the following:
 - based on historical data, any variation in the analytical values for the respective fuel or material does not exceed 1/3 of the uncertainty value to which the operator has to adhere regarding the activity data determination of the relevant fuel or material (see [section 4.2](#))
 - applying the minimum frequency listed in Table 1 would incur unreasonable costs (see [section 4.3](#))
 - where an installation operates for part of the year only, or where fuels or materials are delivered in batches that are consumed over more than one calendar year, the regulator may agree with the operator a more appropriate schedule for analyses. However, this approach must result in a comparable uncertainty as the approach based on the “1/3” rule presented above (see [section 4.4](#)).

4.1 Minimum frequency of analyses (Annex VII of the MRR)

Table 1 lists the minimum frequency of analyses for relevant fuels and materials as laid down in Annex VII of the MRR.

Table 1: Minimum frequency of analyses

Fuel/material	Minimum Frequency of Analyses
Natural gas	At least weekly
Other gases, in particular synthesis gas and process gases such as refinery mixed gas, coke oven gas, blast-furnace gas, convertor gas, oil field and gas field gas	At least daily - using appropriate procedures at different parts of the day
Fuel oil (for example light, medium, heavy fuel oil, bitumen)	Every 20,000 tonnes and at least six times a year
Coal, coking coal, coke, petroleum coke, peat	Every 20,000 tonnes and at least six times a year
Other fuels	Every 10,000 tonnes of fuel and at least four times a year
Untreated solid waste (pure fossil or mixed biomass/fossil)	Every 5,000 tonnes and at least four times a year
Liquid waste, pre-treated solid waste	Every 10,000 tonnes and at least four times a year
Carbonate minerals (including limestone and dolomite)	Every 50,000 tonnes and at least four times a year
Clays and shales	Amounts of material corresponding to 50,000 tonnes of CO ₂ and at least four times a year
Other materials (primary, intermediate and final product)	Depending on the type of material and the variation amounts of material corresponding to 50,000 tonnes of CO ₂ and at least four times a year

4.2 The “1/3” rule

An operator may apply a different frequency to that listed in Table 1 if any variation in the analytical values¹³ for the respective fuel or material does not exceed 1/3 of the

¹³ The term ‘variation in the analytical values’ in this section comprises the following three elements: 1) the variation of the actual value over time, 2) the analytical error to determine the value and 3) the

uncertainty value to which the operator must adhere regarding the activity data determination of the relevant fuel or material. The determination of this variation must be based on historical data, including analytical values for the respective fuels or materials in the reporting period immediately preceding the current reporting period.

Any variation in the analytical value may be determined as the overall uncertainty of uncorrelated input quantities (see Annex II of guidance document 'UKETS02 MRR/FAR - Uncertainty assessments for installations):

Equation 1

$$u_{total} = \frac{\sqrt{(u_1 \times x_1)^2 + (u_2 \times x_2)^2 + \dots + (u_n \times x_n)^2}}{|x_1 + x_2 + \dots + x_n|}$$

where:

u_i relative uncertainty of the analytic value of sample i

x_isample size of sample i

Under the assumptions that the uncertainty of the analytic value of each sample is the same and all sample sizes are similar, the formula simplifies to:

Equation 2

$$u_{total} = \frac{\sqrt{n}}{n} = \frac{u_i}{\sqrt{n}}$$

where:

nnumber of analysed samples

If the total uncertainty related to the analytic values is known (in most cases it is a direct result of the standard deviation of the analytical values) the required minimum number of samples can be determined as:

sampling and any further errors. No distinction is made as to which of those contributes the most to the historic variation observed. Further information can be found in the training material on sampling, which can be downloaded from: https://climate.ec.europa.eu/document/download/79be67c1-25df-4ce0-bd34-f08dd0d523af_en?filename=sampling_training_material_en.pdf

Equation 3

$$n = \frac{u_i^2}{u_{total}^2}$$

Example: A category B installation is burning heavy fuel oil. In the monitoring plan the heavy fuel oil is listed as a major source stream to be monitored by a calculation-based approach. The MRR (and approved monitoring plan) requires it to meet tier 4 ($\pm 1.5\%$) for activity data and to determine the calculation factors emission factor (EF) and net calorific value (NCV) by laboratory analyses in accordance with Articles 32 to 35. The “1/3” rule requires that the uncertainty related to the determination of the calculation factors does not exceed 0.5% (This u_{total} is the input parameter for determining the number of samples).

Table 1 (see [section 4.1](#)) would require analysing at least six times a year. From historic analyses the operator demonstrates that the uncertainty related to the determination of the NCV is 1.00%. The following table displays the results from historic samples.

# of sample	NCV [GJ/t]
1	42.28
2	42.41
3	42.35
4	42.68
5	42.44
6	42.40
7	42.68
8	42.60
9	42.02
10	42.33
11	42.41
12	42.20
Average	42.40
Uncertainty u_i	1.00%

The uncertainty is determined as the standard deviation of the data series (0.45%) multiplied by the Student t-factor for 12 values and a 95% confidence interval (=2.201). The application of this factor is required because uncertainty as defined in Article 3(6) of the MRR¹⁴ always refers to a confidence interval of 95%. The minimum frequency of analysis to meet the requirements of the “1/3” rule is then calculated by:

$$n = \frac{1.0\%^2}{0.5\%^2} = 4$$

Therefore, in this case, the operator may be allowed to apply a lower frequency of analysis of four times per year instead of six times for NCV determination. For the emission factor a similar test can be carried out whether these requirements are fulfilled with 4 samples per year as well.

It is important to note that the “1/3” rule also offers the operator an option to deviate from carrying out analyses in accordance with Article 32 to 35. The MRR, in the definition of tiers for calculation factors in Annex II, under specific situations allows the use of the empirical correlation as specified for Tier 2b in sections 2.1 and 3.1 of Annex II of the MRR to be regarded as Tier 3. However, in such cases the uncertainty of that empirical correlation may not exceed 1/3 of the uncertainty value to which the operator has to adhere regarding the activity data determination of the relevant fuel or material. The operator must demonstrate to the satisfaction of the competent authority that they have complied with this provision.

4.3 Incurrence of unreasonable costs

An operator is also allowed to deviate from applying the minimum requirements for frequency of analyses in Table 1 (see [section 4.1](#)) or applying minimum frequency of analyses resulting from the “1/3” rule if he can demonstrate they would incur unreasonable costs. Article 18(1) defines costs as unreasonable if they exceed the benefit. The benefit shall be calculated by multiplying an improvement factor by a reference price of £20 per allowance and costs shall include an appropriate depreciation period based on the economic lifetime of the equipment. Article 18(3) defines this improvement factor as 1% of the average annual emissions of the respective source streams in the three most recent reporting periods. For further guidance on unreasonable

¹⁴ Article 3(6) of the MRR: “‘uncertainty’ means a parameter, associated with the result of the determination of a quantity, that characterises the dispersion of the values that could reasonably be attributed to the particular quantity, including the effects of systematic as well as of random factors, expressed in per cent, and describes a confidence interval around the mean value comprising 95% of inferred values taking into account any asymmetry of the distribution of values”.

costs, please see section 3.6.2 of guidance document 'UKETS01 MRR - General Guidance for Installations'.

Example: The heavy fuel oil source stream above emits about 40,000 tonnes of CO₂ annually. The costs for the analyses must exceed the benefit to be regarded as unreasonable. If the costs are lower, they are not unreasonable:

$$C < P \cdot AEm \cdot IF$$

where:

C..... Costs [£/year]

P..... specified allowance price = £20 / t CO₂(e)

AEm.... Average emissions from related source stream(s) [t CO₂(e)/year]

IF..... improvement factor = 1%

It is assumed that one analysis costs £1,000. As the benefits are £8,000/year (20 x 40,000 x 1%) the costs for six analyses per year cannot be regarded as unreasonable.

Question 8.4 may provide further helpful information on how to proceed if the application of tier 3 (i.e. analysis in accordance with Articles 32 to 35 of the MRR) incurs unreasonable costs. For further information, as well as access to an UK ETS tool for determining unreasonable costs, please contact your regulator.

4.4 Analyses frequency for specific situations

Article 35(2) gives the operator another option to deviate from the minimum frequency listed in Annex VII of the MRR (see [section 4.1](#)). However, this option may only be applied in either of the following situations:

- an installation operates for part of the year only;
- fuels or materials are delivered in batches that are consumed over more than one calendar year.

In these special situations, the regulator may agree with the operator a more appropriate schedule for analyses. Nonetheless, it has to be assured that the approach the operator and the regulator agree upon will result in an uncertainty comparable to an uncertainty achieved if the approach based on the “1/3” rule were used (see [section 4.2](#)).

5 Laboratories

Pursuant to Article 34 all analyses for the determination of calculation factors shall be carried out by laboratories that are accredited for the relevant analytical methods in accordance with EN ISO/IEC 17025. However, operators may deviate from this requirement if it can be demonstrated to the satisfaction of the regulator that access to accredited laboratories is technically not feasible or would incur unreasonable costs. In this case non-accredited laboratories may be used provided that they meet the requirements listed in Article 34(3) of the MRR. Those requirements are considered appropriate to demonstrate competence equivalent to accreditation in accordance with EN ISO/IEC 17025.

The equivalent requirements concern the quality management and technical competence of the laboratory and should be demonstrated in the form of procedures attached to the monitoring plan.

With respect to **quality management**, the operator may demonstrate the competence by an accredited certification of the laboratory in conformity with EN ISO/IEC 9001, or other certified quality management systems that cover the laboratory. In the absence of such certified quality management systems, the operator shall provide other appropriate evidence that the laboratory can manage in a reliable manner its

- personnel,
- procedures,
- documents, and
- tasks.

With respect to **technical competence**, the operator shall provide evidence that the laboratory is competent and able to generate technically valid results using the relevant analytical procedures. Article 34(3) of the MRR lists the topics on which evidence is to be provided. Table 2 below lists elements which the regulator should take into account when assessing an operator's proposed evidence on the laboratory he uses.

Note: Article 47(7) of the MRR allows operators of installations with low emissions to use any laboratory to determine calculation factors by analyses that is technically competent and able to generate technically valid results using the relevant analytical procedures. Evidence only needs to be provided for the quality assurance measures referred to in point j of Table 2.

Table 2 Elements for demonstrating equivalent technical competence to an accreditation for laboratories

Element of Article 34(3) upon which competence needs to be demonstrated	Important elements for the competent authority to assess (not exhaustive)
(a) Management of the personnel's competence for the specific tasks assigned	<ul style="list-style-type: none"> • Are the personnel executing the sampling and analysis authorised for their job by the management? • Can the competence of the personnel be proven by records of their education, training and experience? • Is an adequate procedure for training and supervision of personnel
(b) suitability of accommodation and environmental conditions	<ul style="list-style-type: none"> • Is the building and the laboratory area sufficiently heated / air-conditioned, safe, secure and clean for the purpose? • Is access to and use of areas affecting the quality of the tests and/or calibrations controlled and are measures taken to ensure good housekeeping? • Are environmental conditions monitored, controlled and recorded as required by the relevant specifications, methods and procedures, or where they influence the quality of the results, and are tests and calibrations stopped when the environmental conditions jeopardise the results?
(c) selection of analytical methods and relevant standards	<ul style="list-style-type: none"> • Is an adequate procedure in use to ensure that the latest valid edition of a standard is used? • Is the procedure for the selection of a method documented and is the procedure actually used for the selection of appropriate methods? • Is the reporting of deviations from the standardised method ensured?
d) where applicable, management of sampling and sample preparation, including control of sample integrity	<ul style="list-style-type: none"> • Are adequate procedures for representative sampling of substances, materials or products implemented? • Are deviations from the required sampling procedures recorded
(e) where applicable, development and validation of new analytical methods or application of methods not	<p>Note: These requirements only apply if the operator's monitoring plan requires analyses which are not yet established, or where no standards are available.</p>

<p>covered by international or national standards</p>	<ul style="list-style-type: none"> • When non-standard methods are used, are these methods well described? • Are the methods used for the determination of the calculation factor(s) validated? • Where new methods are used or developed, at least the following performance characteristics must be known or be determined: sensitivity of the method, repeatability and/or reproducibility, cross-sensitivity against interference
<p>(f) uncertainty estimation</p>	<ul style="list-style-type: none"> • Does the procedure for the estimation of the uncertainty include all components of uncertainty? • Are previous experiences and the results of the validation of the applied method included in the estimation of the uncertainty?
<p>(g) management of equipment, including procedures for calibration, adjustment, maintenance and repair of equipment, and record keeping thereof</p>	<ul style="list-style-type: none"> • Are records maintained of each item of equipment and its software? • Does the laboratory apply procedures for safe handling, transport, storage, use and planned maintenance of the measuring equipment to ensure proper functioning? • Is there a scheme for calibration and maintenance of the equipment and its software implemented? • Can the state of calibration be proven with certificates? • Is there an adequate procedure to ensure that calibration factors are correctly implemented in time?
<p>(i) management of calibration items and reference materials</p>	<ul style="list-style-type: none"> • Is there a programme and procedure for calibration concerning the handling of the reference standards, or for regular purchase of new standards? • Are the reference materials used, where possible, traceable to international standards? • Are adequate procedures for intermediate checking of the calibration status documented and implemented on a regular basis? • Are procedures implemented for safe handling, transport, storage and use of reference standards and reference materials?

	<ul style="list-style-type: none"> • Are procedures implemented for safe transportation, receipt, handling, protection, storage, retention and/or disposal of calibration items? • Is a system used, which enables unambiguous identification of calibration items and reference materials?
(j) quality assurance for calibration and test results, including regular participation in proficiency testing scheme applying analytical methods to certified reference materials, or inter-comparison with an accredited laboratory	<ul style="list-style-type: none"> • Does the laboratory apply procedures to monitor the validity of the test and calibration results? • Are the results of these checks recorded, stored and, where practicable, statistically evaluated? • Does the laboratory participate in inter-laboratory comparison or proficiency testing programmes? • If the laboratory participates in inter-laboratory comparison or proficiency testing programmes, how will appropriate corrective action be taken in case differences are observed between laboratories? • Which other measures has the laboratory implemented for quality assurance of calibration and test results?
(k) management of out-sourced processes	<ul style="list-style-type: none"> • Only relevant where processes are outsourced (e.g. calibration of instruments, analyses by external laboratories etc.) • Does the laboratory have a procedure implemented which guarantees that the purchased services and supplies are within the required specifications? • Are the required specifications included in each order and is each delivery checked against those requirements?
(l) management of assignments, customer complaints, and ensuring timely corrective action	<ul style="list-style-type: none"> • Is the laboratory willing to cooperate with customers in clarifying the customer's request, in monitoring the laboratory's performance in relation to the work performed and in seeking feedback from its customers? • Does the laboratory have a procedure for handling complaints, non-conformities in the application of the methods and mistakes in data handling and calculation methods, including keeping a documentation thereof? • Does this procedure include an analysis of the source of errors or complaints, and identification of corrective actions as well as the timely implementation of the corrective actions?

6 Online gas analysers

Gaseous fuel or material streams may contain organic carbon substances that give rise to emissions and vary in composition over time. The most common gaseous source stream is natural gas which might exhibit fluctuating composition depending on the Member State or region the installation is situated. There are analytical methods based on chromatographic separation of these substances and subsequent detection of each substance. The most common detectors are e.g. the flame ionisation detector (FID)¹⁵ or the mass spectrometry detector. These allow determination of the composition of the gas online and thus calculation of relevant parameters such as NCV or EF17.¹⁶

Article 32(2) of the MRR requires the operator to obtain the competent authority's approval for the use of equipment where online gas chromatographs or extractive or non-extractive gas analysers are used to determine emissions. To obtain approval the relevant information might best be addressed by using a procedure describing the equipment, the method used for sampling and analysis and the relevant standards. The use of these systems is limited to the determination of composition data of gaseous fuels and materials. As minimum quality assurance measures, the MRR requires that the operator shall ensure that an initial validation and annually repeated validations of the instrument are performed¹⁷.

It is recommended that the operator meets the requirements of EN ISO 9001 and that calibration services and the suppliers of calibration gases are accredited in accordance with EN ISO/IEC 17025. Also, where applicable, the initial and annually repeated validation of the instrument should be carried out by a laboratory accredited in accordance with EN ISO/IEC 17025.

¹⁵ The detection principle of the FID is the oxidation/ionisation of substances. As CO₂ is fully oxidised carbon the FID is insensitive to CO₂. Therefore, this detector is not suitable to detect inherent CO₂ which should be part of the emission factor according to Article 48 of the MRR.

¹⁶ Note that Articles 33 to 35 still apply here as well, subject to the tiers required, the technical feasibility and no incurrence of unreasonable costs. For instance, this means that the sampling frequency would have to follow the provisions in Article 35 and Annex VII. It should furthermore often easily be possible to demonstrate that using an accredited laboratory (Article 34 of the MRR) would incur unreasonable costs.

¹⁷ For more information on the initial validation see [section 8.2](#).

The following standards may be considered:

EN ISO 10723	Natural gas – Performance evaluation for online analytical systems
EN 12619	Stationary source emissions – determination of the mass concentration of total gaseous organic carbon – continuous flame ionisation detector method;
EN ISO 6976	Natural gas – calculation of calorific values, density, relative density and Wobbe index from composition
ISO 6974	Natural gas – determination of composition and associated uncertainty by gas chromatography – Part 6: Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide and C1 to C8 hydrocarbons using three capillary columns

7 Annex I - example sampling plan template

1. General information

Operator name
Installation ID <i>Fill in the installation ID (as used by your regulator)</i>
Title of sampling plan
Reference of procedure

2. Responsibilities

Sampling plan completed by: <i>Fill in the name of the author of the sampling plan</i>
Post or department responsible for sampling: <i>Fill in the name of the post or department responsible for the actual sampling</i>
Laboratory responsible for analysis or department responsible for sampling data: <i>Fill in the name of the laboratory that is responsible for analysis of the sample</i>
Other parties: <i>If applicable, fill in the names of other parties involved in sampling and describe their relevance</i>

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3. Sampling objectives

Sampling objectives: <i>Describe the objective(s) of the sampling, e.g. determination of net calorific value, emission factor, oxidation factor</i>
Analysis required: <i>Describe what the laboratory is testing for, e.g. identify constituents to be tested.</i>

4. Specifications of source stream

Name of material or fuel: <i>Fill in the name of the source stream, as used in the monitoring plan</i>
Characteristics of the source stream: <i>Describe the relevant characteristics, such as its phase (gas, liquid or solid), if relevant common or maximum particle size of the fuel or material, density, viscosity, temperature, etc., if those properties are relevant for the sampling procedure</i>
Source and origin of the material or fuel: <i>Describe the source and origin of the source stream, e.g. is the source stream delivered continuously, in batches, produced on site, etc.?</i>
Heterogeneity of the fuel or material and causes of variability (spatial and in time): <i>Describe the heterogeneity of the fuel or material, both spatial and in time, and justify (e.g. origin of source stream, stability of manufacturing process).</i>

5. Sampling methodology

Sampling frequency: <i>Describe the sampling frequency (e.g. "every Monday morning", "every 3 hours", "once per truck load", "once every 200 tonnes", etc.)</i>
Relevant standards: <i>Describe the relevant standards for the sampling methodology</i>
Define place and point of sampling: <i>Specify the place (e.g. the stockpile) and point of sampling (e.g. after delivery or after completion of a deposit). Please note that the sample should be as representative as possible</i>
Equipment used for sampling: <i>Describe the equipment used for sampling</i>
Sampling approach: <i>Describe how the sample is taken, e.g. by probabilistic or judgmental approach</i>
Sampling pattern: <i>Define how the sample is taken, e.g. in the case of random sampling describe how inaccessible parts of the population are dealt with; define how a probabilistic approach is implemented, and/or how decisions are made for a judgmental approach</i>
Sample composition: <i>Describe whether each increment (amount of material obtained through one single sample action) is analysed individually, or combined with other increments to form a composite sample</i>
Number of increments to be collected: <i>Describe the number of increments that make up a sample</i>

Increment and sample size:

Describe the size of one increment (the amount of material that is obtained through one single sampling action). The increment size should accommodate all particle sizes present. Describe the minimum sample size. The minimum sample size must take into account the level of heterogeneity of individual particles, to ensure representativeness of the sample.

Sample reduction or sub sampling (if applicable):

If the overall sample is too large for transport to a laboratory, a sub-sample should be prepared in such a way that the integrity of the sample is protected. If relevant, describe this procedure and justify the representativeness of the final sample

Justification of representativeness:

Give a justification that the chosen approach leads to a representative sample. Take into account the source stream information and characteristics of the population (i.e. the amount of fuel or material represented by the sample)

Access, health and safety:

Identify access problems or restrictions that may affect the sampling pro-gramme. Identify health and safety precautions

6. Procedures for packaging, preservation, storage and transport**Packaging:**

Briefly describe the size, shape and material of the containers used, taking into account the risk of adsorption/absorption/reaction

Sample coding methodology:

Describe how samples are coded. All sample containers should be marked with a unique identifier that is recognized by sampler and laboratory

Preservation:

<p><i>Justify how samples are packed and transported in such a way that the conditions at the time of sampling are preserved</i></p>
<p>Storage: <i>Describe how the sample is stored on site and in the laboratory</i></p>
<p>Transport: <i>Describe relevant conditions during storage. Describe or refer to a chain of custody form that should be completed and sent with each sample</i></p>
<p>Data storage system: <i>Briefly describe the location and functioning of the data storage system and the information it contains, such as sample date, sample code, stockpile reference number, product type, specific location, size, etc.</i></p>

7. Analytical laboratory

<p>Company: <i>Fill in the name of the laboratory responsible for analyses of the sample</i></p>
<p>EN ISO/IEC 17025 Accreditation: <i>Justify to what extent the scope of accreditation of the laboratory covers analysis of samples described in this sampling plan. If the laboratory is not accredited, please refer to the provided evidence that it meets the relevant criteria of Article 34(3) of the MRR</i></p>
<p>Contact details: <i>Fill in contact details of the analytical laboratory</i></p>
<p>Analyses carried out:</p>

Describe the properties to be analysed (e.g. net calorific value, emission factor, oxidation factor, carbon content)
Standards used: Describe the relevant standards used for each parameter analysed
Data storage system: Briefly describe the location and functioning of the data storage system and the information it contains, such as sample date, sample code, stockpile reference number, product type, specific location, size, etc.

8. Signatures

Operator and laboratory have agreed on the content of this sampling plan; in case of evidence that the described heterogeneity of the source stream differs significantly from the information described above, the sampling plan will be updated and notified to the regulator			
	Name	Signature	Date
Operator			
Analytical laboratory			

8 Annex II – Frequently Asked Questions

8.1 How do I demonstrate tier compliance if the supplier has not provided sufficient information?

In some cases, operators may want to use calculation factors, e.g. NCV, EF, carbon content etc. provided by the supplier of a fuel or material. Sampling and analysis is carried out by the supplier. However, in such a case it is still the operator's responsibility to demonstrate compliance with the requirements of Articles 32 to 35 of the MRR. This may be achieved by obtaining information and evidence surrounding the sampling plan applied by the third party and evidence that representative samples have been analysed by an accredited laboratory using appropriate standards. If the laboratory is not accredited to EN ISO/IEC 17025, evidence for meeting equivalent requirements must be provided. If an operator wants to use supplier data for calculation factors the following steps may be taken:

1. Can evidence be provided that an appropriate sampling plan is in place and that analyses are carried out by an accredited laboratory or by a laboratory meeting the equivalent requirements?
2. If yes, then the operator shall be deemed to meet tier 3 for all relevant calculation factors for which this evidence has been provided.
3. If no, then the analytical values obtained from the supplier cannot be considered to meet tier 3. The operator then can either choose:
 - (a) To analyse himself in accordance with Articles 32 to 35 of the MRR, OR
 - (b) To use available default values. If the tier required for this source stream is lower than tier 3, e.g. in case of a category A installation, then those default values should be used without any further action. If the MRR requires application of tier 3 for the source stream, default values may only be used if the operator can demonstrate that conducting this analysis themselves would incur unreasonable costs or is technically not feasible. Please note that before taking into account any justification for not meeting tier 3 in general, it must be assessed whether applying tier 3 but with a lower frequency of analysis (Article 35 and Annex VII) might avoid the incurrance of unreasonable costs. Where suitable default values are not available and the operator is not able to meet at least tier 1, suggesting that a fall-back approach is required, the operator again must demonstrate that using his

own analyses (in accordance with the required tiers) would incur unreasonable costs or not be technically feasible.

Operators are also required to manage their use of supplier data under their written procedure required for control of out-sourced processes under Article 59(3)(f) of the MRR according to the specific requirements of Article 65 of the MRR.

8.2 Online gas analysers: What is the (initial) validation and how can it be performed?

Article 32(2) of the MRR states: *“Where online gas chromatographs or extractive or non-extractive gas analysers are used to determine emissions, the operator shall obtain the competent authority’s approval for the use of such equipment. The equipment shall be used only with regard to composition data of gaseous fuels and materials. As minimum quality assurance measures, the operator shall ensure that an initial validation and annually repeated validations of the instrument are performed.”*

Article 32(1) of the MRR requires validations for the determination of calculation factors to be carried out by applying methods based on corresponding EN standards. For the use of online chromatographs, this includes EN ISO 10723:2012 Natural gas – performance evaluation for online analytical systems.

This gives the operator some freedom to demonstrate compliance. However, the minimum quality assurance measures for the use of online gas chromatographs, as stated in Article 32(2), are an initial validation and annually repeated validations. The approach described in section 13.5.3 of Annex I to Commission Decision 2007/589/EC establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC (MRG 2007) is still considered appropriate for carrying out initial and ongoing validations, except for the date of initial validation. It stated:

“Where applicable, an initial and annually repeated validation of the instrument shall be carried out by a laboratory accredited against EN ISO 17025:2005 using EN ISO 10723:1995 “Natural gas – Performance evaluation for online analytical systems”. In all other cases, the operator shall commission an initial validation and annual inter-comparison:

a) Initial validation

The validation shall be carried out [before the start of the reporting period or before approval of a new monitoring plan using such online gas analysers]¹⁸ or as part of the commissioning of a new system. It includes an appropriate number of repetitions of the analysis of a set of at least five samples representative for the expected value range

¹⁸ The MRG 2007 referred to the beginning of the 2nd trading period only.

including a blank sample for each relevant parameter and fuel or material in order to characterise the repeatability of the method and to derive the calibration curve of the instrument;

b) Annual inter-comparison

The inter comparison of the results of analytical methods shall be executed once a year by a laboratory accredited according to EN ISO 17025: 2005 involving an appropriate number of repetitions of the analysis of a representative sample using the reference method for each relevant parameter and fuel or material; The operator shall apply conservative adjustments (i.e. avoiding under-estimation of emissions) to all relevant data of the respective year in cases in which a difference is observed between the results derived by the results of the gas analyser or gas chromatograph and the accredited laboratory which might lead to an under-estimation of emissions. Any statistically significant (2σ) differences between the end results (e.g. the composition data) of the gas analyser or gas-chromato-graph and the accredited laboratory shall be notified to the regulator and be immediately resolved under supervision of a laboratory accredited according to EN ISO 17025: 2005.”

This alternative initial method is quite onerous requiring at least 5 representative samples measured several times to check the “calibration curve”. The calibration curve can change significantly with time and the approach outlined in the initial validation should be adopted in the annual inter-comparison. Any statistical deviation (2σ) determined from the inter-comparison could be corrected for if a performance evaluation in line with EN ISO 10723 or a 5-point check were performed. Laboratories carrying out the validations should be used in accordance with Article 34 of the MRR.

Where operators seek approval by the regulator using any other approach than the one provided in the MRG 2007, the regulator may evaluate the proposal in the light of the hierarchy in Article 32(1) of the MRR:

- Apply methods based on corresponding EN standards,
- Where such standards are not available, the methods shall be based on suitable ISO standards or national standards.

Note that [section 6](#) of this guidance document provides a non-exhaustive list of such 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.

8.3 How can it be determined whether a sample taken is “representative”?

It must be kept in mind that representativeness is of utmost importance. The following steps must be considered:

- Analytical samples analysed in a laboratory must be representative for the samples submitted to the laboratory.
- Samples submitted to the laboratory must be representative of the batch¹⁹ of fuel or material they are taken from. For example, a combined sample obtained from mixing individual increments/samples must be representative; weighted instead of simple averages need to be calculated.
- Samples taken from, for example, one batch must be representative for the whole batch.
- The integrity of a sample must be maintained throughout the whole sampling and analysis process (combination of increments/samples, sub-sampling, transport and storage, analytical clean-up/pre-treatment, etc.).

Only if each step is fulfilled, representative values, i.e. valid weighted averages, can be obtained from the analyses.

The appropriate sampling approach to obtain representative samples will depend on material properties, e.g. the homogeneity/inhomogeneity of the material in terms of variability in time or space of the carbon content as well as on sampling techniques, e.g. judgemental or probabilistic sampling, minimum sample size, etc. It must be noted that the appropriate sampling approach depends on the purpose of the analyses. Determining trace metal contaminations will lead to a different sampling approach than determining the carbon content as the main objective (see [section 3.3](#)).

Therefore, the sampling plan for obtaining representative samples should be prepared according to fuel or material specific standards. Where such standards are not available, EN 14899 for sampling waste and the supplementing technical reports CEN/TR 15310 as well as EN 15442 can be considered as suitable starting points for preparing a sampling plan. Where there is doubt or a lack of experience with the fuel or material, it is recommended to take more samples initially and then assess based on analyses and growing experience whether combining samples or taking less samples per batch is appropriate without a significant loss of accuracy.

¹⁹ Article 3(33) of the MRR: “batch means an amount of fuel or material representatively sampled and characterised, and transferred as one shipment or continuously over a specific period of time”

Furthermore, it is recommended to keep a sampling record documenting any deviations from the sampling plan and observations made during sampling (e.g. colour, odour, etc.). The sampling record, along with the “chain of custody” document that accompanies the samples sent to the laboratory for analysis, are all traceable back to the sampling plan. It is advisable to check with the chosen analytical laboratory that the packaging, transportation and storage procedures are appropriate to protect the integrity of the sample. CEN/TR 14310-4 is a useful source of guidance on sample packaging, storage, preservation, transport and delivery.

Please note that although those standards are suitable sources for sampling solid or liquid materials, they may fail to provide proper guidance for sampling gaseous fuels. Sampling gaseous fuels is problematic since those fuels cannot be stored easily. In most cases sampling is directly coupled to analysis, e.g. by use of an online gas analyser. Particularly in the case of highly fluctuating gas flows and changes of the composition, continuous sampling is required to obtain representative results (e.g. by use of EN ISO 10723:2012 “Natural gas – Performance evaluation for online analytical systems”). If sampling continuously is technically not feasible or would incur unreasonable costs, the proposed alternative sampling approach providing representative results can be based on e.g. proven correlations such as that a high-volume flow or a specific composition occur under certain conditions during a production process or cycle.

8.4 How to proceed if the application of tier 3 incurs unreasonable costs?

If an operator is required to use tier 3 for calculation factors and demonstrates that the application of Articles 32 to 35 of the MRR would incur unreasonable costs, the following steps must be taken:

- Check if the application of a lower frequency of analyses than the one required by Annex VII or determined by the “1/3” rule would still incur unreasonable costs. Note that recital 16 of the MRR requires operators to always strive to reach highest achievable tier. Therefore, even if the application of the “1/3” rule or the incurrance of unreasonable costs results in analysing just once a year,²⁰ this may still be a more accurate and reliable monitoring approach than deferring to lower tiers since site-specific values are obtained.
- It should be stressed here that only those costs that are additional to a reference system should be considered (for details see section 3.6.2 of ‘UKETS01 MRR – General guidance for installations). This means that e.g. costs related to sampling

²⁰ Please note that analysing once a year must not be confused with sampling just once a year, i.e. the frequency of taking samples or increments from a batch or delivery of a fuel or material. In general, a lot more samples/increments have to be taken over the year to obtain representative results.

can only be considered if sampling is not already undertaken for other purposes. Note that costs up to £2,000 per year (£500 for installations with low emissions) cannot be considered to incur unreasonable costs. Furthermore, it must be noted that a lower frequency of analyses may lead to a revision of the sampling plan. This is because the analytical values still must be representative for the batches or period that the samples are taken from. This makes the preparation of composite samples and sub-sampling more demanding.

- If carrying out analyses in accordance with Articles 32 to 35 and a frequency of at least once per year still incurs unreasonable costs, the operator is allowed to consider lower tiers, i.e. tier 2 or tier 1 default values.
- Only if no suitable default values are available can the operator propose an appropriate fall-back methodology.

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