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DIRECTORATE-GENERAL
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Unit C.2 – Governance and Effort Sharing

Guidance Document

The Monitoring and Reporting Regulation – Guidance on Sampling and Analysis

MRR Guidance document No. 5,

Updated version of 7 October 2021

This document is part of a series of documents provided by the Commission services for supporting the implementation of the "Monitoring and Reporting Regulation" (the "MRR" or "M&R Regulation") for the EU ETS (the European greenhouse gas Emission Trading System). A new version of the MRR has been developed for the use in the 4th phase of the EU ETS, i.e. Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 in its current version[1].

The guidance represents the views of the Commission services at the time of publication. It is not legally binding.

This guidance document takes into account the discussions within meetings of the informal Technical Working Group on MRVA (Monitoring, Reporting, Verification and Accreditation) under the WG III of the Climate Change Committee (CCC), as well as written comments received from stakeholders and experts from Member States. This guidance document was unanimously endorsed by the representatives of the Member States of the Climate Change Committee by written procedure ending on 28th of September 2021.

All guidance documents and templates can be downloaded from the Commission's website at the following address:
https://ec.europa.eu/clima/policies/ets/monitoring_en#tab-0-1.

[1] Updated by Commission Implementing Regulation (EU) 2020/2085 of 14 December 2020 amending and correcting Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council; the consolidated MRR can be found here:
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018R2066-20210101
Note: as some amendments to the MRR will start to apply on 1 January 2022 (see section 1.2 of GD 1 "What is new in the MRR"), they do not appear in the consolidated version in 2021. The complete amendment can be found under https://eur-lex.europa.eu/eli/reg_impl/2020/2085/oj

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Version History

Date	Version status	Remarks
5 Oct 2012	published	Endorsed by CCC on 28 September 2012
27 November 2017	re-published	Correct reference to updated Annex VII of the MRR; update of references to standard and legislation; wording updates (e.g. chapter 5 on equivalence of laboratories)
7 October 2021	Updated version endorsed by CCC	Revision: move from MRR 2012 to MRR 2018, including its revision in 2020, i.e. revision for use in the 4th phase of the EU ETS Clarification on the "1/3" rule in section 4.2 Clarification in chapter 6 on the relation between online gas analysers and the provisions in Articles 33 to 35 Inclusion of Frequently Asked Questions

1 INTRODUCTION

1.1 About this document

This document is part of a series of guidance documents provided on specific topics of monitoring and reporting under the EU ETS. While Guidance Document No. 1 provides a general overview on monitoring and reporting of emissions from installations under the EU ETS, this document (Guidance Document No. 5) explains in more detail the requirements for laboratory analyses. It has been written to support the M&R Regulation as well as the Guidance Document No. 1, by explaining its requirements in a non-legislative language. However, it should always be remembered that the Regulation is the primary requirement.

This document interprets the Regulation regarding requirements for installations. It builds on guidance and best practice identified during earlier phases of the EU ETS.

It also takes into account the valuable input from the task force on monitoring and reporting established under the EU ETS Compliance Forum, and from the informal Technical Working Group on Monitoring, Reporting, Verification and Accreditation (TWG on MRVA) of Member State experts established under the Working Group 3 (WG III) of the Climate Change Committee.

1.2 How to use this document

Where article numbers are given in this document without further specification, they always refer to the M&R Regulation (MRR) in its current version[2].For acronyms, references to legislative texts and links to further important documents, please see the Annex.

This document only refers to emissions starting from 2021 (with the exception of biomass-related topics, which will apply in full only from 2022). A "*New!*" symbol (such as on the margin here) indicates where changes to requirements compared to the MRR 2012 have taken place.

This symbol points to important hints for operators and competent authorities.

This indicator is used where significant simplifications to the general requirements of the MRR are promoted.

The light bulb symbol is used where best practices are presented.

The small installation symbol is used to guide the reader to topics which are applicable for installations with low emissions.

The tools symbol tells the reader that other documents, templates or electronic tools are available from other sources (including those still under development).

The book symbol points to examples given for the topics discussed in the surrounding text.

[2] Implementing Regulation (EU) 2018/2066; The consolidated MRR can be found here: https://eur-lex.europa.eu/eli/reg/2018/2066

1.3 Where to find further information

All guidance documents and templates provided by the Commission on the basis of the M&R Regulation and the A&V Regulation can be downloaded from the Commission's website at the following address:

https://ec.europa.eu/clima/policies/ets/monitoring_en#tab-0-1

The following documents are provided[3]:

- "Quick guides" as introduction to the guidance documents below. Separate documents are available for each audience:
  - Operators of stationary installations;
  - Aircraft operators;
  - Competent Authorities;
  - Verifiers;
  - National Accreditation Bodies.
- Guidance document No. 1: "The Monitoring and Reporting Regulation – General guidance for installations". This document outlines the principles and monitoring approaches of the MRR relevant for stationary installations.
- Guidance document No. 2: "The Monitoring and Reporting Regulation – General guidance for aircraft operators".
- Guidance document No. 3: "Biomass issues in the EU ETS": This document discusses the application of sustainability criteria for biomass, as well as the requirements of Articles 38 and, 39 of the MRR. This document is relevant for operators of installations as well as useful background information for aircraft operators.
- Guidance document No. 4: "Guidance on Uncertainty Assessment". This document for installations gives information on assessing the uncertainty associated with the measurement equipment used, and thus helps the operator to determine whether he can comply with specific tier requirements.
  - Guidance document No. 4a: "Exemplar Uncertainty Assessment". This document contains further guidance and provides examples for carrying out uncertainty assessments and how to demonstrate compliance with tier requirements.
- Guidance document No. 5: "Guidance on Sampling and Analysis" (only for installations). This document deals with the criteria for the use of non-accredited laboratories, development of a sampling plan, and various other related issues concerning the monitoring of emissions in the EU ETS (this document).
  - Guidance document No. 5a: "Exemplar Sampling Plan". This document provides an example sampling plan for a stationary installation.
- Guidance document No. 6: "Data flow activities and control system". This document discusses possibilities to describe data flow activities for monitoring in the EU ETS,

[3] This list reflects the status at the time of writing this updated guidance. Further documents may be added later.

the risk assessment as part of the control system, and examples of control activities. It is relevant to installations as well as for aircraft operators.

- Guidance document No. 6a: “Risk Assessment and control activities – examples”. This document provides further guidance and an example for a risk assessment.

- Guidance document No. 7: “Continuous Emissions Monitoring Systems (CEMS)”. For stationary installations, this document gives information on the application of measurement-based approaches where GHG emissions are measured directly in the stack, and thus helps the operator to determine which type of equipment has to be used and whether he can comply with specific tier requirements.
- Guidance document No. 8: “EU ETS Inspections”. This document provides guidance for competent authorities for carrying out inspections. It mainly focusses on site-visit inspections of stationary installations.

The Commission furthermore provides the following electronic templates:

- Template No. 1: Monitoring plan for the emissions of stationary installations
- Template No. 2: Monitoring plan for the emissions of aircraft operators
- Template No. 3: Monitoring plan for the tonne-kilometre data of aircraft operators
- Template No. 4: Annual emissions report of stationary installations
- Template No. 5: Annual emissions report of aircraft operators
- Template No. 6: Tonne-kilometre data report of aircraft operators
- Template No. 7: Improvement report of stationary installations
- Template No. 8: Improvement report of aircraft operators

There are furthermore the following **tools** available for operators:

- Unreasonable costs determination tool;
- Tool for the assessment of uncertainties;
- Frequency of Analysis Tool;
- Tool for operator risk assessment.

The following MRR **training material** is available for operators:

- Roadmap through M&R Guidance
- Uncertainty assessment
- Unreasonable costs
- Sampling plans
- Data gaps
- Round Robin Test

Besides these documents dedicated to the MRR, a separate set of guidance documents on the A&V Regulation is available under the same address.

All EU legislation is found on EUR-Lex: **http://eur-lex.europa.eu/**

The most important legislation is furthermore listed in the Annex of this document.

Also, competent authorities in the Member States may provide useful guidance on their own websites. Operators of installations should in particular check if the competent authority provides workshops, FAQs, helpdesks etc.

2 OVERVIEW

2.1 Overview of this document

Note: This document is only relevant for installations which determine calculation factors by analyses, or – regarding the competence requirements of laboratories – apply on-line gas analysers or continuous emission measurement systems (CEMS).

This document provides an overview of the importance of sampling and analysis and how this topic is treated in the MRR. In particular, the MRR uses the term “analyses in accordance with Article 32 to 35” on several occasions where calculation factors are to be determined by analysis (usually in the context of high tier approaches). Section 2.2 provides an introduction to this topic. Section 2.3 then gives a more detailed summary of the MRR’s requirements for analyses, and explains also how those requirements relate to situations where the MRR allows the use of “industry best practice”.

Chapter 3 gives guidance on the requirements of Article 33 for preparing a sampling plan. Chapter 4 discussed how to determine the appropriate frequency of analyses based on Article 35.

Thereafter the requirements for laboratories used to carry out analyses for the determination of calculation factors as laid down in Article 34 are elaborated in Chapter 5. This focusses particularly on the possibilities to demonstrate equivalence to an accredited service, if the laboratory is not accredited in accordance with EN ISO/IEC 17025.

Annex II supplements Chapters 3 and 4 by providing an example of a sampling plan template.

2.2 Calculation factors – Principles

[This section is based on section 6.2 of Guidance Document 1 (general guidance for installations). It is included here for reasons of completeness and to allow this to be read as a self-standing document.]

Calculation factors are the focus of this paper. These factors are:

- In the case of the standard methodology for combustion of fuels, or fuels used as process input: Emission factors, net calorific values, oxidation factors and biomass fractions;
- In the case of the standard methodology for process emissions (in particular decomposition of carbonates): Emission factors and conversion factors;
- For mass balances: Carbon contents and, if applicable, the biomass fractions and net calorific values.

The following formula shows how the calculation factors relate to the calculation of emissions. The example relates to the most common case, i.e. emissions from the combustion of fuels, using the standard calculation method in accordance with Article 24(1):

Example: Calculation-based monitoring of combustions of fuels

$$Em = AD \cdot NCV \cdot EF \cdot OF \cdot (1 - BF)$$

Where:

Em ..... Emissions [t CO_2]

AD..... Activity data (= fuel quantity) [t or Nm^3]

Calculation factors:

NCV.... Net Calorific Value [TJ/t or TJ/Nm^3]

EF ..... Emission factor [t CO_2/TJ, t CO_2/t or t CO_2/Nm^3]

OF..... Oxidation factor [dimensionless]

BF ..... Biomass fraction [dimensionless]

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

a. from **default values** (see section 6.2.1 of guidance document No. 1); or

b. by **laboratory analyses**.

The applicable tier will determine which of these options is used. Lower tiers allow for default values, i.e. for 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 of course more accurate. The result of the analysis is valid for each batch from which the sample has been taken, while a default value is usually an average or conservative value determined on the basis of big quantities of that material. For example, emission factors for coal as used in national inventories might be applicable to a country-wide average of several (or even many) coal types as used also in energy statistics, while an MRR analysis will be valid for the particular batch analysed (one coal type).

Important note: In all cases, the operator must ensure that activity data and all calculation factors are used consistently. 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 taken into account appropriately, for arriving at 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 mass[4].

New!

With respect to biomass source streams, the operator has to determine the biomass fractions only for mixed fuels or materials. For the biomass fraction of all other fuels or materials, the operator may use either a default value of 100% where the fuel or material consists exclusively of biomass, or a default value of 0% for fossil fuels or material. However, Article 38(5) stipulates that the operator may only apply an emission factor of

[4] See section 4.3.1 of guidance document No. 1

zero (i.e. a biomass fraction of 100%) for biomass if he can demonstrate that biofuels, bioliquids and biomass fuels used for combustion comply with the sustainability and the greenhouse gas emissions saving criteria of the RES Directive[5]. For further guidance on biomass related topics, please see section 6.3.5 of Guidance Document 1 and Guidance Document 3.

2.3 General requirements for 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, in order to ensure valid and comparable results at a high quality level. In particular, the following points need consideration:

- The laboratory must demonstrate its competence. This is achieved by one of the following approaches:
  - 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) 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.
- The way samples are taken from the material or fuel to be analysed is considered crucial for receiving *representative* results.[6] Therefore, operators have to develop sampling plans in the form of written procedures (see Chapter 3) and get them approved by the competent authority. Note that this applies also where the operator does not carry out the sampling himself, but treats it as an outsourced process.
- Analytical methods usually have to follow international or national standards[7].

Note that the above is usually related to the highest tiers for calculation factors. Therefore, these rather demanding requirements are rarely applicable to smaller installations. In particular operators of installations with low emissions may use "any laboratory that is technically competent and able to generate technically valid results using the relevant analytical procedures, and that 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 and corrective actions, if needed, for calibration and

[5] For this purpose, the "RED II" (Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)) will have to be used from 1 January 2022. In 2021, the RED I (Directive 2009/28/EC) still applies. For more details, see guidance document No. 3.

[6] Question 4.3 of the FAQ document may provide further helpful information on how to determine whether a sample is "representative". The FAQs can be downloaded under the following link: https://ec.europa.eu/clima/sites/clima/files/ets/monitoring/docs/faq_mmr_en.pdf

[7] For the use of standards, Article 32(1) 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."

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 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. In some cases, this is the lowest tier where no default values are applicable. In such cases, where despite approval to apply a lower tier methodology analyses are still required, it may not be appropriate or possible to apply Articles 32 to 35 in full. However, the competent authority should deem the following as minimum requirements:

Simplified!

- 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 that provides evidence for quality assurance measures and corrective actions, if needed, as referred to in Article 34(3).
- The operator should submit a sampling plan in accordance with Article 33.
- The operator should determine the frequency of analysis in accordance with Article 35.

2.4 Procedures for analytical methods

Annex I of the MRR requires that a monitoring plan shall contain, if applicable, a list of the analytical methods to be used for the determination of all relevant calculation factors for each source streams, and a description of the written procedures for those analyses. How such procedures can be described in the monitoring plan is shown by the following example.

Example of the required MP summary for an analysis procedure:

Item according to Article 12(2)	Possible content (examples)
Title of procedure	Analysis of NCV of solid and liquid fuels.
Reference for procedure	Solid fuels: ANA 1-1/UBA; Liquid fuels: ANA 1-2/UBA; Comparison by external (accredited) laboratory: ANA 1-3/ext
Diagram reference (where applicable)	N.A.
Brief description of procedure	Bomb calorimeter method is used. Appropriate amount of sample is based on experience from earlier measurements of similar materials. Samples are used in dry state (dried at 120°C for at least 6h). NCV is corrected for moisture content by calculation. Solid fuels: as in standard. Liquid fuels: Only slightly adapted from standard; samples are not dried.
Post or department responsible for the procedure and for any data generated	Company's Laboratory - Head of department. Deputy: HSEQ manager.

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

Location where records are kept	Hardcopy: Laboratory Office, shelf 27/9, Folder identified “ETS 01-ANA-yyyy” (where yyyy is the current year). Electronically: “P:\ETS_MRV\labs\ETS_01-ANA-yyyy.xls”
Name of IT system used (where applicable).	Internal log of the lab (MS Access database): sample numbers and origin/name of sample are tracked together with the results.
List of EN or other standards applied (where relevant)	EN 14918:2009 with modifications for using also for non-biomass and liquid fuels.

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.

This 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 have to be taken over the year to obtain representative results. This Chapter 3 and its sections only deal 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 wherever something is to be analysed in a laboratory. It is crucial 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 to a large extent 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 EU 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 50 ml 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 50 kg 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, in order 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 green boxes as red ones, each 2x2 increment may contain different numbers of green and red ones. 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 green and red boxes for analysis).

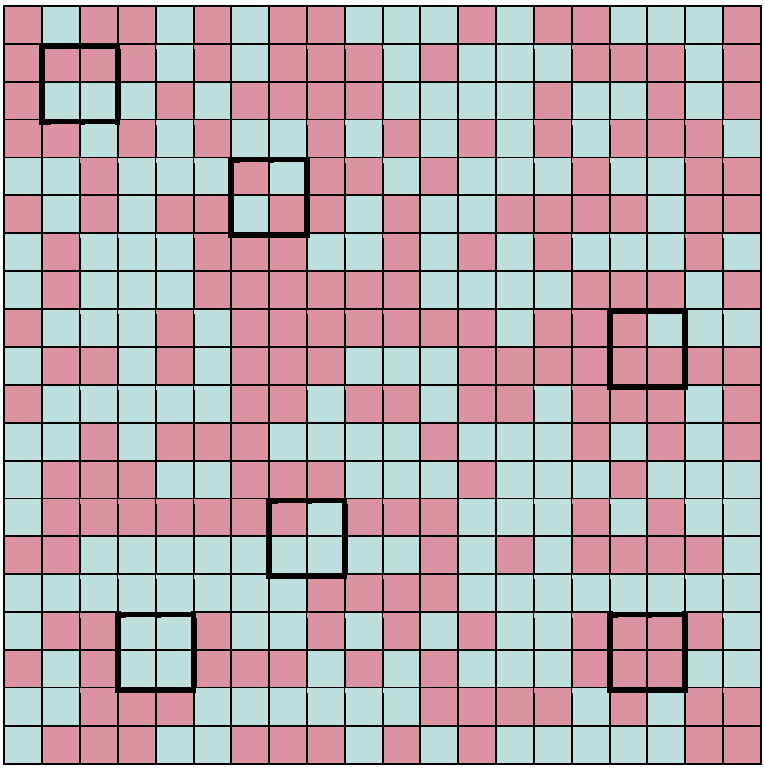

Figure 1: Example of a random two-component mixture with highly uniform particle size distribution. The bold squares illustrate possible samples to be taken.

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.

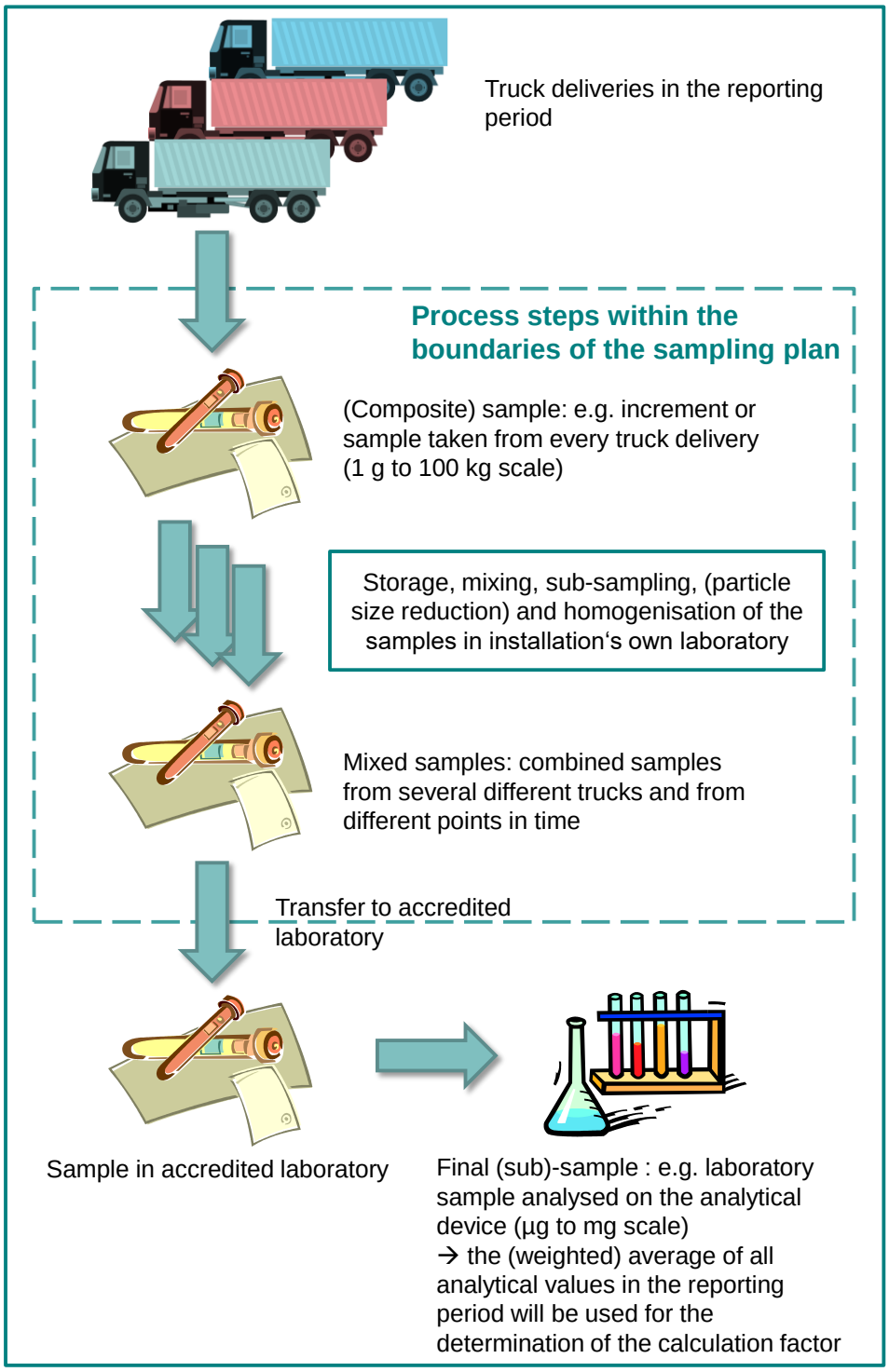

Figure 2: Example of a flow sheet for sampling and analyses

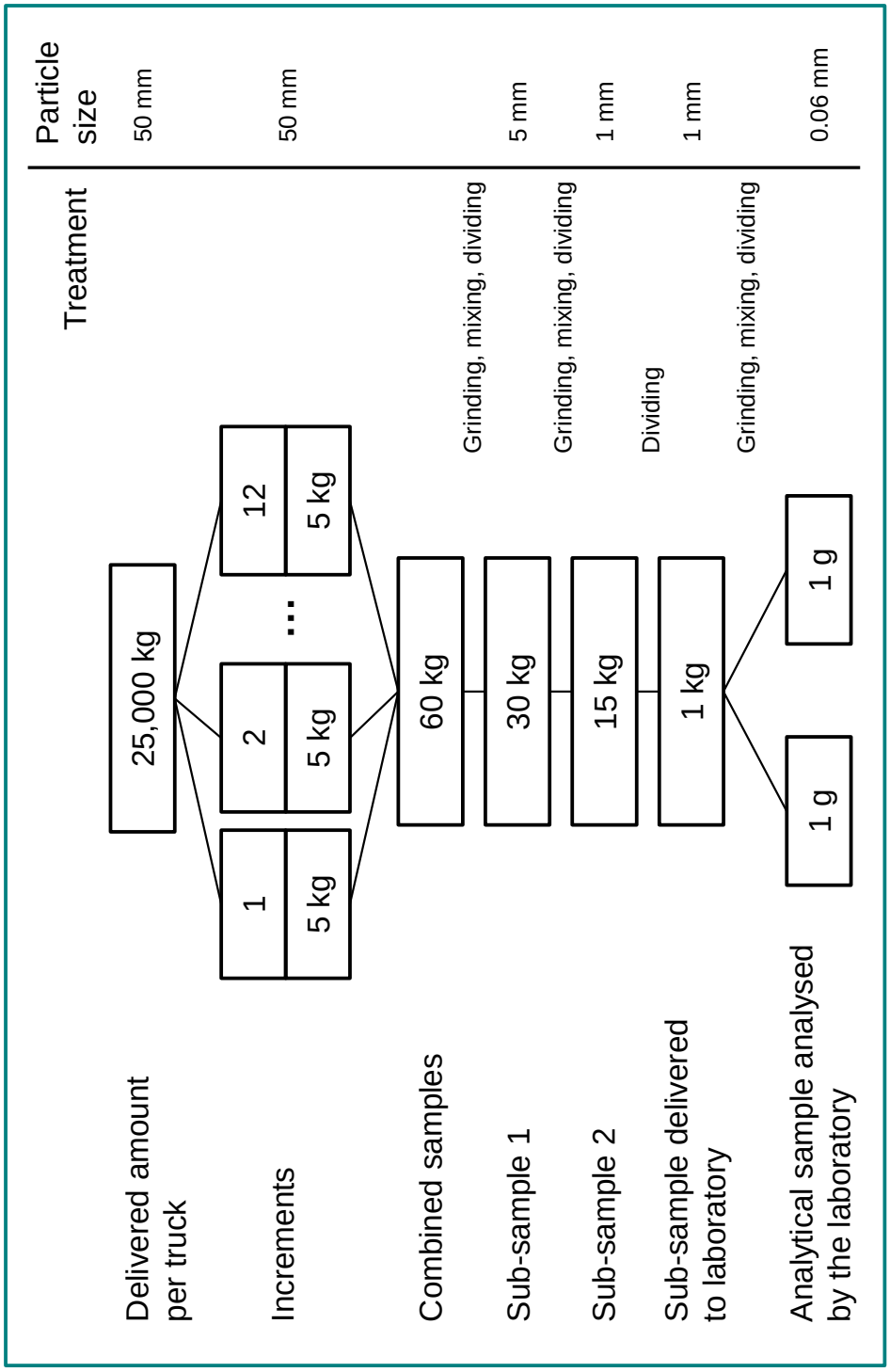

Figure 3. *Example of a sampling plan flow sheet for the determination of the carbonate content of clay*

Generally, all standards containing provisions for preparing sampling plans are suitable, in particular 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, in particular 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 in agreement with the laboratory carrying out the analysis for the respective fuel or material (see Chapter 5) and subject to the approval of the competent authority.

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

3.2 Sampling plan requirements of the MRR

For putting the above into practice in a practical and consistent manner, Article 33 requires the operator to submit a sampling plan to the competent authority 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 has to 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 of analytical values thereof allow the determination of representative calculation factors, e.g. that sampling and analysis of the carbon content[9] 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 in particular 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 party[10]. In any event, the operator is responsible for correct sampling defined in an appropriate sampling plan in accordance with Article 33 regardless whether sampling or analysis is carried out by the operator or by third parties.

[9] As pointed out in section 6.3.1 of Guidance document No. 1, the emission factor is based on the carbon content of a fuel or material. Carbon content is the primary object of analysis.

[10] See FAQ 1 in section 9.1)

Example for 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
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 the waste department of the installation's laboratory[11]
Brief description of the procedure[12]	• 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	Hardcopy: Laboratory Storage Room, shelf 27/9, Folder identified "ETS 01-SP". Electronically: "P:\ETS_MRV\Analyses\ETS_01-SP.xls"
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 competent authority 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 this is 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 from 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. This should be one of the first steps. In the most general case, 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 takes into account 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? E.g. 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 in a pile of several metres 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, the Annex of this document contains an example of a template for a sampling plan.

4 FREQUENCY OF ANALYSES

According to Article 35 the operator has to 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 in section 4.1);
- 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 with regard to 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 competent authority may agree with the operator a more appropriate schedule for analyses. However, this approach has to result in a comparable uncertainty as the approach based on the "1/3" rule presented above (see section 4.4).

New!

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, oilfield and gasfield 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

Fuel/material	Minimum Frequency of Analyses
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 (see section 4.1) if any variation in the analytical values[13] for the respective fuel or material does not exceed 1/3 of the uncertainty value to which the operator has to adhere with regard to the activity data determination of the relevant fuel or material. The determination of this variation has to 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 III of Guidance Document 4 on Uncertainty):

$$u_{\text{total}} = \frac{\sqrt{(u_1 \cdot x_1)^2 + (u_2 \cdot x_2)^2 + ... + (u_n \cdot x_n)^2}}{\left| x_1 + x_2 + ... + x_n \right|}$$

where:

u_i.....relative uncertainty of the analytic value of sample i

x_i.....sample 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:

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

where:

n .....number 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:

[13] The term 'variation of the analytical values' in this section comprises all of the following three elements: 1) the variation of the actual value over time, 2) the analytical error to determine the value and 3) the sampling and any further errors. No distinction is made as to which of those contributes the most to the historic variation observed. Further background information can be found in the training material on sampling, which can be downloaded from:
https://ec.europa.eu/clima/sites/default/files/ets/monitoring/docs/sampling_training_material_en.pdf

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

This approach has been successfully implemented in an Excel based tool provided by the Netherlands. It can be downloaded from **https://ec.europa.eu/clima/policies/ets/monitoring_en#tab-0-1**

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 (±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	42,4
7	42,68
8	42,6
9	42,02
10	42,33
11	42,41
12	42,2
average	**42.4**
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)[14] 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.

New!

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 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 with regard to the activity data determination of the relevant fuel or material. The operator has to demonstrate to the satisfaction of the competent authority that he complies 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 euro 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 costs, please see section 4.6.1 of Guidance Document 1 (General Guidance for Installations).

Example: The heavy fuel oil source stream above emits about 40,000 tonnes of CO_2 annually. The costs for the analyses have to exceed the benefit in order to be regarded as unreasonable. If the costs are lower they are not unreasonable:

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

[14] Article 3(6): '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;

where:

C ..... Costs [€/year]

P ..... specified allowance price = 20 € / t $CO_{2(e)}$

AEm .... Average emissions from related source stream(s) [t $CO_{2(e)}$/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 4.4 of the FAQ document[15] 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, incurs unreasonable costs. Furthermore, the Commission has published a tool ("Unreasonable costs determination tool") on the MRVA website (see link in section 1.3).

4.4 Analyses frequency for specific situations

New!

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 competent authority may agree with the operator a more appropriate schedule for analyses. Nonetheless, it has to be assured that the approach the operator and the competent authority 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).

[15] https://ec.europa.eu/clima/sites/clima/files/ets/monitoring/docs/faq_mmr_en.pdf

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 competent authority that access to accredited laboratories is technically not feasible or would incur unreasonable costs. In this case also non-accredited laboratories may be used provided that they meet the requirements listed in Article 34(3). 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 is capable of managing 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) lists the topics on which evidence is to be provided. Table 2 lists elements which the competent authority should take into account when assessing an operator's proposed evidence on the laboratory he uses.

Note: Article 47(7) 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), on which competence needs to be demonstrated	Important elements for the competent authority to assess (non-exhaustive)
(a) Management of the personnel's competence for the specific tasks assigned	• Is 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 implemented (especially for new personnel)?

Element of Article 34(3), on which competence needs to be demonstrated	Important elements for the competent authority to assess (non-exhaustive)
(b) suitability of accommodation and environmental conditions	• 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	• 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	• 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 covered by international or national standards	Note: These requirements only apply if the operator's monitoring plan requires analyses which are not yet established, or where no standards are available. • 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 from the matrix of the sample/test object.
(f) uncertainty estimation	• 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?
(g) management of equipment, including procedures for calibration, adjustment, maintenance and repair of equipment, and record keeping thereof	• 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?

Element of Article 34(3), on which competence needs to be demonstrated	Important elements for the competent authority to assess (non-exhaustive)
(h) management and control of data, documents and software	• Is an adequate procedure for checking calculations and data transfer on a regular basis implemented and are the corrective actions in case of encountered mistakes specified?
(i) management of calibration items and reference materials	• 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? • 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 schemes, applying analytical methods to certified reference materials, or inter-comparison with an accredited laboratory	• 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 outsourced processes	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	• 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)[16] 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 EF[17].

Article 32(2) 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 performed[18].

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.

The following standards may be considered:

EN ISO 10723: Natural gas – Performance evaluation for on-line 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;

[16] The detection principle of the FID is the oxidation/ionisation of substances. As CO_2 is fully oxidised carbon the FID is insensitive to CO_2. Therefore this detector is not suitable to detect inherent CO_2 which should be part of the fuels emission factor according to Article 48.

[17] 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) would incur unreasonable costs.

[18] For more information on the initial validation see FAQ No.2, section 9.2.

7 ANNEX I: ACRONYMS AND LEGISLATION

7.1 Acronyms used

CA ..... Competent Authority

CEMS..... Continuous Emission Measurement System

EF..... Emission factor

EU ETS ..... EU Emission Trading Scheme

GD..... Guidance Document

MP..... Monitoring Plan

MRR ..... Monitoring and Reporting Regulation (M&R Regulation)

MRV ..... Monitoring, Reporting and Verification

MRVA..... Monitoring, Reporting, Verification and Accreditation

MS..... Member State(s)

NCV..... Net calorific value

7.2 Legislative texts

EU ETS Directive: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, as amended. Download of the consolidated version:
https://eur-lex.europa.eu/eli/dir/2003/87/2020-01-01

M&R Regulation: Commission Implementing Regulation (EU) No. 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 and amending Commission Regulation (EU) No. 601/2012. Download under: **https://eur-lex.europa.eu/eli/reg_impl/2018/2066/oj** and latest amendment under:
https://eur-lex.europa.eu/eli/reg_impl/2020/2085/oj

A&V Regulation: Commission Implementing Regulation (EU) No. 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, as amended. Download of consolidated version:
https://eur-lex.europa.eu/eli/reg_impl/2018/2067/2021-01-01

RES Directive (RED II): Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast). Download under:
https://eur-lex.europa.eu/eli/dir/2018/2001/oj

8 ANNEX II: EXAMPLE FOR A SAMPLING PLAN TEMPLATE

1. General information

Operator name:
Installation ID: *Fill in the installation ID (as used by your competent authority)*
Title of sampling plan:
Reference of procedure:

2. Responsibilities

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

3. Sampling objectives

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

4. Specifications of source stream

Name of material or fuel: *Fill in the name of the source stream, as used in the monitoring plan*
Characteristics of the source stream: *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*
Source and origin of the material or fuel: *Describe the source and origin of the source stream, e.g. is the source stream delivered continuously, in batches, produced on site, etc.?*
Heterogeneity of the fuel or material and causes of variability (spatial and in time): *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).*

5. Sampling methodology

Sampling frequency: *Describe the sampling frequency (e.g. "every Monday morning", "every 3 hours", "once per truck load", "once every 200 tonnes", etc.)*
Relevant standards: *Describe the relevant standards for the sampling methodology*
Define place and point of sampling:

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
Equipment used for sampling: *Describe the equipment used for sampling*
Sampling approach: *Describe how the sample is taken, e.g. by probabilistic or judgmental approach*
Sampling pattern: *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*
Sample composition: *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*
Number of increments to be collected: *Describe the number of increments that make up a sample*
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 programme. 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: *Justify how samples are packed and transported in such a way that the conditions at the time of sampling are preserved*
Storage: *Describe how the sample is stored on site and in the laboratory*
Transport: *Describe relevant conditions during storage. Describe or refer to a chain of custody form that should be completed and sent with each sample*
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.*

7. Analytical laboratory

Company: *Fill in the name of the laboratory responsible for analyses of the sample*
EN ISO/IEC 17025 Accreditation: *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)*
Contact details: *Fill in contact details of the analytical laboratory*
Analyses carried out: *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*

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 competent authority

	Name	Signature	Date
Operator			
Analytical laboratory			

9 ANNEX III – FREQUENTLY ASKED QUESTIONS

9.1 Supplier data: What if the supplier does not provide sufficient information for demonstrating compliance with the required tiers?

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. 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 has to 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, 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 analysing himself 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 has to be assessed whether applying tier 3 but with a lower frequency of analysis (Article 35 and Annex VII) might avoid the incurrence 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 has to 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) according to the specific requirements of Article 65.

9.2 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) 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 of MRG 2007 is still considered appropriate for carrying out initial and ongoing validations. 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][19] 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 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-chromatograph and the accredited laboratory shall be notified to the competent authority

[19] The MRG 2007 here referred to the beginning of the 2nd trading period only.

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.

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

- 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.

9.3 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 have to 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 batch[20] 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.

[20] Article 3(33): "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"

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 has to 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. of this guidance document).

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. In the case of doubt or a lack of experience with the fuel or material, it is recommended to take more samples at first and then assess on the basis of analyses and growing experience whether combining samples or taking less samples per batch is appropriate without a significant loss of accuracy.

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,..). The sampling record, along with the “chain of custody” document that accompanies the samples that are 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 the use of an online gas analyser. In particular, in the case of highly fluctuating gas flows and changes of the composition, continuous sampling is required to obtain representative results (e.g. by the 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.

9.4 How to proceed if the application of tier 3, i.e. analysis in accordance with Articles 32 to 35, 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 would incur unreasonable costs, the following steps have to 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 incurrence of unreasonable costs results in analysing just once a year[21] this may still be considered to 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 taken into account (For details see Guidance document No.1 and the FAQs contained therein). This means that e.g. costs related to sampling can only be taken into account if it is not already done 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 has to be noted that a lower frequency of analyses may lead to a revision of the sampling plan. This is because the analytical values still have to be representative for the batches or time period which 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, the operator has to propose an appropriate fall-back methodology.

[21] 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.