EUROPEAN COMMISSION
DIRECTORATE-GENERAL
CLIMATE ACTION
Directorate A – International and Climate Strategy
CLIMA.A.3 - Monitoring, Reporting, Verification

Guidance Document

The Monitoring and Reporting Regulation – Guidance on Uncertainty Assessment

MRR Guidance document No. 4, Final Version of 5 October 2012

This document is part of a series of documents provided by the Commission services for supporting the implementation of Commission Regulation (EU) No. 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council[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 the Monitoring and Reporting Regulation under the WGIII of the Climate Change Committee (CCC), as well as written comments received from stakeholders and experts from Member States. This guidance document was endorsed by written procedure closing 28th September 2012, by the Climate Change Committee representatives of all Member States except one.

All guidance documents and templates can be downloaded from the Commission's website at the following address:
http://ec.europa.eu/clima/policies/ets/monitoring/index_en.htm.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:181:0030:0104:EN:PDF

TABLE OF CONTENTS

1 INTRODUCTION

1.1 About this document

This document is part of a series of guidance documents provided by the Commission services 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 and GD2 presents similar guidance for aircraft operators, this document (Guidance Document No. 4) explains in more detail the requirements for uncertainty assessments for installations. It has been written to support the M&R Regulation, as well as Guidance Document No. 1, by explaining 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 also builds on guidance and best practice developed during the first two phases of the EU ETS (2005 to 2007 and 2008 to 2012), in particular the experience gathered by the Member States based on the MRG 2007 including a set of guidance notes known as the ETSG[2] guidance notes developed under the framework of IMPEL.

It also takes into account the valuable input from the task force on monitoring established under the EU ETS Compliance Forum, and from the informal technical working group (TWG) of Member State experts established under the working group 3 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. For acronyms used, references to legislative texts and links to further important documents please see the Annex 1.

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).

---

[2] ET support group; IMPEL is the European Union Network for the Implementation and Enforcement of Environmental Law. The notes are found at http://impel.eu/projects/emission-trading-proposals-for-future-development-of-the-eu-ets-phase-ii-beyond.

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

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:

http://ec.europa.eu/clima/policies/ets/monitoring/documentation_en.htm

The following documents are provided[3]:

- 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". This document outlines the principles and monitoring approaches of the MRR relevant for the aviation sector. It also includes guidance on the monitoring plan templates provided by the Commission.
  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, 39 and 53 of the MRR. This document is relevant for operators of installations as well as for aircraft operators.
- Guidance document No. 4 (this document): "Guidance on Uncertainty Assessment". This document does include some repetition of the guidance given in Guidance Document 1, the General Guidance for installations, in order to allow stand-alone reference.
- 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.
- 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, 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.

The Commission furthermore provides the following electronic templates[4]:

- 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

[3] This list is at the current stage non-exhaustive. Further documents may be added later.
[4] This list is at the current stage non-exhaustive. Further templates may be added later.

- 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

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 RELEVANCE OF UNCERTAINTY ASSESSMENT

2.1 What is uncertainty?

[This section is identical with section 4.7 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.]

When somebody would like to ask the basic question about the quality of the MRV system of any emission trading system, he would probably ask: "How good is the data?" or rather "Can we trust the measurements which produce the emission data?" When determining the quality of measurements, international standards refer to the quantity of "uncertainty". This concept needs some explanation.

There are different terms frequently used in a similar way as uncertainty. However, these are not synonyms, but have their own defined meaning:

- **Accuracy**: This means closeness of agreement between a measured value and the true value of a quantity. If a measurement is accurate, the average of the measurement results is close to the "true" value (which may be e.g. the nominal value of a certified standard material[5]). If a measurement is not accurate, this can sometimes be due to a systematic error. Often this can be overcome by calibrating and adjustment of instruments.
- **Precision**: This describes the closeness of results of measurements of the same measured quantity under the same conditions, i.e. the same thing is measured several times. It is often quantified as the standard deviation of the values around the average. It reflects the fact that all measurements include a random error, which can be reduced, but not completely eliminated.
- **Uncertainty[6]**: This term characterizes the range within which the true value is expected to lie with a specified level of confidence. It is the overarching concept which combines precision and assumed accuracy. As shown in Figure 1, measurements can be accurate, but imprecise, or vice versa. The ideal situation is precise and accurate.

If a laboratory assesses and optimizes its methods, it usually has an interest in distinguishing accuracy and precision, as this leads the way to identification of errors and mistakes. It can show such diverse reasons for errors such as the need for maintenance or calibration of instruments, or for better training of staff. However, the final user of the measurement result (in the case of the ETS, this is the operator and the competent authority) simply wants to know how big the interval is (measured average ± uncertainty), within which the true value is probably found.

In the EU ETS, only one value is given for the emissions in the annual emissions report. Only one value is entered in the verified emissions table of the registry. The op-

[5] Also a standard material, such as e.g. a copy of the kilogram prototype, disposes of an uncertainty due to the production process. Usually this uncertainty will be small compared to the uncertainties later down in its use.

[6] The MRR defines in 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.

erator can't surrender "N ± x%" allowances, but only the precise value N. It is therefore clear that it is in everybody's interest to quantify and reduce the uncertainty "x" as far as possible. This is the reason why monitoring plans must be approved by the competent authority, and why operators have to demonstrate compliance with specific tiers, which are related to permissible uncertainties.

More details on the definition of tiers are given in chapter 6 of GD 1. The uncertainty assessment which is to be added to the monitoring plan as supporting document (Article 12(1)) is discussed in section 5.3 of GD 1.

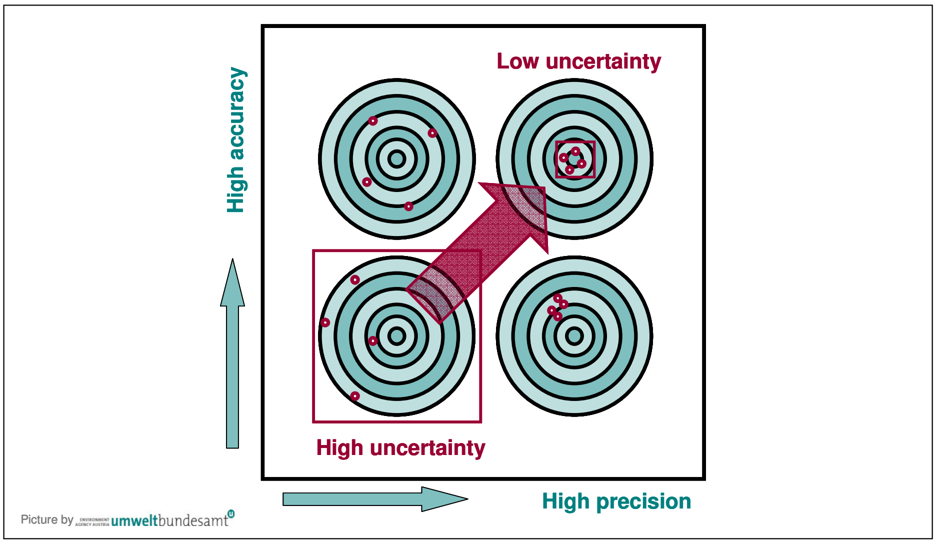

Figure 1: Illustration of the concepts accuracy, precision and uncertainty. The bull's eye represents the assumed true value, the "shots" represent measurement results.

Important note: The uncertainty assessment is necessary to determine which tier is met. The monitoring plan always has to reflect the tier actually applied, not the minimum one required. The general principle is that operators should attempt to improve their monitoring systems wherever possible.

2.2 Uncertainty in the MRR

When reading the MRR the term "uncertainty" comes up on several occasions. The most important sections are:

Simplified!

- Article 12(1) requires operators of installation to submit a document supporting the monitoring plan that should contain the following information:
  - Evidence[7] for compliance with uncertainty thresholds for activity data;
  - Evidence for compliance with uncertainty required for calculation factors, if applicable[8];
  - Evidence for compliance with uncertainty requirements for measurement based methodologies, if applicable;
  - If a fall-back methodology is applied for at least part of the installation, an uncertainty assessment for the total emissions of the installation is to be presented to confirm that the uncertainty threshold according to Article 22(c) is met.
- Article 47(4) exempts operators of installations with low emissions from delivering an uncertainty assessment to the competent authority. Paragraph (5) also exempts those operators from including uncertainty of determining stock changes in their uncertainty assessment.

This document provides an overview of the importance of uncertainty and how uncertainty is treated in the MRR.

2.3 Overview of this document

Figure 2 should help to identify relevant chapters in this document containing guidance for assessing uncertainty for the monitoring approaches chosen for an installation.

[7] Such evidence may be for example providing documents containing the manufacturer's specification or calculations made. The evidence needs to be sufficient to allow the competent authority to approve the associated monitoring plan.

[8] This is applicable only where the sampling frequency for analyses is determined based on the rule of 1/3 of the activity data uncertainty (Article 35(2)).

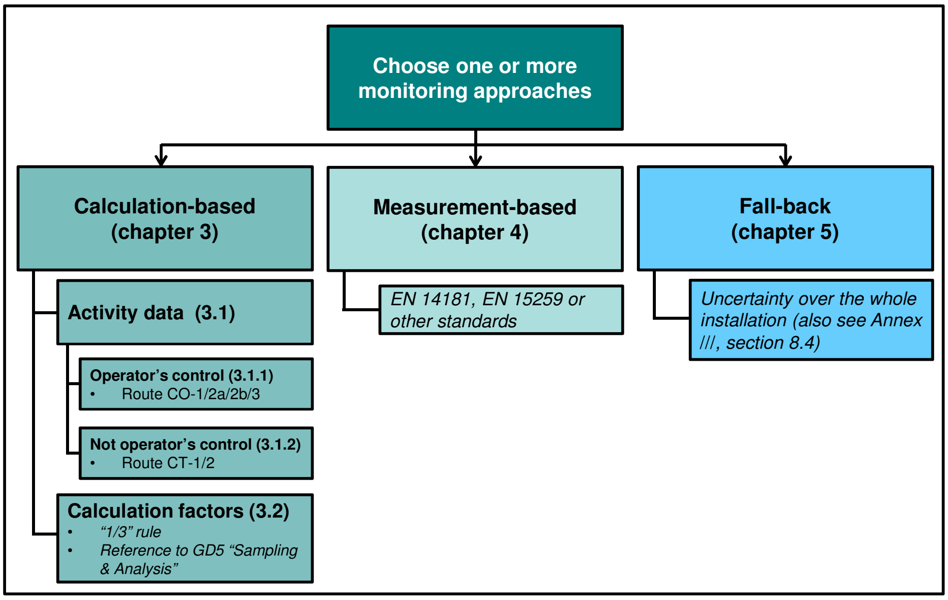

Figure 2: Relevant chapters and sections in this document regarding determination of uncertainty

This document is divided into chapters according to the monitoring approach applied:

- Calculation-based approaches are discussed in chapter 3;
- For measurement-based approaches, see chapter 4;
- Fall-back approaches are described in chapter 5.

Due to the availability of various simplification options under the MRR, there are usually several routes by which an operator can demonstrate that the uncertainty levels corresponding to certain tiers are achieved, as shown in Figure 2. Those options (or routes) are assigned codes throughout this document. For example, if a calculation-based methodology is applied and the activity data of a source stream are monitored by a measurement system outside the operator's own control, chapter 3 and sections 3.1 and 3.1.2 (Route CT-1, CT-2 or CT-3) in particular will provide relevant guidance for assessing uncertainty related to that activity data.

3 UNCERTAINTY FOR CALCULATION-BASED APPROACHES

The following formula shows the calculation of emissions related to the most common case, i.e. 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]

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]

For each parameter the MRR defines tiers that shall apply, subject to being technically feasible and not incurring unreasonable costs.

Those parameters can be divided into the following two types:

- **Activity data (AD)**: Tiers here relate to the required minimum uncertainty over the reporting period of the amount of fuel burned (uncertainty is discussed in section 3.1 for this purpose).
- **Calculation factors (NCV, EF, Carbon Content,…)**: Tiers here relate to specific methodology set out in the MRR for the determination of each factor, e.g. using default values or carrying out analyses (corresponding uncertainty issues are discussed in section 3.2).

3.1 Activity data

Please note that everything said here for the activity data of a source stream monitored by a calculation-based approach is also applicable to the input or output material of a source stream monitored by a mass balance approach.

The tiers for activity data of a source stream (see section 4.5 of GD 1) are defined using thresholds for a maximum uncertainty allowed for the determination of the quantity of fuel or material over a reporting period. Whether a tier is met, must be demonstrated by submitting an uncertainty assessment to the competent authority together with the monitoring plan, except in case of installations with low emissions. For illustration, Table 1 shows the tier definitions for combustion of fuels. A full list of the tier thresholds of the MRR is given in section 1 of Annex II of the MRR.

Table 1: Typical definitions of tiers for activity data based on uncertainty, given for the combustion of fuels (for example).

Tier No.	Definition
1	Amount of fuel [t] or [Nm^3] over the reporting period[9] is determined with a maximum uncertainty of less than **± 7.5 %**.
2	Amount of fuel [t] or [Nm^3] over the reporting period is determined with a maximum uncertainty of less than **± 5.0 %**.
3	Amount of fuel [t] or [Nm^3] over the reporting period is determined with a maximum uncertainty of less than **± 2.5 %**.
4	Amount of fuel [t] or [Nm^3] over the reporting period is determined with a maximum uncertainty of less than **± 1.5 %**.

Note that the uncertainty is meant to refer to "all sources of uncertainty, including uncertainty of instruments, of calibration, any additional uncertainty connected to how the measuring instruments are used in practice, and of environmental impacts", unless some simplifications are applicable. The impact of the determination of stock changes at the beginning and end of the period has to be included, where applicable (see example in section 8.3 of Annex III).

In principle there are two possibilities for determining the activity data in accordance with Article 27(1):

- Based on continual metering of the process which causes the emissions
- Based on aggregation of metered amounts separately delivered taking into account relevant stock changes.

The MRR does not require every operator to equip the installation with measuring instruments at any cost. That would contradict the MRR's approach regarding cost effectiveness. Instruments may be used which are either

- **Under the operator's own control** (see section 3.1.1), or
- **Under the control of other parties** (in particular fuel suppliers; see section 3.1.2). In the context of commercial transactions such as fuel purchase it is often the case that the metering is done by only one of the trade partners. The other partner may assume that the uncertainty associated with the measurement is reasonably low, where such measurements are governed by legal metrological control. Alternatively, requirements on quality assurance for instruments, including maintenance and calibration can be included in the purchase contracts. However, the operator must seek a confirmation on the uncertainty applicable for such meters in order to assess if the required tier can be met.

Thus, the operator may choose whether to use his own instruments or to rely on instruments used by the supplier. However, a slight preference is given by the MRR to the operator's own instruments: If the operator decides to use other instruments despite having his own instruments at his disposal, he has to provide evidence to the competent authority that the supplier's instruments allow compliance with at least the same tier, give more reliable results and are less prone to control risks than the methodology based on his own instruments. This evidence must be accompanied with a simplified uncertainty assessment.

[9] Reporting period is the calendar year.

An exception to this concerns Article 47(4)[10] which allows operators of installations with low emissions to determine the amount of fuel or material by using available and documented purchasing records and estimated stock without comparing the quality of their own instruments with the suppliers' instruments.

Throughout this document, different ways of assessing uncertainty are discussed. It should be kept in mind that many of these options should be seen as simplifications of the complete uncertainty assessment. However, none of the simplified routes should be considered as a preferred route. Generally the operator is always allowed to perform an individual (complete) uncertainty assessment (see Annex III of this document).

3.1.1 Measuring system under the operator's own control

3.1.1.1 General aspects

If the operator uses metering results based on measuring systems under his own control, he has to ensure that the uncertainty threshold of the relevant tier level is met. Consequently an uncertainty assessment is necessary. Although operators of installations with low emissions are exempt from the requirement to provide the uncertainty assessment to the competent authority, they may still require such assessment for their own purposes, for example, to claim compliance with a particular activity data tier.

There are several sources of uncertainty, in particular errors which are caused by a lack of precision (in principle this is the meter's uncertainty as specified by the manufacturer for use in an appropriate environment, and certain conditions for its installation, such as length of straight piping before and after a flow meter) and a lack of accuracy (e.g. caused by aging or corrosion of the instrument, which may result in drift). Therefore the MRR calls for the uncertainty assessment to take account of the measuring instrument's uncertainty, as well as the influence from calibration and all other possible influencing parameters. However, in practice such uncertainty assessment can be demanding, and may sometimes exceed the resources of operators. For the ambitious researcher, an uncertainty assessment "never ends". It is always possible to consider even more sources of uncertainty. Thus, there is a need for pragmatism and to focus on the most relevant parameters contributing to the uncertainty. The MRR allows several pragmatic simplifications.

Figure 3 shows different approaches for uncertainty assessment, laid down by the MRR to prove compliance with the tier requirements of the MRR.

[10] Article 47(4): "By way of derogation from Article 27, the operator of an installation with low emissions may determine the amount of fuel or material by using available and documented purchasing records and estimated stock changes. The operator shall also be exempt from the requirement to provide the uncertainty assessment referred to in Article 28(2) to the competent authority."

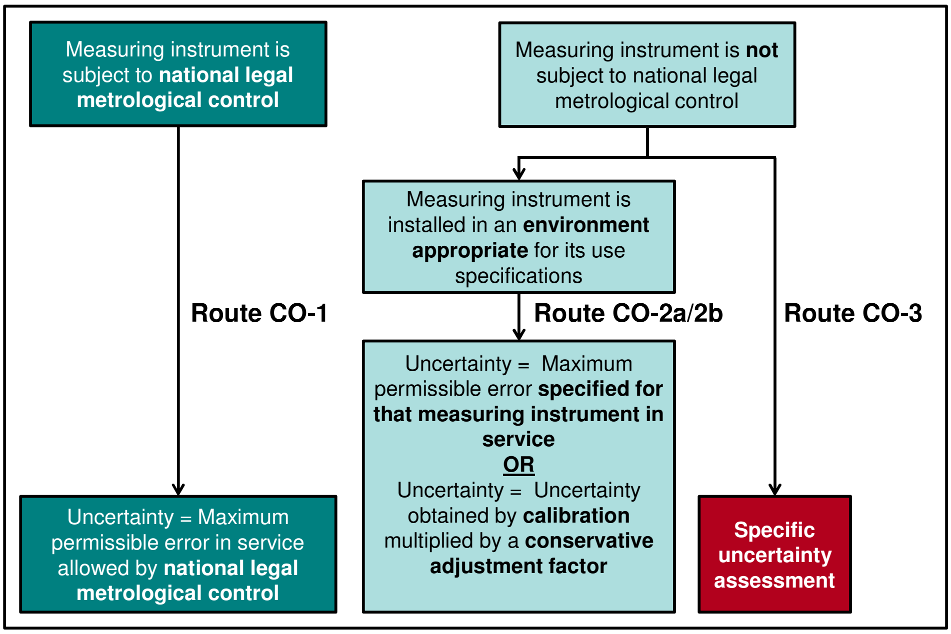

Figure 3: Activity data for calculation-based approaches: Approaches for determination of the uncertainty achieved ("C" means calculation based, "O" means instrument is under operator's own control)

The operator can simplify the uncertainty assessment, if

- The measuring instrument[11] is subject to legal metrological control (**Route CO-1**). In this case the maximum permissible error in service laid down in the relevant national legal metrological text can be used as the overall uncertainty.
- The measuring instrument[11] is not subject to national legal metrological control but is installed in an environment appropriate for its use specifications. Then the operator may assume that the uncertainty over the whole reporting period as required by the tier definitions for activity data in Annex II of the MRR equals:
  - the maximum permissible error specified for that instrument in service(**Route CO-2a),** or
  - where available and lower, the uncertainty obtained by calibration, multiplied by a conservative adjustment factor for taking into account the effect of uncertainty in service (**Route CO-2b**).

Where those simplifications are not applicable, or do not show that the required tier is met, a specific uncertainty assessment in accordance with **Route CO-3** and Annex III needs to be carried out. An operator is not obliged to use any of the simplified approaches. He can always use Route CO-3.

[11] Please note that the singular form "measuring instrument" is used here for simplicity reasons. In the case of more instruments being involved in the determination of the activity data of a single source stream the simplifications apply to all of them. The uncertainty related to the resulting activity data in the units required can be determined by error propagation (see Annex III).

3.1.1.2 Selecting an approach

An operator looking for the simplest approach should first check if Route CO-1 is applicable, i.e. if the measuring instrument is subject to national legal metrological control and that at least the tier required[12] is met. If the maximum permissible error in service laid down in the relevant legislation for national legal metrological control is higher than the uncertainty required for the tier to be met, the operator may use another, but less simplified approach, i.e. either Route CO-2a or CO-2b. Only if these do not lead to the required result would the operator have to carry out a specific uncertainty assessment in accordance with Route CO-3 and Annex III.

Whichever route is chosen, the result must be robust evidence that the uncertainty determined meets the tier required. Where this is not the case, the operator must take the necessary steps to comply with the M&R Regulation by:

- Carrying out corrective action, i.e. installing a measurement system that meets the tier requirements, or
- providing evidence that meeting the required tier is technically infeasible or would incur unreasonable costs, and using the next lower tier in accordance with the result of the uncertainty assessment.

3.1.1.3 Simplification ("Route CO-1")

Measuring instrument is subject to national legal metrological control (NLMC)

Overall uncertainty = Maximum permissible error in service (NLMC)

The first simplification allowed by the MRR is the most straightforward in practice: Where the operator demonstrates to the satisfaction of the CA, that a measuring instrument is subject to national legal metrological control (NLMC), the maximum permissible error in service (MPES) allowed by the metrological control legislation may be taken as the overall uncertainty, without providing further evidence[13]. The most appropriate evidence for being under NLMC is a certificate of the official verification of the instrument[14].

NLMC usually is applicable where market transactions (trades) require the reference to accepted standards (traceability). Within NLMC each type of measuring instrument is assessed by evaluating the measurement results obtained by a large number of tests.

Generally, measuring instruments subject to NLMC are considered more reliable, because an assessment of the measuring instrument is obligatory and the measuring in-

---

[12] For calculation based approaches Article 26 of the MRR defines which tier is to be applied, subject to installation category and source stream category. For more details see Guidance document No. 1.

[13] The philosophy behind this approach is that control is exerted here not by the CA responsible for the EU ETS, but by another authority which is in charge of the metrological control issues. Thus, double regulation is avoided and administrative burden is reduced.

[14] Article 3(c) of the MID (2004/22/EC) defines: 'legal metrological control' means the control of the measurement tasks intended for the field of application of a measuring instrument, for reasons of public interest, public health, public safety, public order, protection of the environment, levying of taxes and duties, protection of the consumers and fair trading;

strument is checked and calibrated (calibration, see Route CO-2b) by a governmental authority or by an entrusted accredited body.

<u>Background information on maximum permissible errors under NLMC</u>

Under legal metrological control calibration is considered valid where the uncertainty resulting from the calibration procedure is lower than the ***maximum permissible error*** *(MPE)* ***in verification****. The term "in verification" is a metrological term here and must not be confused with verification under the EU ETS.*

Moreover it is considered that the equipment under regular service is exposed to measurement conditions that might have impact on the measurement result. This aspect led to the introduction of a parameter called the ***maximum permissible error in service*** *(MPE in service = MPES). This value represents a fair estimation of the uncertainty of a device under regular operation, which undergoes regular legal metrological control complying with the associated regulations. It sets a threshold for simplified checks which could be applied during regular operation and has therefore to be considered as the uncertainty which needs to be attributed to the daily operation of the measurement equipment. This means that the MPES is more appropriate for use to ensure a fair exchange of goods, the ultimate objective of legal metrological control.*

For some measuring instruments the MPE "under rated operating conditions"[15] *are regulated in the* ***Measuring Instruments Directive*** *(2004/22/EC) (MID) or by the Non-Automatic Weighing Instruments Directive (2009/23/EC) (NAWI), which intends to create a common market for measuring instruments across EU Member States. MPE in service is subject to national legislation. Metrological control systems usually apply a factor of 2 to convert the maximum permissible error derived in verification into the maximum permissible error in service (MPES). It needs to be mentioned that this factor is not derived from statistics (unlike the difference between standard and expanded uncertainty) but follows from general experience in legal metrology with measuring instruments which have undergone successful type approval tests*[16]*.*

3.1.1.4 Simplification ("Route CO-2a")

Measuring instrument is <u>not</u> subject to national legal metrological control but is installed in an environment appropriate for its use specifications

Overall uncertainty = Maximum permissible error in service

Simplified!

The second simplification allowed by the MRR, applies to measuring instruments that are not subject to national legal metrological control but are installed in an environment appropriate for their use specifications.

For the second ETS phase, the so-called ETSG guidance document[17] proposed a simplified approach, which allowed the overall uncertainty for a source stream's activi-

[15] Annex I of the MID defines: "The rated operating conditions are the values for the measurand and influence quantities making up the normal working conditions of an instrument." Thus, the definition of the MPE provided in the MID refers to the MPE in service (MPES). However, it should be noted that the MID only regulates the placing on the market and putting into use. It does not regulate any calibration or maintenance to be carried out in service.

[16] Resulting from specific experience for some kinds of appliances other values for this factor are commonly used, ranging from 1.25 (e.g. for automatic weighing systems) up to 2.5 (e.g. for traffic speed metering devices).

[17] The notes are found as Annex at http://impel.eu/projects/emission-trading-proposals-for-future-development-of-the-eu-ets-phase-ii-beyond

ty data to be approximated by the uncertainty known for a specific type of instrument, under the condition that other sources of uncertainty are sufficiently mitigated. This is considered to be the case in particular if the instrument is installed according to certain required conditions. The ETSG guidance note contains a list of instrument types and installation conditions which helps the user applying this approach.

The MRR has picked up the principle of this approach and allows the operator to use the "Maximum Permissible Error (MPE) *in service*"[18] (MPES) specified for the instrument as overall uncertainty, provided that measuring instruments are installed in an environment appropriate for their use specifications. Where no information is available for the MPES, or where the operator can achieve better values than the default values, the uncertainty obtained by calibration may be used, multiplied by a conservative adjustment factor for taking into account the higher uncertainty when the instrument is "in service". The latter approach reflects Route CO-2b.

The information source for the MPES[19] and the appropriate use specifications are not further specified by the MRR, leaving some room for flexibility. It may be assumed that

- the manufacturer's specifications,
- specifications from legal metrological control, and
- guidance documents such as the Commission's guidance[20]

are suitable sources for MPES. The uncertainties given there may only be taken as the overall uncertainty, if the measuring instruments are installed in an environment appropriate for their use specifications (including Steps 1 to 4 below are met). If this is the case values taken from these sources can be considered as representing the MPES and no further corrections to that uncertainty value are necessary.

The operator can assume he meets the MRR requirements in such cases, if he shows evidence that all of the requirements of the following four steps are met:

[18] The MPE in service is significantly higher than the MPE of the new instrument. The MPE in service is often expressed as a factor times the MPE of the new instrument.

[19] Please note that MPE and MPES for instruments under NLMC are based on experience and they are not transferable to industrial measurement. The same denomination for instruments not subject to NLMC is only used for simplicity reasons.

[20] Annex II of this Guidance Document provides conservative values for uncertainty ranges of common measuring instruments and additional conditions.

Step 1: Operating conditions regarding relevant influencing parameters are available[21]

The manufacturer's specification for that measuring instrument contains operating conditions, i.e. description of the environment appropriate for its use specifications, regarding relevant influencing parameters (e.g. flow, temperature, pressure, medium etc.) and maximum permissible deviations for these influencing parameters. Alternatively, the manufacturer may have declared that the measuring instrument complies with an international standard (CEN or ISO standard) or other normative documents (such as recommendations by OIML[22]), which lay down acceptable operating conditions regarding relevant influencing parameters.

Step 2: Operating conditions regarding relevant influencing parameters are met

The operator demonstrates evidence that the operating conditions regarding relevant influencing parameters are met. For this evidence operators should make a check-list of the relevant influencing parameters (for example, see section 8.1, in particular Table 2 and Table 3) for different measuring instruments and compare for each parameter the specified range with the used range. This list should be provided to the competent authority as part of the uncertainty assessment when submitting a new or updated monitoring plan.

The result for this step should be an assessment that

- the measurement instrument is installed appropriately,
- the measuring instrument is appropriate to measure the medium of interest,
- there are no other factors that could have adverse consequences on the uncertainty of the measurement instrument.

Only if all of this is the case, can it be assumed that the MPES provided in the suitable source (see above) is appropriate for use without further correction.

Step 3: Performing quality assured calibration procedures

The operator shows evidence that the regular calibration (calibration, see Route CO-2b) is performed by an institute accredited in accordance with EN ISO/IEC 17025, employing CEN, ISO or national standards where appropriate. Alternatively, if calibration is performed by a non-accredited institute or by a manufacturer's calibration, the operator has to show evidence (e.g. by calibration certificate), of suitability and that the calibration is performed using the instrument manufacturer's recommended procedure and the results comply with the manufacturer's specifications.

[21] 'CE' marked measuring instruments are in conformity with the essential requirements laid down in Annex I of the MID. This Annex requires manufacturers to specify such appropriate operating conditions. If the manufacturer's specifications do not contain requirements for operating conditions regarding relevant influencing parameters, the operator has to carry out an individual uncertainty assessment (Route CO-3). However, in simple cases, expert judgement might be sufficient, in particular for minor and de-minimis source streams and for installations with low emissions.

[22] Documents containing technical specifications adopted by the Organisation Internationale de Métrologie Légale (OIML). http://www.oiml.org/

Step 4: Further quality assurance procedures for measuring activity data

Under Article 58(3), the operator is required to establish, document, implement and maintain various written procedures to ensure an effective control system, including in relation to quality assurance of relevant measurement equipment, and handling of resulting data. Where certified quality or environmental management systems are in place[23], e.g. EN ISO 9001, EN ISO 14001, EMAS, to ensure that control activities (calibration, maintenance, surveillance and loss/failure management etc.) are carried out, it is recommended that these systems also include the quality assurance for measuring activity data under the EU ETS.

Unless all of the requirements of the four steps are fulfilled it cannot be assumed that the MPES taken from suitable sources (see above) can be used for uncertainty without further corrections. However, overall uncertainties might be calculated by combination of the uncertainties provided in the suitable sources and a conservative estimate of the uncertainty related to the parameters causing this non-compliance, e.g. flow rate is partially outside the normal operating range, by the means of error propagation (see Route CO-3 and Annex III).

3.1.1.5 Simplification ("Route CO-2b")

Simplified!

Measuring instrument is not subject to national legal metrological control but is installed in an environment appropriate for its use specifications

Overall uncertainty

=

Uncertainty from calibration × conservative adjustment factor

Calibration[24]

The performance of regular calibration is the process where metrology is applied to measurement equipment and processes to ensure conformity of measuring instruments in use with a known international measurement standard. This is achieved by using calibration materials or methods that ensure a closed chain of traceability to the "true value" performed as a measurement standard.

Calibration should, if possible, be carried out by an accredited laboratory. Appropriate calibration procedures and intervals may be found in the manufacturer's specification, standards provided by accredited laboratories, etc.[25]

[23] A control system is usually established in the installation for other purposes such as quality control or minimizing costs. In a lot of cases material and energy flows are also of special relevance for other internal reporting systems (such as financial controlling).

[24] Also see "EA 4/02 - Guidance to Expression of Uncertainty of Measurement in Calibration http://www.european-accreditation.org/Docs/0002_Application%20documents/0002_Application%20documents%20for%20Laboratories%20Series%204/00100_EA-4-02rev01.PDF

Example: Requirements for calibration of a flow meter for non-aqueous liquids with static start/stop measurement

For calibration the following aspects need to be considered:

- The flow meter is installed in accordance with the manufacturer's specifications.
- The flow meter as well as the rest of the whole calibration system are filled completely and are free from gases.
- The flow meter is at operating temperature.
- All parameter settings, to the extent available, should be documented.
- During zero flow rate before and after the measurement no signal indicating a flow is detected.
- The calibration conditions (flow rate, temperature, pressure, liquid type,…) are within the operating conditions.
- The flow rate is stable.
- The pressure must be high enough to avoid gasification or cavitation[26]. Density and viscosity have an influence on the calibration curve as well. Therefore, it is optimal to calibrate under the same conditions as during (intended) normal operation and to use the same, if available, or similar liquids.
- Adjusting to zero ("zeroing") is to be done before and not during a measurement series. Conditions of the liquid (temperature, pressure) are to be documented at the moment of zeroing. Zeroing is not required if the output signal for zero flow rate is lower than the range for the zero value provided by the manufacturer.

The core element of each calibration procedure is the comparison of measurement results with a reference standard by applying a procedure which enables the determination of a calibration function and of measurement uncertainties. The result of calibration will be a reliable assessment of the calibration function, its linearity (where this is a requirement) and the measurement uncertainty. The uncertainty obtained by calibration should, to the extent possible, relate to the operating range of the measuring instrument in actual use. Thus, the calibration procedure should reflect to the extent possible the operating conditions where the instrument is installed (i.e. where it is actually applied).

In many cases the measurand of interest is not measured directly but rather calculated from other input quantities with a functional relationship, e.g. a volumetric flow (f_V) is calculated by measuring inputs like density (ρ) and pressure difference (Δp) through the relationship $f_V = f_V(\rho, \Delta p)$. The uncertainty related to the measurand of interest will

---

[25] Also see "International vocabulary of metrology" http://www.bipm.org/utils/common/documents/jcgm/JCGM_200_2008.pdf

NOTE 1 A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

NOTE 2 Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with [metrological] verification of calibration.

[26] Cavitation is the formation and then immediate implosion of cavities in a liquid, which may occur when a liquid is subjected to rapid changes of pressure, e.g. in turbines.

then be determined as the combined standard uncertainty via error propagation[27] (see Annex III). For the combined standard uncertainty associated with the measurement result, uncertainty contributions of long term drift and operational conditions are also important influences which have to be considered (besides the uncertainty associated with calibration).

The **expanded uncertainty of measurement** is achieved by multiplying the combined standard uncertainty by a coverage factor. This factor is often taken to equal 2 for normal distributions of data (Gaussian distributions). A factor of 2 corresponds to a probability of 95% that the correct value is covered (i.e. a 95% confidence interval). Note that this coverage factor is still part of the expression of the uncertainty of measurement in calibration. This coverage factor is not the conservative adjustment factor (see below).

Frequencies of calibration

Depending on the type of measuring instrument and the environmental conditions the uncertainty of a measurement might increase over time (drift). To quantify and to mitigate the increase of uncertainty resulting from drift an appropriate time interval for re-calibration is necessary.

In the case of a measuring instrument subject to NLMC (Route CO-1) the frequency of calibration (re-calibration) is regulated by the relevant legal text.

For other measuring instruments intervals for re-calibration should be determined on the basis of information provided by e.g. manufacturer's specifications or other suitable sources. As the result of every calibration allowing quantification of the drift that has occurred, time series analysis of previous calibrations may also be helpful to determine the relevant calibration interval. Based on this information the operator should use appropriate calibration intervals subject to the CA's approval.

In any case the operator has to check annually if the measuring instruments used still comply with the tier required (under point (b) of the first paragraph of Article 28).

Industry practice

Various situations need to be guarded against when it comes to calibration in industrial circumstances, including

- simplifications for particular applications that do not then meet requirements for calibration according to legal standards;
- single-point-tests or short checks that may be designed, for example, for checking the zero value and for providing day to day quality assurance, but which do not constitute full calibration;
- postponement of calibrations due to favourable ad-hoc checks (suggesting proper operation of monitoring equipment) and due to the costs involved;
- failure to follow-up the results of the calibration by making adequate corrections.

Moreover, a problem may occur when a device is not easily accessible for calibration, e.g. it cannot be de-installed for checks or calibration during operation of the installation and the process cannot be shut-down without major disruption to the installation

[27] It is more appropriate to call it "propagation of uncertainty" although "error propagation" is more frequently used.

or to the security of supply associated with the product. There may be long periods between shut-downs of the production process and in such cases a periodic calibration according to shorter intervals may not be feasible.

Where only limited possibilities for calibration exist, the operator must seek approval by the CA for an alternative approach, enclosing in the submission of the monitoring plan any relevant evidence with regards to technical feasibility or unreasonable costs[28]. The hierarchy[29] of Article 32(1) for application of different standards should be considered.

Conservative adjustment factor

To take into account any further random as well as systematic errors in service, the uncertainty obtained from calibration (expanded uncertainty, see above) is to be multiplied by a **conservative adjustment factor**. The operator should determine this conservative adjustment factor, e.g. based on experience, subject to the approval of the CA. In the absence of any information or experience the use of a harmonised factor of 2 is recommended as pragmatic yet appropriate approach. The result obtained may be used as the overall uncertainty without further corrections.

A conservative adjustment factor is only applicable if the measuring instrument is used within the use specifications in accordance with Article 28(2), last sub-paragraph. Consequently, the requirements described for Route CO-2a (step 1 to step 4) have to be met. If those requirements are not met this simplification route is not applicable and specific uncertainty assessment described under Route CO-3 and Annex III is required.

3.1.1.6 Full uncertainty assessment ("Route CO-3")

Full uncertainty assessment ("Route CO-3")

The operator is always entitled to carry out a specific uncertainty assessment, e.g. if the operator is of the opinion that this provides more reliable results. If this is the case or where none of the simplification routes (Routes CO-1 or CO-2a/2b) are possible, an uncertainty assessment in accordance with Annex III has to be carried out.

It is important to note that the obligation to carry out a specific uncertainty assessment does not necessarily mean that this assessment has to be completely started from new. In many cases some prerequisites may apply concerning the simplifications Routes CO-1 or CO-2a/2b. In these cases uncertainties gathered from there might be starting points for further calculations, e.g. via error propagation (see Annex III, in par-

[28] MRR Article 59(1), 2nd sub-paragraph requires: "Where components of the measuring systems cannot be calibrated, the operator or aircraft operator shall identify those in the monitoring plan and propose alternative control activities."

[29] Article 32(1): "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."

ticular section 8.2). This approach not only presents a more pragmatic and less burdensome way for operators to assess uncertainty it may in most cases also provide more reliable results.

> Example: An operator is using a turbine meter subject to national legal metrological control for the consumption of a liquid source stream. As the MRR requires converting the volumetric flow into mass flows the operator has to determine the density of the liquid. As this is determined regularly by an aerometer no simplification, i.e. Route CO-1 or Route CO-2a/2b applies for the source stream if expressed in tonnes. However, the operator may be well advised to use the uncertainty laid down in the relevant national legal metrological text related to the determination of the volume in the overall uncertainty calculation by error propagation (see section 8.3, in particular example 7).

3.1.2 Measuring system not under the operator's own control

3.1.2.1 General aspects

The operator may use a measurement system outside his own control to determine activity data, provided that this system complies with at least as high a tier, gives more reliable results and is less prone to control risks[30] than using his own instruments, if available. For these cases activity data may be determined either by

- amounts taken from invoices issued by the trading partner, or
- using direct readings from the measurement system.

Whichever approach is used, the same tiers for activity data are required as for systems under the operator's own control (see section 3.1.1). The only difference is how the operator can demonstrate this compliance and what simplifications may be applied.

In the case of invoices providing the primary data for determining the material or fuel quantity, the MRR requires the operator to demonstrate that the trade partners are independent. In principle, this should be considered a safeguard for ensuring that meaningful invoices exist. In many cases it will also be an indicator of whether national legal metrological control (section 3.1.1, Route CO-1) is applicable.

Note that there is a "hybrid" possibility allowed by the M&R Regulation: The instrument is outside the control of the operator (section 3.1.2), but the reading for monitoring is taken by the operator. In such a case the owner of the instrument is responsible for maintenance, calibration and adjustment of the instrument, and ultimately for the applicable uncertainty value, but the data on fuel or material quantity can be directly checked by the operator. This is a situation frequently found for natural gas meters.

Figure 4 shows the way provided by the MRR to comply with the tier requirements in case of measurement systems not under the operator's control.

[30] For guidance on risk assessment see Guidance document No. 6 (Data flow and control activities).

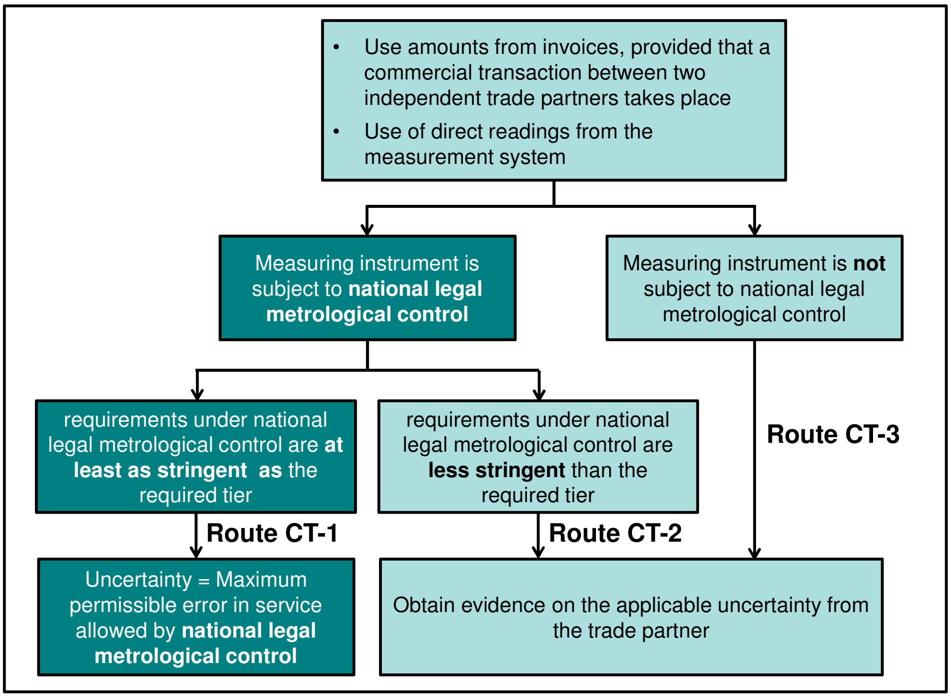

Figure 4: Activity data for calculation-based approaches: Approaches for determination of the uncertainty achieved ("C" means calculation-based, "T" means instrument is under trading partner control)

The operator can simplify the uncertainty assessment:

- If the measuring instrument is subject to legal metrological control, the maximum permissible error laid down in the relevant national legal metrological text can be used as the overall uncertainty for assessing whether the tier requirements in accordance with Article 26 are met (**Route CT-1**).
- If the applicable requirements under national legal metrological control are less stringent than the uncertainty threshold of the tier required in accordance with Article 26, the operator may obtain evidence from the trade partner concerning the uncertainty that is actually applicable **(Route CT-2)**.
- If the measuring instrument is not subject to national legal metrological control, the operator may obtain evidence from the trade partner relating to the uncertainty concerned (**Route CT-3**).

As discussed in section 3.1.1.2, the operator must ensure that the required tier in accordance with Article 26 can be achieved. If not, either corrective action is required or a lower tier may be applied where evidence for unreasonable costs or technical infeasibility can be provided (as long as this still complies with at least as high a tier, gives more reliable results and is less prone to control risks than the use of available instruments under the operator's own control).

3.1.2.2 Simplification ("Route CT-1")

Measuring instrument of the trade partner is subject to national legal metrological control (NLMC).

Simplified!

Overall uncertainty = Maximum permissible error in service (MPES)

This simplification is applicable for the same reasons and under the same conditions as given under section 3.1.1.3, Route CO-1. The operator must still be able to demonstrate that the trade partner's measuring instrument complies with at least as high a tier as an instrument available under the operator's own control and gives more reliable results and is less prone to control risks.

3.1.2.3 “Route CT-2”

The operator shall obtain evidence of the applicable uncertainty from the trade partner responsible for the measurement system.

If the applicable requirements under national legal metrological control are less stringent than the tier requirements of Article 26, the operator has to obtain evidence from the trading partner that the required tiers are met. The operator must be able to demonstrate that the trade partner's measuring instrument complies with at least as high a tier as an instrument available under the operator's own control and gives more reliable results and is less prone to control risks.

This may also be based on an uncertainty assessment as explained in Annex III, using information on the measuring instruments obtained from the trade partner. Please also see the information given under Route CO-3 (section 3.1.1.6).

3.1.2.4 "Route CT-3”

The operator shall obtain evidence of the applicable uncertainty from the trade partner responsible for the measurement system.

This route is similar to Route CT-2 above. In such a case where the transaction is not subject to NLMC, the operator has to obtain evidence from the trading partner that the required tiers of Article 26 are met. The operator must be able to demonstrate that the trade partner's measuring instrument complies with at least as high a tier as an instrument available under the operator's own control and gives more reliable results and is less prone to control risks.

This may also be based on an uncertainty assessment as explained in Annex III, using information on the measuring instruments obtained from the trade partner. Please also see the information given under Route CO-3 (section 3.1.1.6).

3.2 Calculation factors

In contrast to the tiers for activity data, the tiers for calculation factors[31] are not based on uncertainty thresholds being met, but instead determinations involving default values or values derived from laboratory analyses. However, determinations involving laboratory analyses are linked to required frequencies for analyses (Article 35), and one option allowed for determining the required frequency is expressed in terms of the “uncertainty” related to the frequency of analyses. Article 35(2) states:

“The competent authority may allow the operator to use a different frequency than those referred to in paragraph 1, where minimum frequencies are not available or where the operator demonstrates one of the following:

a) *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 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…“*

It should be noted that the uncertainty assessment required in this case is different and the detail is not considered within the scope of this document. Instead, the topic is covered more specifically by Guidance document No. 5: "Guidance on Sampling & Analysis" (see section 1.3).

[31] The MRR defines in Article 3(7): ‘calculation factors’ means net calorific value, emission factor, preliminary emission factor, oxidation factor, conversion factor, carbon content or biomass fraction

4 UNCERTAINTY FOR MEASUREMENT-BASED APPROACHES

For a measurement-based approach including monitoring of N_2O, Annex I of the MRR requires a list of all relevant equipment, indicating its measurement frequency, operating range and uncertainty. The MRR does not mention any circumstances under which simplifications to determine the uncertainty apply, as there are for calculation-based approaches.

However, Article 42 requires that all measurements shall be carried out based on the following standards:

- EN 14181 Stationary source emissions – Quality assurance of automated measuring systems,
- EN 15259 Air quality – Measurement of stationary source emissions – Requirements for measurement sections and sites and for the measurement objective, plan and report
- And other corresponding EN standards.

EN 14181 for example contains information about quality assurance procedures (QAL 2 and 3) to minimise the uncertainty as well as guidelines on how to determine the uncertainty itself. For QAL 1 guidance can be found in EN ISO 14956 Air quality - Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty.

Article 42 further states: *"Where such standards are not available, the methods shall be based on suitable ISO standards, standards published by the Commission 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.*

The operator shall consider all relevant aspects of the continuous measurement system, including the location of the equipment, calibration, measurement, quality assurance and quality control."

In the case that suitable standards or guidelines do not contain information about the determination of the uncertainty, some aspects for this determination may be taken from Annex III.

5 UNCERTAINTY FOR FALL-BACK APPROACHES

An operator may apply a fall-back methodology, i.e. a monitoring methodology not based on tiers, for selected source streams or emission sources, provided that all of the following conditions are met:

- applying at least tier 1 under the calculation-based methodology for one or more major source streams or minor source streams and a measurement-based methodology for at least one emission source related to the same source streams is technically not feasible or would incur unreasonable costs;
- the operator assesses and quantifies each year the uncertainties of all parameters used for the determination of the annual emissions in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (JCGM 100:2008)[32], or another equivalent internationally accepted standard, and includes the results in the annual emissions report;
- the operator demonstrates to the satisfaction of the competent authority that by applying such a fall-back monitoring methodology, the overall uncertainty threshold for the annual level of greenhouse gas emissions for the whole installation does not exceed
  - 7.5% for category A installations,
  - 5.0% for category B installations and
  - 2.5% for category C installations.

Further guidance for assessing the uncertainty can be found in Annex III, in particular in section 8.4.

[32] (JCGM 100:2008) Evaluation of measurement data – Guide to the expression of uncertainty in measurement (GUM): http://www.bipm.org/en/publications/guides/gum.html

6 ANNEX I: ACRONYMS AND LEGISLATION

6.1 Acronyms used

EU ETS ...... EU Emission Trading Scheme

MRV .... Monitoring, Reporting and Verification

MRG 2007.. Monitoring and Reporting Guidelines

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

MID............. Measurements Instruments Directive (MID 2004/22/EC)

MP.............. Monitoring Plan

CA .... Competent Authority

NLMC .... National legal metrological control

ETSG .... ETS Support Group (a group of ETS experts under the umbrella of the IMPEL network, who have developed important guidance notes for the application of the MRG 2007)

CEMS......... Continuous Emission Measurement System

MPE .... Maximum Permissible Error (term usually used in national legal metrological control)

MPES......... Maximum Permissible Error in service (term usually used in national legal metrological control)

MS.............. Member State(s)

GUM........... ISO Guide to the Expression of Uncertainty in Measurement (JCGM 100:2008), downloadable from http://www.bipm.org/en/publications/guides/gum.html.

6.2 Legislative texts

EU ETS Directive: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, most recently amended by Directive 2009/29/EC. Download consolidated version: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2003L0087:20090625:EN:PDF

M&R Regulation: Commission Regulation (EU) No. 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:181:0030:0104:EN:PDF

A&V Regulation: Commission Regulation (EU) No. 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:181:0001:0029:EN:PDF

MRG 2007: Commission Decision 2007/589/EC of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council. The download of the consolidated version contains all amendments: MRG for N_2O emitting activities, aviation activities; capture, transport in pipelines and geological storage of CO_2, and for the activities and greenhouse gases only included from 2013 onwards. Download: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2007D0589:20110921:EN:PDF

7 ANNEX II: CONSERVATIVE MEASUREMENT UNCERTAINTIES FOR THE MOST COMMON MEASURING INSTRUMENTS

The following tables provide an overview of conservative measurement uncertainties for certain categories of common measuring instruments

The uncertainty values and additional conditions presented in the tables below should be considered only if more specific information is not available from the manufacturer of the measuring instrument, or from normative documents such as those published by OIML[33]. Also, these uncertainty values should be considered only if steps 1 to 4 (see section 3.1.1.4) are met. If this is not the case Route CO-2a is not applicable. For measuring instruments suitable for gases and liquids relevant OIML documents are R137 and R117. For measuring instruments for solids R76 is a suitable source.

Please also note that a time period for recalibration is advised for each instrument. This implies that after each calibration the requirements to apply simplification Route CO-2b (section 3.1.1.5) might be applicable and provide more reliable results. This option should always be considered before applying standard values listed below.

Simplified!

Rotor meter
Medium: gas Relevant standards: EN 12480:2002+A1:2006 Uncertainty for 0-20% of the measurement range: 3% Uncertainty for 20-100% of the measurement range: 1.5% Conditions: - Once per 10 year cleaning, recalibration and if necessary adjusting - Annual inspection of the oil level of the carter - Application filter for polluted gas - Life span 25 years
Medium: liquid Uncertainty for 0-10% of the measurement range: 1% Uncertainty for 10-100% of the measurement range: 0.5% Conditions: - Once per 5 year cleaning, recalibration and if necessary adjusting (or at an earlier time when flow liquid of 3500 hours × maximum range of the meter has run through the meter

[33] Documents containing technical specifications adopted by the Organisation Internationale de Métrologie Légale (OIML). http://www.oiml.org/

- Annual maintenance according to instructions of manufacturer / general instructions measurement principle
- Life span 25 years

Turbine meter
Medium: gas Relevant standards: EN 12261:2002 + A1:2006 Uncertainty for 0-20% of the measurement range: 3 % Uncertainty for 20-100% of the measurement range: 1,5% Conditions: - Once per 5 year cleaning, recalibration and if necessary adjusting - Annual visual inspection - Once per three months lubrication of bearings (not for permanent lubricated bearings) - Application filter for polluted gas - No pulsating gas stream - Life span 25 years - No overload of longer than 30 minutes › 120% of maximum measurement range
Medium: liquid Uncertainty for 10-100% of the measurement range: 0.5% Conditions: - Once per 5 year cleaning, recalibration and if necessary adjusting - Once per three months lubrication of bearings (not for permanent lubricated bearings) - Application filter for polluted liquid - Life span 25 years - No overload of longer than 30 minutes › 120% of maximum measurement range

Bellows meter / diaphragm meter
Medium: gas Relevant standards: EN 1359:1998 + A1:2006 Uncertainty for 0-20% of the measurement range: 7.5% Uncertainty for 20-100% of the measurement range: 4.5% Conditions: - Once per 10 year cleaning, recalibration and if necessary adjusting - Annual maintenance according to instructions of manufacturer / general instructions measurement principle - Life span 25 years

Orifice meter

Medium: gas and liquid

Relevant standards: EN ISO 5167

Uncertainty for 20-100% of the measurement range: 3%

Conditions:

- Annual calibration of the pressure transmitter
- Once per 5 years calibration of the orifice meter
- Annual inspection of abrasion orifice and fouling
- Annual maintenance according to instructions of manufacturer / general instructions measurement principle
- Life span 30 years
- No corrosive gases and liquids

Guidelines for building in orifices, if not stated otherwise by the manufacturer: minimum of 50D free input flow length before the orifice and 25D after the orifice: smooth surface of inner wall.

Venturi meter

Medium: gas and liquid

Relevant standards: EN ISO 5167

Gas: Uncertainty for 20-100% of the measurement range: 2%

Liquid: Uncertainty for 20-100% of the measurement range: 1,5%

Conditions:

- Annual calibration of the pressure transmitter
- Once per 5 years calibration of entire measuring instrument
- Annual visual inspection
- Annual maintenance according to instructions of manufacturer / general instructions measurement principle
- Life span 30 years
- No corrosive gases and liquids

Ultrasonic meter

Medium: gas and liquid

Relevant standards: ISO 17089-1:2010

Gas: Uncertainty for 1-100% of the measurement range: 2%

Gas (clamp on): Uncertainty for 1-100% of the measurement range: 4%

Liquid: Uncertainty for 1-100% of the maximum measurement range: 3%Conditions: - Once per 5 years cleaning, recalibration and if necessary adjusting - Annual inspection of contact between transducer and tube wall. When there is not sufficient contact, the transducer assembly has to be replaced according to the specifications of the manufacturer. - Annual inspection on corrosion of wall - Annual inspection of transducers - Annual maintenance according to instructions of manufacturer / general instructions measurement principle - Life span 15 years - No disturbances in frequencies - Composition of medium is known Guidelines for building in ultrasonic meters, if not stated otherwise by the manufacturer: minimum of 10D free input flow length before the meter and 5D after the meter

Vortex meter
Medium: gas Gas: Uncertainty for 10-100% of the measurement range: 2,5% Liquid: Uncertainty for 10-100% of the measurement range: 2% Conditions: - Once per 5 years cleaning, recalibration and if necessary adjusting - Annual inspection of sensors - Annual inspection of bluff body - Annual inspection on corrosion of wall - Annual maintenance according to instructions of manufacturer / general instructions measurement principle - Life span 10 years - Set-up is free of vibration - Avoid compressive shocks Guidelines for building in vortex meters, if not stated otherwise by the manufacturer: minimum of 15D free input flow length before the meter and 5D after the meter

Coriolis meter
Medium: gas and liquid Gas: Uncertainty for 10-100% of the measurement range: 1,5% Liquid: Uncertainty for 10-100% of the measurement range: 1%

Conditions: - Once per 3 years cleaning, recalibration and if necessary adjusting - Stress-free installation - Monthly control of adjusting zero point - Annual inspection of corrosion and abrasion - Annual check on sensors and transmitters - Annual maintenance according to instructions of manufacturer / general instructions measurement principle - Life span 10 years

Oval gear meter
Medium: liquid Uncertainty for 5-100% of the measurement range: 1% Conditions: - Viscid liquids (oil): Once per 5 years cleaning, recalibration and if necessary adjusting - Thin liquids: Once per 2 years cleaning, recalibration and if necessary adjusting - Annual inspection of abrasion - Annual maintenance according to instructions of manufacturer / general instructions measurement principle - Life span 30 years

Electronic Volume Conversion Instrument (EVCI)
Medium: gas Relevant standards: EN 12405-1:2005+A1:2006 Uncertainty for 0,95-11 bar and -10 – 40℃: 1% - Conditions: Once per 4 years recalibration and if necessary adjusting - Replace batteries (frequency is dependent on instructions manufacturer) - Annual maintenance according to instructions of manufacturer / general instructions measurement principle - Life span 10 years

8 ANNEX III: FULL UNCERTAINTY ASSESSMENT FOR SOURCE STREAMS

8.1 Introduction

This Annex should provide an overview about the general approach to assess uncertainties if no simplifications are applicable. For further details you may consult the GUM.

In principle the uncertainty assessment shall comprise

- the specified uncertainty of the applied measuring instrument,
- the uncertainty associated with the calibration and
- any additional uncertainties connected to how the measuring instrument is used in practice.

If additional measurements such as pressure and temperature measurement are required, the uncertainty of these measurements has to be considered as well. If the uncertainty information of the manufacturer cannot be applied, the operator has to substantiate and justify that the deviations from the specification do not influence the uncertainty. If this is not possible, he has to make conservative and substantiated estimations of the uncertainty. Possible influences on the uncertainty include:

- Deviation from working range
- Different uncertainties subject to load or flow rate
- Atmospheric conditions (wind, temperature variation, humidity, corroding substances)
- Operation conditions (adhesion, density and viscosity variation, irregular flow rate, in-homogeneity)
- Installation conditions (raising, bending, vibration, wave)
- Using the instrument for other medium than the one it is designed for
- Calibration intervals
- Long-term stability

The general focus should be on the most significant parameters such as **temperature, pressure (difference), flow rate, viscosity,** etc., whichever applicable. Significant influences on the uncertainty have to be taken into account and evaluated. The uncertainty can be calculated with the appropriate error propagation formula. Some examples for the calculation of a specific uncertainty are given in this annex.

Table 2 provides a list of various influencing parameters that might be relevant for uncertainty assessment. It is not deemed complete, whereas in many cases some aspects can be neglected as they are likely to have minimal impact upon the results. However, it could be used as first starting point when running a risk assessment with regard to the uncertainty of activity data and help focus on the most relevant influencing parameters. Table 3 provides some measuring instrument specific influencing parameters.

Table 2: Influencing parameters on the determination of activity data

	Gaseous Source Streams	**Fluid Source Streams**	**Solid Source Streams**
Influencing parameter related to the equipment and its installation	turbulences in gas stream impacts of cladding temperature of environment long-run behaviour (calibration and maintenance frequency) acceptable measurement range electromagnetic fields	turbulences in fluid stream, bubbling of dissolved gases temperature of environment long-run behaviour (calibration and maintenance frequency) acceptable measurement range electromagnetic fields storage capacity and monitoring phase changes	exposure to wind and radiation temperature of environment long-run behaviour (calibration and maintenance frequency) position on scale electromagnetic fields storage capacities / volumes slope of conveying belts start and stop behaviour acceptable measurement range storage capacity and monitoring vibration
Influencing parameter related to the medium being measured	temperature pressure compressibility factor dew-point (for some gases only) corrosiveness	temperature density viscosity boiling or melting point (for some rare circumstances only) corrosiveness	purity / humidity accessibility as net weight (e.g. packaging) handling of medium impacts by drying density flow characteristics (e.g. related to grain size) adhesiveness melting point (for some rare constellations only)

Table 3: Measuring instrument specific influencing parameters and way to validate/mitigate them

Metering of gases/liquids		
Measuring instrument	*Influencing parameter*	*Validation/mitigation option*
Turbine meter	Intermittent flow, pulsation	Appropriate operating parameters, avoid pulsation, e.g. by using controlling instruments
Bellows meter	Correct detection of temperature and pressure	Use Electronic Volume Conversion Instrument EVCI
Orifice meter, Venturi meter	Damages, Roughness of the pipe, stability of pressure difference detectors	Satisfy EN ISO 5167 requirements
Ultrasonic meter	Strong noise signals	Reduce noise
Vortex meter	Pulsation	Avoid pulsation
Coriolis meter	Stress, vibration	Build in compensators
Oval gear meter	Resonances, pollution	Dampers, filters
Metering of solids		
Measuring instrument	*Influencing parameter*	*Validation/mitigation option*
Conveyor belt weighing	Adhesion, sliding if belt is slanted	Use horizontal belt
Wheel loader scale	Adhesion	Zeroing after each measurement
Wagon weigh bridge	Weighed object not fully on scale ("full draught“)	Use big enough scales
Hopper weigher, truck weigher, crane weigher	Wind	Use wind protection sites

8.2 Error propagation laws

In many cases the measurand of interest is not measured directly but rather calculated from other input quantities being measured through a functional relationship, e.g. a volumetric flow (f_V) is calculated by measuring inputs like density (ρ) and pressure difference (Δp) through the relationship $f_V = f_V(\rho, \Delta p)$. The uncertainty related to the measurand of interest will then be determined as the combined standard uncertainty via error propagation.

For input quantities it is necessary to distinguish between:

- Uncorrelated (independent) input quantities, and
- Correlated (interdependent) input quantities.

If the operator uses different measuring instruments to determine the activity data of parts of the source stream, the associated uncertainties can be assumed to be uncorrelated.

Example: A gas flow measurement is converted from m³ to Nm³ by taking into account temperature and pressure which are measured by separate measuring instruments. These parameters can generally be considered as uncorrelated (see section 8.2.1).

Example: The annual consumption of coal of a coal-fired power plant is determined by weighing the batches delivered during the year with the same belt weigher. Due to drift-effects during operation in practice and due to uncertainties associated to the calibration of the belt weigher, the uncertainties associated with the results of weighing are correlated (see section 8.2.2).

However, this assumption has to be assessed carefully for each case as there may be significant correlation between two input quantities if the same measuring instrument, physical measurement standard, or reference datum having a significant standard uncertainty is used.

8.2.1 Uncorrelated input quantities:

If uncorrelated input quantities $X_1,..,X_n$ are being used to calculate the measurand $Y=Y(X_1,..X_n)$ the uncertainty of Y can be determined by:

$$U_Y = \sqrt{(\frac{\partial Y}{\partial X_1} \cdot U_{X_1})^2 + (\frac{\partial Y}{\partial X_2} \cdot U_{X_2})^2 + ... + (\frac{\partial Y}{\partial X_n} \cdot U_{X_n})^2} \qquad (1)$$

where:

U_Y........ uncertainty (absolute value) of the measurand Y

U_{Xi} .... uncertainty (absolute value) of the input quantity X_i

Example 1: Uncorrelated input quantities

$Y=Y(X_1, X_2)$ is defined by the following relationship:

$$Y = X_1 \cdot X_2$$

The partial derivatives are:

$$\frac{\partial Y}{\partial X_1} = X_2 \qquad \frac{\partial Y}{\partial X_2} = X_1$$

The absolute uncertainty is then given by:

$$U_{Y_1} = \sqrt{(X_2 \cdot U_{X_1})^2 + (X_1 \cdot U_{X_2})^2}$$

where:

U_Y........ absolute uncertainty of measurand Y

U_{Xi}....... absolute uncertainty of input quantity X_i

The relative uncertainty is given by:

$$\frac{U_Y}{Y} = u_Y = \sqrt{\frac{(X_2 \cdot U_{X_1})^2 + (X_1 \cdot U_{X_2})^2}{X_1^2 \cdot X_2^2}} = \sqrt{(\frac{U_{X_1}}{X_1})^2 + (\frac{U_{X_2}}{X_2})^2} = \sqrt{u_{X_1}{}^2 + u_{X_2}{}^2}$$

where:

u_Y........ relative uncertainty of measurand Y

u_{Xi}........ relative uncertainty of input quantity X_i

The square of the relative uncertainty of the measurand is therefore simply determined as the sum of the squares of the relative uncertainties of the input quantities.

Example 2: Independent uncertainties of a sum

A steam boiler for the production of process steam is operated by heating gas as fuel. The used heating gas is supplied to the boiler by ten different pipes. The amount of gas is determined by ten different standard orifice plates according to EN ISO 5167. The uncertainty associated with the determination of the annual consumption of heating gas (uncertainty of a sum) for the steam boiler is calculated by following formula:

$$u_{total} = \frac{\sqrt{(U_1)^2 + (U_2)^2 + ... + (U_{10})^2}}{\left| x_1 + x_2 + ... + x_{10} \right|}$$

Where:

u_{total}..... total (relative) uncertainty associated with the determination of the heating gas

U_i......... uncertainty (absolute value) of the individual standard orifice plates

x_i.......... quantities of heating gas that are measured annually by the different orifice plates

Example 3: Independent uncertainties of a product

A combined heat and power plant with several boilers is fired by natural gas as the only fuel. The annual quantity consumed is determined by a measurement system at the central transfer station (before distribution to the individual boilers) which consists of a turbine meter, a separate pressure measurement and a separate temperature measurement. The turbine meter determines the flow rate at operating conditions.

For emissions reporting the standard volume of natural gas is relevant. For the conversion of operating m³ into standard m³, measurements of pressure and temperature have to be considered. Therefore the uncertainty associated with the determination of the natural gas in standard m³ (uncertainty of a product) is calculated by following formula:

$$u_{total} = \sqrt{u_V^2 + u_T^2 + u_P^2}$$

Where:

u_{total} ..... total (relative) uncertainty associated with the determination of natural gas

u_V .... (relative) uncertainty of the volume measurement

u_T .... (relative) uncertainty of the temperature measurement

u_p......... (relative) uncertainty of the pressure measurement

8.2.2 Correlated input quantities:

If correlated input quantities $X_1,..,X_n$ are being used to calculate the measurand $Y=Y(X_1,..X_n)$ the uncertainty of Y can be determined by:

$$U_Y = \left(\left|\frac{\partial Y}{\partial X_1}\right| \cdot U_{X_1}\right) + \left(\left|\frac{\partial Y}{\partial X_2}\right| \cdot U_{X_2}\right) + \ldots + \left(\left|\frac{\partial Y}{\partial X_n}\right| \cdot U_{X_n}\right) \quad (2)$$

where:

U_Y........ uncertainty (absolute value) of the measurand Y

U_{Xi} .... uncertainty (absolute value) of the input quantity X_i

Example 4: Correlated input quantities

$Y=Y(X_1, X_2)$ is defined by the following relationship:

$$Y = X_1 \cdot X_2$$

If the example above was calculated for correlated input quantities the relative uncertainty would be obtained as:[34]

$$u_Y = u_{X_1} + u_{X_2}$$

The relative uncertainty of the measurand is therefore simply determined as the sum of the relative uncertainties of the input quantities.

Example 5: Correlated uncertainties of a sum

A power plant is coal-fired. The annual consumption of coal is determined by weighing the batches delivered during the year with the same belt weigher. Due to drift-effects during operation in practice and due to uncertainties associated to the calibration of the belt weigher, the uncertainties associated with the results of weighing are correlated.

Therefore, the uncertainty associated with the determination of the coal (uncertainty of a sum) is calculated by following formula:

$$u_{total} = \frac{U_1 + U_2 + \ldots + U_n}{|x_1 + x_2 + \ldots + x_n|}$$

Where:

u_{total} ..... total (relative) uncertainty associated with the determination of coal

U_i......... uncertainty (absolute value) of the belt weigher ($U_1 = U_2 = U_n$)

x_i .... quantities of coal of the different batches

In this case the (relative) uncertainty associated with the determination of coal is equal to the (relative) uncertainty of the belt weigher.

Example 6: Correlated uncertainties of a product

A mineral industry determines the loss on ignition by weighing the product on a table scale before and after the burning process. The loss on ignition is the mass difference before and after the burning process related to the initial weight. The uncertainties associated with the results of the weighing are correlated, because the same table scale is used.

Therefore, the uncertainty associated with the determination of the loss on igni-

[34] Please note that this is only applicable for the very special case where all of the input estimates are correlated with correlation coefficients of 1. If the coefficient is different from 1, more complex functions for covariances are to be considered which are not within the scope of this document. For further reading please consult the GUM (see footnote 32.

tion (uncertainty of a product) is calculated by the following formula:

$$u_{total} = u_1 + u_2$$

Where:

u_{total} ..... is the total (relative) uncertainty associated with the determination of the loss on ignition

$u_{1,2}$....... (relative) uncertainty of the mass measurement before and after heating

8.3 Case studies

Example 7: Uncertainty of the amount of stored fuel

The overall annual consumption of gasoil is calculated from the aggregated deliveries with tank trucks. The trucks are equipped with a flow meter on the truck subject to national legal metrological control with a maximum permissible error of 0.5%. One truck is able to deliver 25,000 litres of gasoil. After the annual forecast the operator expects to require 750,000 litres annually on average over the next year. Therefore, 30 tank truck deliveries per year are expected.

The storage tank for gasoil at the installation has a capacity of 40,000 litres. With a cross section of 8m² the uncertainty of level reading is 2.5% of the total capacity.

Note that the storage tank is capable of containing 40,000/750,000=5.3% of the annually used quantity and therefore has to be considered for the uncertainty assessment[35].

The annual quantity Q of gasoil is determined by formula (10) in section 6.1.1 of Guidance Document 1:

$$Q = P - E + (S_{begin} - S_{end})$$

Where:

P .... Purchased quantity over the whole year

E .... Exported quantity (e.g. fuel delivered to parts of the installation or other installations which are not included in the EU ETS)

S_{begin}.... Stock of the gasoil tank at the beginning of the year

S_{end}...... Stock of the gasoil tank at the end of the year

As the quantity of purchased gasoil over the whole year (P) is not determined by a single measurement but as the sum of many measurements, i.e. 30 truck

[35] According to Article 28(2), derogation is granted where the storage facilities are not capable of containing more than 5% of the annual used quantity of the fuel or material considered. In such case the uncertainty of stock changes may be omitted from the uncertainty assessment.

deliveries, P can be written as:

$$P = P_1 + P_1 + .. + P_{30}$$

Where:

P_i......... Purchased quantity from one truck

Now all input quantities for the determination of Q can be considered as uncorrelated[36]. Under the assumption that no gasoil is being exported (E=0) the uncertainty can therefore be determined in accordance with section 8.2.1 as an uncorrelated uncertainty of a sum:

$$u_Q = \frac{\sqrt{(U_{S,begin})^2 + (U_{S,end})^2 + (U_{P1})^2 + .. + (U_{P30})^2}}{\left| S_{begin} - S_{end} + P_1 + .. + P_{30} \right|}$$

u_Q........ total (relative) uncertainty associated of Q

$U_{S,\,P}$..... (absolute) uncertainty of the stock level reading or quantity provided by one tank

The uncertainty related to the stock level reading is the same for both readings. As the difference between S_{begin} and S_{end} cannot be predicted S_{begin}-S_{end} can be assumed as zero. If further all P_i are considered as equal quantities having equal absolute uncertainties the equation simplifies to:

$$u_Q = \frac{\sqrt{2 \cdot (U_S)^2 + n \cdot (U_{Pi})^2}}{P}$$

$$u_Q = \frac{\sqrt{2 \cdot (40000 \cdot 2.5\%)^2 + 30 \cdot (25000 \cdot 0.5\%)^2}}{750000} = 0.21\%$$

As the activity data related to gasoil consumption has to be expressed in tonnes the density of the fuel has to be taken into account. The uncertainty for determining the bulk density using representative samples is around 3%. Using the formula from section 8.2.1 for uncorrelated uncertainties of a product leads to:

$$u_{Q(tonnes)} = \sqrt{u_{Q(Volume)}^2 + u_{density}^2} = \sqrt{0{,}21\%^2 + 3\%^2} = 3.007\%$$

Although the flow metering had a rather low uncertainty the conversion into tonnes displays that the influence of the uncertainty of the density determination is the most significant contribution to the overall uncertainty. Future improvements should therefore relate to determination of the density with lower uncertainty.

[36] The level reading on the storage tank cannot be considered as being within one measurement series because of the long time period between the measurements (beginning and end of the year). However, as it is still the same measuring instrument that is being used, there may be some kind of correlation. Consideration as uncorrelated is an assumption for this particular example. In general it has to be assessed, e.g. by determining correlation coefficients in accordance with the GUM[32], if correlation really can be ruled out.

Example 8: Uncertainty for source streams partly transferred to connected installations not falling under the EU ETS

When the installation is partly covered by EU ETS and not all parts of that installation fall under the scheme, the quantity measurement determined by an internal sub-meter (uncertainty is 5%) for the non-EU ETS part may have to be subtracted from the quantity of the source stream that is measured by the main meter which falls under national metrological control (uncertainty is 2%).

Suppose the installation site uses 500,000 Nm³ natural gas annually. Out of that amount of natural gas 100,000 Nm³ will be transferred and sold to an installation not falling under EU ETS. To determine the consumption of natural gas of the EU ETS installation, the consumption of natural gas by that connected installation has to be subtracted from the total natural gas consumption of the installation site. To assess the uncertainty for the natural gas consumption of the EU ETS installation, following calculation is performed:

$$u_{sourcestream} = \frac{\sqrt{(2\% \cdot 500{,}000)^2 + (5\% \cdot 100{,}000)^2}}{|500{,}000 + (-100{,}000)|} = 2.8\%$$

Please note, that the uncertainty of the main gas meter under national metrological control does not have to be assessed. The uncertainty of the internal sub-meter that is not guaranteed by national metrological control has to be assessed and confirmed before being able to determine the uncertainty associated with the source stream.

8.4 Uncertainty over the whole installation (fall-back approaches)

This section is relevant if at least parts of the installation's emissions are monitored by a fall-back approach.

Example 9: Overall uncertainty with a fall-back approach

A category A installation has been exclusively burning natural gas during the second trading period with annual emission of 35,000 t CO_2. As this fuel is obtained by a commercial transaction subject to national legal metrological control the uncertainty related to the activity data may be 2.0% using the maximum permissible error allowed by the relevant nation legislation. The 2.0% will also be the uncertainty related to the total emissions as all calculation factors applied are default values are for reasons of simplicity not influencing uncertainty[37].

Due to the extension of the scope of the EU ETS from 2013 (third trading peri-

[37] Please note that also a default value (e.g. IPCC values or National Inventory values) exhibits an uncertainty related to that value. This uncertainty also has to be taken into account by calculating the uncertainty of the source stream from the independent uncertainties of the product (see example 3) using error propagation.

od) onwards an additional source stream will have to be included into the GHG permit and therefore will be required to be monitored. The operator proves to the satisfaction of the CA that applying at least tier 1, e.g. installing a measurement system, is technically not feasible and proposes to use a fall-back approach. The operator provides evidence in accordance with the GUM that an uncertainty assessment for that source stream gives an uncertainty (95 % confidence interval) of 18%. The expected emissions from that source stream are 12,000 t CO_2 annually.

When applying a fall-back approach for a category A installation the operator has to demonstrate that the uncertainty of the emissions for the whole installation does not exceed 7.5%. In the given example the operator has to calculate the uncertainty using the equation

$$Em_{total} = Em_{NG} + Em_{FB}$$

where:

Em_{total} .. total emissions of the installation

Em_{NG} ... emissions resulting from natural gas burning (35,000 t CO_2)

Em_{FB} ... emissions resulting from the source stream monitored by a fall-back approach (12,000 t CO_2)

As the (relative) uncertainty of the overall emissions can be interpreted as the uncertainties of a sum, the overall uncertainty is calculated by:

$$u_{total} = \frac{\sqrt{(2.0\% \cdot 35{,}000)^2 + (18\% \cdot 12{,}000)^2}}{|35{,}000 + 12{,}000)|} = 4.8\%$$

The uncertainty related to the emissions over the whole installation is not exceeding 7.5%. Therefore, the proposed fall-back approach is applicable.