

**Competent Authority Interpretation the Main Uncertainty Analysis  
Requirements resulting from the Revised Monitoring & Reporting Guidelines  
(MRG 2007)**

## INTRODUCTION

The requirements of the European Commission's revised Monitoring and Reporting Guidelines (hereafter referred to as MRG 2007) will apply for Phase 2 of the EU Emissions Trading Scheme starting 1<sup>st</sup> January 2008, and replace the requirements of the original MRG (Commission Decision of 29<sup>th</sup> January 2004). Details of the wider changes resulting from MRG 2007 are reported in the document "*Main Changes Proposed in EU ETS MRG2*", and further indication of implications and responsibilities in "*Guide to the Commission Decision MRG 2007 establishing Guidelines for Monitoring and Reporting in accordance with the EU ETS*". The present guidance aims to identify the main issues pertinent to uncertainty analysis requirements (**including where further analysis may not be required**) and suggest practical approaches for meeting two main requirements. Operators are not obligated to follow the suggested practical approaches or to meet indicative factors where they are provided, or associated conditions, but they will need to carry out their own alternative or supplementary analysis.

## KEY DEVELOPMENTS

The most significant developments in MRG 2007 in relation to uncertainty analysis can be summarised as follows:

- Greater clarity is provided throughout to distinguish between *accuracy* and *uncertainty* requirements. *Accuracy* is specifically defined in Section 2(3)(a) and *uncertainty* in Section 2(3)(b).
- Section 4.3 (The Monitoring Plan) modifies the required content of monitoring plans, and includes a new requirement according to Section 4.3(g) for "*evidence demonstrating compliance with uncertainty thresholds for activity data and other parameters (where applicable) for the applied tiers for each of the source streams to be monitored*". *Source stream* is defined in Section 2(1)(d).
- Section 5.3 (The Fall-Back Approach) offers an alternative to normal Section 5.2 (Tiers of Approaches) compliance where it is not technically feasible or would lead to unreasonable costs to meet even Tier 1 for all (except de minimis) source streams. Operators wishing to apply the fall-back approach need to gain Competent Authority approval for a customised monitoring methodology for the whole installation and an overall uncertainty analysis. The uncertainty analysis is specifically required to take into account the ISO/TAG4 Guide on the Expression

of Uncertainty in Measurement, and ISO 5186:2005, and demonstrate compliance with overall an uncertainty threshold advised in MRG 2007 Table 2.

- Section 7.1 (Uncertainty Assessment - Calculation) provides much more detailed insight in relation to minimum uncertainty analysis requirements. Key pieces of text are:
  - The third paragraph: *The uncertainty determined for the measurement system within the tier system shall comprise the **specified uncertainty of the applied measurement instruments, uncertainty associated with the calibration and any additional uncertainty connected to how the measurement instruments are used in practice.** The stated threshold values within the tier system refer to the uncertainty associated to the value for one reporting period.* This indicates need to consider three key components, the fundamental uncertainty of the measurement system, the uncertainty associated with the system's calibration, and uncertainties caused by the environment in which the system is used. Definitions of "measurement", "measurement instrument", and "measurement system" are provided in Section 2(3).
  - The fifth paragraph: *"...the operator shall provide written proof of the uncertainty level associated with the determination of activity data for each source stream in order to demonstrate compliance with the uncertainty thresholds defined in Annexes II-XI of these Guidelines. **The operator shall base the calculation on the specifications as provided by the supplier of the measurement instruments.** If the specifications are not available, the operator shall provide for an uncertainty assessment of the measurement instrument. In both cases, he shall take into account necessary corrections of these specifications from effects resulting from the actual use conditions like ageing, conditions of the physical environment, calibration and maintenance. **These corrections may involve conservative expert judgement.***
  - The sixth paragraph: *"If measurement systems are applied, the operator shall take into account the cumulative effect of all components of the measurement system on the uncertainty of the annual activity data using the error propagation law..."*

However, Section 7.1 does indicate potential for dispensation from the above requirements in the case of two specific circumstances:

1. **Installations with low emissions (less than 25 ktonnes fossil CO<sub>2</sub> annually, according MRG 2007 Section 16) – see further reference below.**
2. **Under the fourth paragraph (Section 7.1): *As regards commercially traded fuels or materials, competent authorities may permit the determination of the annual fuel/material flow by the operator based solely on the invoiced amount of fuel or material without further individual proof of associated uncertainties, provided that national legislation or the demonstrated application of relevant national or international standards ensures that***

***respective uncertainty requirements for activity data are met for commercial transactions.*** This allows potential dispensation for operators from having to provide further proof of activity (flow) data measurement uncertainty where they can demonstrate for a source stream:

- The fuel/material qualifies within the respective MRG 2007 Section 2(2)(f)&(g) definitions for commercially traded fuels/materials, and:
- The invoiced amount of fuel/material is underpinned by relevant national legislation or relevant national/international standards inclusive of an inherent uncertainty that meets the MRG 2007 activity tier level required of the installation (for example, less than  $\pm 1.5\%$  for highest tier compliance).

In other respects, it is noticeable that Section 7.1 makes no provision to allow dispensation from the stated requirements on grounds of unreasonable costs.

- Section 7.2 (Measurement) requires operators who want to apply a measurement based methodology (i.e. to monitor using a continuous emission monitor) to demonstrate that it will result in lower uncertainty than a relevant calculation based methodology by reporting *the quantitative results of a more comprehensive uncertainty analysis considering the following sources of uncertainty taking into account EN 14181*
  - *the specified uncertainty of continuous measurement equipment;*
  - *uncertainties associated to the calibration;*
  - *additional uncertainty connected to how the monitoring equipment is used in practice*
- Section 13.6 (Sampling Methods and Frequency of Analysis) provides more guidance on representative sampling and analysis required in relation to top tier determinations of emission, oxidation, and conversion factors, NCVs, carbon content, biomass fraction and composition data. The preferred approach is for operators to demonstrate that ***the sampling procedure and frequency of analyses shall be designed to ensure that the annual average of the relevant parameter is determined with a maximum uncertainty of less than 1/3 of the maximum uncertainty which is required by the approved tier level for the activity data for the same source stream***
- Section 16 (Requirements for Installations with Low Emissions) offers some flexibility to allow various dispensations for “small installations” including in relation to uncertainty analysis requirements, namely:
  - *The uses of fuels or materials can be determined based on purchasing records and estimated stock changes without further consideration of uncertainties.*

**This allows installations with emissions <25,000 tonnes fossil CO<sub>2</sub> per year (according to Section 16) to derive their data concerning fuel/material use direct from purchase records and known stockpile movements without carrying out a further uncertainty assessment. It is also interpreted as allowing an affected operator dispensation from**

needing to check or be aware of their supplier's uncertainty analysis and whether this suggests compliance with a particular tier uncertainty threshold, or to report an uncertainty value against a source stream in their ETS2 monitoring plan submission. Operators should enter tier 1 in their ETS2 submissions regarding such circumstances.

- *Where necessary, the operator may use information as specified by the supplier of relevant measurement instruments irrespective of specific use conditions to estimate the uncertainty of activity data.*

**This applies where purchasing records are not available (the operator is relying on their own activity data metering) or to where secondary meters are used to disaggregate part of a source stream passed on to a non-EU ETS activity. Even under these circumstances, operators (of installations with emissions <25,000 tonnes fossil CO<sub>2</sub> per year, in accordance with Section 16) are allowed to waive Step 2 of the main uncertainty assessment guidance (regarding use conditions).**

- *Member States may permit the use of simplified monitoring plans....*

**This includes provision for the Member State to waive the MRG Section 4.3(g) need for a monitoring plan to contain “evidence demonstrating compliance with the uncertainty thresholds for activity data and other parameters (where applicable) for the applied tiers for each source stream”. However, it does not provide option to waive the MRG 2007 Section 4.3(e) need for monitoring plans to contain “a list and description of the tiers for activity data, emission factors, oxidation factors and conversion factors for each of the source streams to be monitored”. Therefore, operators proposing to rely on purchasing records and estimated stock changes without further consideration of uncertainties should enter Tier 1 in their ETS2 monitoring plan submissions for activity data and the source streams concerned.**

## PRACTICAL APPROACHES

Where required:

**APPENDIX I (UNCERTAINTY ASSESSMENT OF QUANTITY MEASUREMENTS (ACTIVITY DATA) IN RELATION TO EU ETS REQUIREMENTS – GUIDANCE NOTE I)** proposes a methodology for meeting the uncertainty assessment requirements of Section 7.1 in as a practical a way as possible. **Before applying the full methodology, operators should note Points 1 and 2 above in the “Key Developments” section (under Section 7.1) and further clarification in the following note as to whether they may have dispensation from need to undertake such analysis.** Otherwise, the guidance attempts to provide core component values suitable for most operators to be able to select as appropriate, and points to requisite action where they are not. In this respect, operators are usually advised to approach the supplier of the measurement system for additional

information or alternative expert judgement. It should be noted that no attempt is made to define “expert” to allow operators flexibility to seek compromise between understanding of the measurement system and the environment in which the system is being used.

**APPENDIX II (UNCERTAINTY ASSESSMENT OF ACTIVITY SPECIFIC FACTORS - GUIDANCE NOTE II)** advises how to determine the uncertainty associated with determinations of installation-specific net calorific values, emission factors, oxidation factors, conversion factors, carbon contents, biomass fractions and composition data. This is in order to compare against the MRG 2007 Section 13.6 threshold advising activity-specific factors are determined with a maximum uncertainty of less than 1/3 of the maximum uncertainty required for activity tier compliance. **Note that this is only relevant where highest tier compliance is required.**

## Appendix I

### **Uncertainty Assessment of Quantity Measurements (Activity Data) in relation to EU ETS requirements – Guidance Note I**

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#### **Introduction**

This guidance note outlines a practical way to assess the uncertainty of measurement instruments and measurement systems that are used as part of an EU ETS monitoring methodology. Section 7.1 of the MRG requires operators to take account of the cumulative effect of the components of a measurement system on the uncertainty of annual amount of source stream using the error propagation law. Specific reference is made to ISO-5168:2005<sup>1</sup> and the Guide to Expression of Uncertainty in Measurement<sup>2</sup> but these standards are detailed and complicated to apply. Of course, the operator is free to use the standards, but we think that this guidance note provides a more practical and proportionate method to determine the uncertainty of the majority of EU ETS related measurement instruments and measurements systems used to measure the amount of fuel or material in an installation. If the operator has better information on the company specific measurement situation than the information in this guidance, the operator should use this better information. The onus of proving and substantiating the uncertainties in those cases shall always be on the operator (see steps 1 and 2 of section II of this note for further information).

This guidance note has been developed by the Emissions Trading Technical Support Group (ETSG) which is operated in support of the IMPEL EU ETS Project. The members of the ETSG endorse the methodology described in this guidance note as a very useful and suitably practical approach for the assessment of measurement instrument and measurement system uncertainty as required by the MRG. It is suggested that this note is read in conjunction with the MRG and any associated guidance provided by Member States.

This guidance note consists of two sections in which the following questions are answered:

**Question I:** When to assess the measurement uncertainties in relation to MRG monitoring requirements?

**Question II:** How to assess the uncertainty of a quantity measurement of a source stream?

**Note:** Uncertainties will always be expressed as a 95% confidence interval around the annual values.

#### **I. When to assess the measurement uncertainties in relation to MRG monitoring requirements?**

The operator has to describe in his monitoring plan how from each source stream the CO<sub>2</sub> emissions will be determined. In principle the uncertainty associated with the

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<sup>1</sup> ISO-5168:2005 “Measurement of fluid flow – Procedures for the evaluation of uncertainties.

<sup>2</sup> Guide to the Expression of uncertainty in measurement, ISO/TAG 4. Published by ISO (1993; improved reprint, 1995) on behalf of BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.

amount of a source stream (fuel, raw material, auxiliary and product) has to be submitted and substantiated in the monitoring plan. Section II of this guidance document outlines how to assess the uncertainty of a quantity measurement of a source stream.

Before continuing, it is important to note that there are some situations where the MRG does not require the operator to provide written proof of the uncertainty associated with the determination of the amount of fuel or material. Subject to Competent Authority approval, the **uncertainty does not have to be assessed** for source streams involving:

- Commercially traded (or standard) fuels or materials where the uncertainty requirements applicable to the measurements will be guaranteed by national legislation or the proven application of relevant national and international standards. The total amount of fuel or material and the net calorific value of the fuel can be derived from supplier invoices without considering and substantiating the uncertainty of the measurement instrument. (MRG 2007, Section 7.1);
- De minimis source streams where a no tier approach may be applied, and the selected method does not involve compliance with an uncertainty threshold. (MRG 2007, Section 5.2);
- All quantities of major and minor source streams within small installations (those that emit in total less than 25 ktonnes of fossil CO<sub>2</sub> annually, according to MRG 2007, Section 16) where the uncertainty associated with the amount of these source streams does not have to be substantiated or assessed. Operators may base the determination of the amount of fuel or material on purchasing records (for example, invoices) and/or estimated stock changes. The quantity measurement instrument does not have to be guaranteed by national legislation or the proven application of relevant national and international standards. When substantiating the uncertainty of internal meters operators may use the uncertainty advised by the meter supplier irrespective of the circumstances in which the meters are being used (see step 2 for further information).

The operator **has to assess the uncertainty** for the quantity measurements of the following source streams:

- All major and minor source streams (within installations emitting  $\geq 25$  ktonnes of fossil CO<sub>2</sub> annually) that are not commercially traded (or standard) fuels or materials;
- All major and minor source streams (within installations emitting  $\geq 25$  ktonnes of fossil CO<sub>2</sub> annually) that belong to commercially traded (or standard) fuels or materials but that are not or not only being measured by guaranteed main meters;
- Major and minor source streams within small installations (those that emit in total less than 25 ktonnes of fossil CO<sub>2</sub> annually, according to MRG Section 16) where the amount of fuel or material cannot be determined on the basis of supplier data and/or stock changes. When supplier data, invoices and stock changes cannot be used by the operator, small installations are allowed to use the information specified by the manufacturer of the measurement instrument in order to estimate the uncertainty of activity data. The same is true for

situations in which the operator cannot use supplier data of internal meters (please see step 2 for further information).

## **II How to determine the uncertainty of a quantity measurement of a source stream?**

The required tiers for the quantity measurement are related to each source stream. As a result the achieved uncertainty for each source stream has to be assessed. It should be noted that for emissions trading the operator needs to assess the uncertainty of the measurement data over a year, rather than the uncertainty of an individual observation at one particular moment in time. Random errors are a major factor in the uncertainty of an individual observation, but not the uncertainty of measurement data over a year. In this case systematic errors are more significant. Random errors tend to average during the year.

The practical way to determine and assess the uncertainty associated to the amount of a source stream consists of the following five steps:

- Step 1: Assess the uncertainty of the measurement instrument;
- Step 2: Assess the additional uncertainty of “context specific” factors (i.e. how the measurement instrument is used in practice);
- Step 3: Assess the uncertainty of pressure and temperature corrections for gas meters;
- Step 4: Sum up the uncertainties of steps 1, 2 and 3;
- Step 5: Assess the uncertainty of the amount of the source stream.

### **Step 1: Assess the uncertainty of the measurement instrument**

This step concerns the instrument specific uncertainty that is linked to the measurement principle of a meter. Annex I to this guidance contains standard uncertainty levels for the most common measurement instruments. The operator is allowed to submit this uncertainty level in his monitoring plan without further assessing and substantiating that number provided that the measurement instrument concerned meets the conditions laid down in Annex I and the relevant measurement principle is applicable. If the specific meter does not meet one or more condition laid down in Annex I, the operator has to substantiate and justify that the conditions concerned do not influence the uncertainty. The operator is also allowed to make a conservative and substantiated judgement of the additional effect that the non-compliance of the conditions concerned would have on the uncertainty of the measurement instrument.

As an alternative to Annex I, operators may submit their own values for their measurement instruments, as derived or provided by the instrument manufacturer.

Where an operator decides to use this guidance note, they should describe how they propose to meet the conditions for the measurement instrument that are prescribed for the measurement principle concerned in Annex I within their written procedures covering the quality assurance of measuring equipment. It is appropriate to refer to the requirements of the manufacturer if these are applicable, and provided that these requirements are available within the installation. In any case, the procedures must show the frequency with which the operator carries out the maintenance and calibration of the measurement instruments.

It can be the case that the uncertainty depends on the total quantity that a measurement instrument actually measures: for example, for 0-20% of the maximum measurement range another uncertainty applies than for 20-100% of the maximum measurement range. If both situations occur within the representative company-specific circumstances of the installation, the operator does not have to calculate the weighted average uncertainty. The uncertainty of the weighted average measurement value is sufficient for those cases. Below an example of how to calculate this average is included.

*Example:*

A rotor meter that measures gas has an uncertainty of 3% for 0-20% of the maximum measurement range and an uncertainty of 1,5% for 20-100% of the maximum measurement range (see Annex I). In a year 480,000 m<sup>3</sup> natural gas flows through the meter during 8000 hours. The maximum flow (100%) is 220 m<sup>3</sup>/hour. The weighted average flow corresponds to 27,3% of the maximum measurement range:

$$\frac{480,000}{8,000 * 220} = 27,3\%$$

Conclusion: as 27,3% is within the range of 20-100%, the operator may apply an uncertainty of 1,5%.

If the measurement instrument concerned is not mentioned in Annex I, the operator has to assess the uncertainty of that measurement instrument in a year on the basis of specifications provided by the supplier of the measurement instrument. The conditions that have to be met for that uncertainty have to be derived from supplier data. This should include specifications regarding maintenance and calibration requirements.

**Step 2: Assess the additional uncertainty of context specific factors**

This step is not applicable to measurement instruments within small installations (emitting less than 25 ktonnes fossil CO<sub>2</sub> annually, according to MRG Section 16). They can apply an uncertainty of 0% for the outcome of step 2.

To assess the additional uncertainty the following questions need to be answered:

- Is the measurement instrument installed according to the requirements of the manufacturer or, if those data are not available, according to general requirements that apply to that measurement principle?<sup>3</sup>
- Is the medium (gas, fluid, solid substance) that is measured by the meter a medium for which the measurement instrument has been designed according to the requirements of the manufacturer or, if these data are not available, according to the general requirements applicable to that measurement principle?
- Are there no other factors that can have adverse consequences on the uncertainty of the measurement instrument?<sup>4</sup>

<sup>3</sup> In some cases manufacturer data for old instruments no longer exist. For those situations general calibration and maintenance requirements that are applicable to the relevant measurement principle, can be applied.

If the answer to all three above questions is yes, the operator can use an uncertainty of 0% for the outcome of step 2. If the answer to one or more of these questions is no, the operator has to make a conservative and substantiated judgement of the additional uncertainty that is connected to the factor or factors for which the operator has answered negatively. This judgement has to be done in consultation with the manufacturer of the measurement instrument or another expert.<sup>5</sup>

### **Step 3: Assess the uncertainty of the pressure and temperature corrections for gas meters**

Pressure and temperature corrections are only applicable to the determination of the amount of gas and not to the measurement of fluids or solid substances. For fluids and solid substances the operator can use an uncertainty of 0% for the outcome of step 3. The operator has to correct the actual amount of gas for pressure and temperature to normal conditions. This correction is compulsory since not correcting these elements may cause major systematic errors. The following situations can occur in practice.

#### *Situation I Gas meter with Electronic Volume Conversion Instrument (EVCI)*

If the operator has a gas meter with an EVCI that determines the pressure and temperature, the following standard uncertainties and numbers can be applied for the outcome of step 3 for the ECVI.

However **when a temperature and pressure measurement covers more than one meter** those measurements cannot be regarded as independent from each other.

Therefore step 3a is introduced which reflects the situation in which the measurement of pressure and temperature are interdependent (this would for example be the case in situation III).

$$U_{\text{step } 3} = 0,5$$

$$U_{\text{step } 3a} = 0$$

The uncertainty of 0,5% can only be used if the operator meets the conditions laid down in Annex I for ECVI. These conditions have to be submitted in the part of the monitoring plan that relates to the quality assurance of measurement equipment.<sup>6</sup>

#### *Situation II Gas meter using separate pressure and temperature measurement*

If the operator has a gas meter using a separate pressure and temperature measurement at that meter, he has to make a conservative and substantiated judgement of the uncertainty of the pressure and temperature measurement in consultation with the manufacturer of the meter or another expert.

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<sup>4</sup> A factor that can have an adverse effect could be the composition of the medium that flows through the measurement instrument. In this practical method to assess uncertainties the departing point is that the effect of ageing on the uncertainty is zero if the operator meets the calibration and maintenance requirements in Annex I.

<sup>5</sup> In some cases an in-house expert could be used to make a conservative judgement. An operator is allowed to use an inhouse-expert provided that he is capable of making that expert judgement and that the competent authority agrees with that in-house expert judgement in the context of validating the monitoring plan.

<sup>6</sup> In response to Section 4.3(m) and Section 10.3.1 of the MRG.

The uncertainty has to be calculated according to the following formula in the outcome of step 3.

$$U_{\text{step}_3} = \sqrt{(U_{\text{pressuremeasurement}})^2 + (U_{\text{temperaturemeasurement}})^2}$$

$$U_{\text{step}_3a} = 0$$

Where:

U is the uncertainty.

*Situation III Gas meter without separate pressure and temperature measurement*

If there is a gas meter without separate pressure and temperature measurement at that meter (correction takes place on the basis of pressure and temperature measurement/EVCI at the main gas meter), the operator has to make a conservative and substantiated judgement of the uncertainty of the pressure and temperature measurement at the location of the gas meter concerned in consultation with the manufacturer of the meters or another expert. The operator has to take the differences in pressure and temperature into account between the location of the pressure and temperature measurement and the location of the gas meter concerned.

The uncertainty of the pressure and temperature measurement has to be determined according to the following formula in the outcome of step 3:

$$U_{\text{step}_3} = 0$$

$$U_{\text{step}_3a} = \sqrt{(U_{\text{pressuremeasurement}})^2 + (U_{\text{temperaturemeasurement}})^2}$$

Where:

U is the uncertainty.

**Step 4: Sum up the uncertainty of step 1, 2 and 3**

Steps 1, 2 and 3 lead to uncertainty levels that need to be summed up to determine the total uncertainty of the individual quantity measurement. The following formula has to be applied by the operator:

$$U_{\text{quantitymeasurement}} = \sqrt{(U_{\text{step}_1})^2 + (U_{\text{step}_2})^2 + (U_{\text{step}_3})^2}$$

Where:

U is the uncertainty.

Note:

The uncertainty of step 3a ( $U_{\text{step}_3a}$ ) has to be 'saved' for step 5.

**Step 5: Assess the uncertainty of the amount of the source stream**

In steps 1 to 4 the operator has determined the uncertainty of one individual (corrected) quantity measurement. If the amount of a source stream is determined by more measurement instruments, the operator has to sum up the uncertainties of these different individual measurements (the components of the measurement system) to determine the total cumulative uncertainty of the amount of the source stream.

The following formula has to be applied by the operator:

$$U_{\_source\_stream} = \sqrt{\left( \frac{\sqrt{(U_1 * x_1)^2 + (U_2 * x_2)^2 + (U_n * x_n)^2}}{x_1 + x_2 + x_n} \right)^2 + (U_{\_step\_3a})^2}$$

Where:

$U_{\_source\_stream}$  is the total uncertainty of the source stream;

$U_1 - U_n$  are the uncertainties of the individual quantity measurements as determined in step 4;

$x_1 - x_n$  are the quantities that are measured annually by the measurement instruments concerned.

If the total uncertainty of the source stream is measured with one measurement instrument and situation I or II as described in step 3 is applicable, the outcome of step 5 is the same as the outcome of step 4.

To assess the uncertainties associated to the amount of the source streams in a practical way operators may consider the uncertainties in the formula as uncorrelated uncertainties. In practice the measurements may be partly interdependent and partly uncorrelated.

## Annex I: standard measurement uncertainties for the most common measurement instruments

<p><b>Rotor meter</b></p> <p>Medium: gas</p> <p>Uncertainty for 0-20% of the maximum measurement range: 3 %          Uncertainty for 20-100% of the maximum measurement range: 1,5%</p> <p>Conditions:</p> <ul style="list-style-type: none"> <li>- Once per 10 year cleaning, recalibration and if necessary adjusting</li> <li>- Annual inspection of the oil level of the carter</li> <li>- Application filter for polluted gas</li> <li>- Life span 25 years</li> </ul>
<p>Medium: fluid</p> <p>Uncertainty for 5-100% of the maximum measurement range: 0,3%</p> <p>Conditions:</p> <ul style="list-style-type: none"> <li>- Once per 5 year cleaning, recalibration and if necessary adjusting (or at an earlier time when flow of 3500 hours × maximum range of the meter has run through the meter</li> <li>- Annual maintenance according to instructions of manufacturer / general instructions measurement principle</li> <li>- Life span 25 years</li> </ul>
<p><b>Turbine meter</b></p> <p>Medium: gas</p> <p>Uncertainty for 0-20% of the maximum measurement range: 3 %          Uncertainty for 20-100% of the maximum measurement range: 1,5%</p> <p>Conditions:</p> <ul style="list-style-type: none"> <li>- Once per 5 year cleaning, recalibration and if necessary adjusting</li> <li>- Annual visual inspection</li> <li>- Once per three months lubrication of bearings (not for permanent lubricated bearings)</li> <li>- Application filter for polluted gas</li> <li>- No pulsating gas stream</li> <li>- Life span 25 years</li> <li>- No overload of longer than 30 minutes &gt; 120% of maximum measurement range</li> </ul>
<p>Medium: fluid</p> <p>Uncertainty for 10-100% of the maximum measurement range: 0,3%</p> <p>Conditions:</p> <ul style="list-style-type: none"> <li>- Once per 5 year cleaning, recalibration and if necessary adjusting</li> <li>- Once per three months lubrication of bearings (not for permanent lubricated bearings)</li> <li>- Application filter for polluted fluid</li> <li>- Life span 25 years</li> <li>- No overload of longer than 30 minutes &gt; 120% of maximum measurement range</li> </ul>

**Bellows meter**

Medium: gas

Uncertainty for 0-20% of the maximum measurement range: 6 %

Uncertainty for 20-100% of the maximum measurement range: 4%

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 fluid

Uncertainty for 30-100% of the maximum measurement range: 1,5%

Conditions:

- Annual calibration of pressure meter
- Once per 5 years calibration of entire measurement instrument
- 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 fluids

Guidelines for building in orifices: minimum of 4D free input flow length before the orifice and 2D after the orifice: smooth surface of inner wall.

**Venturi meter**

Medium: gas and fluid

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

Conditions:

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

**Ultrasonic meter**

Medium: gas and fluid

Uncertainty for 1-100% of the maximum measurement range: 0,5%

Conditions:

- Once per 5 years cleaning, recalibration and if necessary adjusting
- Annual inspection of contact transducer with tube wall; when there is no sufficient contact, contact material has to be replaced according to specifications 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: minimum of 10D free input flow length before the meter and 5D after the meter

**Vortex meter**

Medium: gas

Uncertainty for 10-100% of the maximum 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: minimum of 15D free input flow length before the meter and 5D after the meter

Medium: fluid

Uncertainty for 10-100% of the maximum measurement range: 1,5%

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 and gas bubbles

Guidelines for building in vortex meters: minimum of 15D free input flow length before the meter and 5D after the meter

**Coriolis meter**

Medium: gas and fluid

Uncertainty for 1-100% of the maximum measurement range: 1%

Conditions:

- Once per 5 years cleaning, recalibration and if necessary adjusting
- 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

**Ovalrad meter**

Medium: fluid

Uncertainty for 5-100% of the maximum measurement range: 0,5%

Conditions:

- Viscid fluids (oil): once per 5 years cleaning, recalibration and if necessary adjusting
- Thin fluids: 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

Uncertainty for 0,95-11 bar and -10 – 40°C: 0,5%

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

## Appendix II

### Uncertainty Assessment of Activity Specific Factors - Guidance Note II

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#### Introduction

According to section 13.6 MRG the preferred approach is for sampling procedure and frequency of analyses to be designed such that the annual average of the activity-specific factors is determined with a maximum uncertainty of less than 1/3 of the maximum uncertainty which is required for activity tier compliance. This guidance clarifies how to determine the uncertainty for the net calorific value, emission factor, oxidation factor, conversion factor, the carbon content, the biomass fraction and the composition data. It provides for a practical method to assess that uncertainty.

#### **1. How to assess the uncertainty of the activity-specific factors that are relevant for determining the CO<sub>2</sub> emissions in an installation?**

Before describing this method it is important to indicate the situations in which the MRG does not require the operator to provide written proof of the uncertainty associated with the determination of the activity-specific factors. The uncertainty does not have to be assessed in the following cases:

1. The variable concerned is not relevant for determining CO<sub>2</sub> emissions.
2. The operator is allowed to use standard factors for the variable concerned.
3. The operator is allowed to determine the variable according to the minimum frequency of analyses indicated in MRG Table 5.<sup>7</sup>
4. The net calorific value of a commercially traded (or standard) fuel or material is based on accepted national or international measurement standards. In that case the operator can take the net calorific value from the invoice of the supplier. He does not have to assess and substantiate the uncertainty of the net calorific value.

*Further situations where determinations are not required:*

- The conversion factor is not relevant for determining the CO<sub>2</sub> emissions from a fuel stream.
- The oxidation factor is not relevant for determining the CO<sub>2</sub> emissions from a material stream.
- The operator uses a standard factor 1 for the oxidation factor.
- For the net calorific value and emission factor the operator uses standard factors.<sup>8</sup>

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<sup>7</sup> The requirement in the Guidance on CO<sub>2</sub> monitoring is in accordance with the frequency of analyses laid down in table 5 in section 13.6 of the MRG.

<sup>8</sup> Section 11 of the MRG or standard factors as reported by the respective Member State in its latest national inventory submitted to the Secretariat of the United Nations Framework Convention on Climate Change.

The operator shall assess the uncertainty for all factors that are relevant to the determination of CO<sub>2</sub> emissions within the installation if those factors have to be determined according to the required tier.

## 2. How to determine the uncertainty of the activity-specific factors

If the activity-specific factors that are relevant for determining CO<sub>2</sub> emissions have to be determined, the maximum allowable uncertainty connected to that variable is 1/3 of the maximum uncertainty that applies to the activity tier (regarding the quantity measurement of the source stream).

*Example:*

If the amount of coal within the installation has to be determined with a required uncertainty of <1.5% (tier 4), the net calorific value and the emission factor of coal have to be determined with an uncertainty of 1/3 \* <1,5% = <0,5%.

The advantage of this approach is that the operator does not have to sample and analyse the raw materials or fuels of a constant composition to a needless extent. If the operator cannot meet the required uncertainty for one or more variables or is not able to demonstrate compliance with the uncertainty requirement, the operator can opt for applying the conservative frequency of analyses laid down in Table 5 of Section 13.6 of the MRG.

### Method

The uncertainty in determining the variables can be reduced by increasing the number of samples and analyses. Statistically the uncertainty in the average emission factor or net calorific value will diminish with a factor  $1/\sqrt{n}$  where n is the number of independent observations on which the average is based. An independent observation is the (average) resultant analyses of one sample or one mixed sample.

To meet the uncertainty requirement for the variables the operator, when drafting the monitoring plan, has to determine through historical data how often analyses and sampling have to be carried out. Subsequently sampling and analyses have to be carried out according to the calculated frequency. On the basis of the results of the analyses the operator can calculate whether he meets the required uncertainty in practice. In view of this the operator can adjust the frequency of samples and analyses.

### Helpful tool for operators

With the aid of the spreadsheet 'Uncertainty variables CO<sub>2</sub> emissions.xls' and the historical results of analyses of the variables that are available within the installation site and applicable to the installation site concerned, the operator can discern quickly the number of analyses he has to carry out to meet the required uncertainties. This spreadsheet can be downloaded from:

[www.emissieautoriteit.nl>mediatheek>hulpmiddelen](http://www.emissieautoriteit.nl>mediatheek>hulpmiddelen).<sup>9</sup>

In the work table 'history' the results of analyses carried out in the past and the required uncertainty of the quantity measurement can be filled in. On the basis of this the spreadsheet calculates a minimum number of samples and analyses and will

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<sup>9</sup> Currently only the Dutch version of this spreadsheet is to be found on the website.

advise the operator the frequency of those samples and analyses. As from 2008 the results of analyses can be filled in the worktable 'uncertainty'. This worktable will calculate the actual realised uncertainty of the variable concerned.

The spreadsheet is a simple approach that assumes that the installation will apply the annual average of the variable when monitoring CO<sub>2</sub> emissions without using a weighted factor for the flow. Alternatively, the operator is allowed to use a method of his own to determine the uncertainty of the variables.

### **Monitoring plan**

If the operator uses this guidance he is advised to submit in association with his monitoring plan for every source stream which tier is required and which tier is achieved. For the activity-specific factors the operator has to indicate confirmation of the uncertainty of the factor concerned. This can be done by an attached Annex to the monitoring plan that contains a print-out of the work table 'history' in the spreadsheet for all the factors. The operator is also allowed to refer to confirmations and justifications that are available within the installation site. The part of the monitoring plan that relates to the quality assurance of the measurement equipment has to show clearly for each variable how many samples and analyses will be taken.