v2

EXPLANATORY & GUIDANCE document (E&G-d) on IED-based (draft) Waste Incineration BREF and BAT conclusions

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ANNEX 3
Monitoring & Uncertainties

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Annex 3.b: About the INERIS study and standards requirements

Abbreviations and explanations

Please see Annex 1 to this Explanatory and Guidance document (E&G-d) for:

- a summary of abbreviations
- and, in its section 2, explanations on measurements wording.

1. Need for a study on monitoring systems performances

The question of measurement uncertainty at low concentration levels and of compliance with the IED as well as with the requirements of the relevant standards has been raised in the framework of the revision of the Waste Incineration BREF for setting of BATAEL ranges and BATAEL based Emission Limit Values in accordance with the requirements of IED Chapter 2. In most cases, these values, in particular the lower part of the ranges, are significantly lower than the ELVs currently set in Annex VI of the IED.

In order to determine the implementation and compliance conditions for BATAEL-based ELVs that come under IED Chapter 2, the first step is to understand the rules set in IED Chapter 4 and Annex VI for the ELVs defined in this Annex.

1.1 Requirements on uncertainties in IED Chapter 4 and Annex VI ELVs

For Waste incineration plants (and co-incineration plants in the scope of IED Chapter 4), IED Chapter 4 and Annex VI[1] set requirements and thresholds on uncertainties in two different ways:

- Directly, for continuously monitored substances, expressed as CI95% (Confidence Intervals at 95%), of the daily IED Annex VI ELVs[2], which, *de facto,* is an absolute uncertainty to be subtracted from the measured valid half-hourly values (See Table 3.a-1 in Annex 3.a of this E&G-d.)
- Indirectly, by requesting to use standards on monitoring that:
  - Impose Quality Assurance Levels tests and Annual Surveillance Test (see EN 14181 and EN 15267-1, -2 and -3):
    - QAL1: offsite certification (made by TÜV or MCERTS) of the future online instrument (AMS) before it is put on the market. Usually, the QAL 1 certificate provides the LoQ (Limit of Quantification)
    - QAL2: onsite calibration (every 3 year for incineration plants) of the online instrument (AMS) by a certified laboratory using a reference system (SRM)
    - QAL3: regular checking of the drift
    - AST: annual checking of QAL2 calibration.
  - Set maximum uncertainties for SRMs (Standard Reference Methods) used to calibrate the online instruments (AMS, Automated Measurement Systems) and to perform periodic measurements. See Table 3.b-1 below.

[1] Similar requirements are made for LCPs in IED Chapter 3 and Annex V.

[2] Similar uncertainty thresholds are given for Large Combustion Plants in IED Annex V.

	$U_{max\ IED}$	U_{maxAMS} (= 0,75 Umax IED)	U_{SRM} (requested by SRM standards)
CO	10%	7,5%	6% (EN 15058)
SO_2	20%	15%	20% (EN 14791)
NO_x	20%	15%	10% (EN 14792)
Dust	30%	22,5%	20% (rev pr EN 13284-1)
TOC, CH_4	30%	22,5%	15% (XP X 43-554)
HF, $NH_{3(France)}$	40%	30%	-
HCl	40%	30%	30% (EN 1911)
Water vapour	-	-	20% (EN 14790)
O_2	-	-	6% (EN 14789)

***Table 3.b-1**: Maximum uncertainties required by IED Annex VI, EN 15267-3 and the standards for SRMs. The 2nd column shows IED Annex VI CI95%. The 3rd column shows the part of it (75%) allocated to AMSs according to EN 15267-3, section 14, the rest being for peripheral instruments (See INERIS report § 2.1.7 and 2.3.3, pp. 31 and 34/132). The 4th column shows the maximum uncertainty requested for the different substances by the relevant SRMs standards and their n°. The shades of orange how far is the requirement for SRMs from the downgraded objective that the SRM uncertainty is less than half of the AMS uncertainty.*

According to EN 14181 and ISO 11095, the uncertainty of the SRMs (U_{SRM}) should be much smaller than the uncertainty of the AMSs (see INERIS report § 2.3.3, p. 35/132). However, even a downgraded goal aiming at having SRMs uncertainties equal to half of the AMSs maximum uncertainties is not achieved. Indeed, as one can see on Table 3.b-1, it is already far from being the case for IED maximum uncertainties with the maximum uncertainties of SRMs. The maximum uncertainties required for SRMs are just a little bit smaller than the ones devoted to the AMSs. For SO_2, it is even worse, the maximum uncertainty allowed for the SRM (20%) is larger than the one required for the AMS (15%).

On the other hand, the incineration sector ELVs and emissions are already the lowest of all combustion industries. Because of these very low levels of emission, *in situ* calibrations, the QAL2, QAL3 and the AST are for years a challenge. See Annex 3.c to this E&G-d on QAL2 calibration functions. If ELVs are lowered, the relative uncertainty will significantly increase, potentially making impossible the compliance with the requirements of the monitoring standards in respect of maximum acceptable uncertainty.

1.2 A study commissioned to INERIS

CEWEP, ESWET and FEAD commissioned INERIS[3], the French Institute expert in measurement and uncertainties, to make a study in order to assess in the context of the WI BREF the performances of:

- the online instruments, AMSs (Automated Measuring Instruments),

[3] INERIS (*Institut National de l'Environnement Industriel et des Risques*) is a public institution of an industrial and commercial nature, placed under the aegis of the French ministry in charge of the environment. It is the regular advisor of the Ministry of the Environment on these issues (monitoring, uncertainties, compliance with ELVs). The authors of the INERIS report for the Waste incineration BREF are members of the CEN (European Committee for Standardisation) and in particular, they are active in the working groups on standards on the monitoring of substances which are controlled for incineration (dust, HCl, HF, SO_2, NOx, NH_3, etc.).

- the measurement methods, SRMs (Standard Reference Methods), applied by control laboratories for onsite calibration of AMSs and when checking compliance with ELVs during periodic measurements,
  both available on the market today and expected in a foreseeable future.

The findings of INERIS, were published on 10/11/2017 in report n° DRC-17-168319-02463-B[4], *"Study of the performances of existing and under development AMSs (Automated Measuring Systems) and SRMs (Standard Reference Methods) for air emissions at the level of and below existing ELVs (Emission Limit Values) and BATAELs (Best Available Techniques Associated Emission Levels) for Waste Incineration, Co-incineration and Large Combustion Plants"*.

The report is available on several websites. See E-&G-d Main document, section 6.2.

2. Structure of the INERIS study report

2.1 Methods to estimate uncertainties

The INERIS report reminds that the quality of both the AMSs and SRMs performances is mainly evaluated through 2 characteristics:
- Measurement uncertainty at the level of the ELVs;
- Ratio between the ELV and the LoQ (Limit of Quantification).

The report then compares the two methods used to estimate measurements uncertainties (see its summary, p. 14):

- *"The GUM approach, which is to calculate, for each pollutant, the expanded uncertainty of one measuring system from the evaluation of the uncertainty components arising from its individual performance characteristics"*, i.e. for instance the impact of ambient temperature or feeding voltage, which are varied one by one in a wide range.
  According to EN 15267-3 and EN ISO 14956, "*the GUM approach (…) is systematically applied during the procedure of certification of an AMS (…) in order to estimate the uncertainty of the AMS before it is put on the market".*
- "*The second approach uses the information from Inter-Laboratory Comparisons (ILCs), where the results of various measurement systems fulfilling the requirements of uncertainty for standard reference methods (SRMs) and implemented by accredited control bodies (laboratories) are compared. It should be noted that this approach is applied today only for the comparison of different equipment implemented by laboratories of control, that is to say, for SRMs."*

"During ILCs, the influencing factors do not all vary or vary in a narrower range than the default ranges given in EN ISO 14956 Standard (GUM approach) and used during certification, which should minimise the uncertainty estimate compared to a calculation with relatively larger ranges."

"However, since the uncertainty components linked to the implementation of different 'measurement systems' and to the implementation by different teams of control laboratories have a large influence, the uncertainties estimated based on the reproducibility variance of the ILCs are generally higher than those given by the GUM approach (…). The final estimation of uncertainty using

[4] This is the revised version of report n° DRC-16-159382-06994A published on 22/07/2016, which was revised and complemented further to comments and questions by Commission DG ENVI, JRC-EIPPCB, Article 13 Forum members and WI BREF TWG members, in particular during presentations in Brussels and Seville during summer 2016 and a workshop in Brussels on 21/10/2016

ILCs includes all influencing factors (see Table below) and therefore provides a more truthful picture of the performance of measurement systems."

"ILCs approach is a necessary complement to the GUM approach."

	GUM	ILC
Applies to	One measuring system at a time, fulfiling the requirement of uncertainty of the standard reference methods (SRMs) or to be used for self-monitoring (AMSs) Applies to any concentration	Several measuring systems fulfiling requirements of uncertainty for standard reference methods (SRMs), implemented in parallel by several control laboratories. Could be applied as well to AMS, even if not done up to now because not required by the standard and difficult to implement. Applies to any concentration
Method	'Quadratic Sum' of a list of standard uncertainties (equal to the sum of variances) corresponding to standardized ranges of variation of several factors (voltage, …) See EN 15267-3 and EN ISO14956	Dispersion of measured values obtained by different measuring systems and accredited teams on a same flue gas. See ISO 5725
Completeness	Does not include uncertainties due to sampling, DAHS (Data Acquisition and Handling System), nor the ones due to human factors. For AMS it also does not include the uncertainty of the SRM which is used for the calibration of the AMS.	Includes all sources of uncertainties but does not cover the full ranges of variation of the factors covered in GUM.
Pros	Possibility to see the relative influence of the different components of standardised uncertainty components.	Provides an overview of the overall uncertainties. Considers the influence of human factors, of using different equipment and of DAHS (Data Acquisition and Handling System).
Cons	Does not consider the uncertainties due to human factor, variability of equipment and DAHS (Data Acquisition and Handling System), nor, for AMS, the uncertainty of the SRM used to calibrate the AMS. Need to model the measurement to identify influence parameters of measurement and relationship between these parameters and the measurand. Necessity to be able to quantify the performance characteristics, including the effect of influencing quantities.	Availability of ILCs on representative matrices on all parameters. (a real matrix with hot and wet conditions is highly recommended). No possibility to quantify the individual contribution of each influence parameter or metrological performance.
Findings	Shows often low uncertainty values compared to the ILCs approach	Shows significant higher uncertainty values (when ILCs are carried out on actual flue gases)

***Table 3.b-2**: Comparison between the GUM and the ILCs approaches. Excerpt from INERIS report Ref. n° DRC-17-168319-02463B, pp. 15-16 and p. 30-31.*

According to the INERIS report (see p. 31/132), *"very few control bodies* [laboratories] *show uncertainty estimation tables linked to the concentration level coming from the Inter-Laboratory Comparisons connected to the validation of an EU Standard or from Inter-Laboratory Comparisons they* *took part in, organised for instance by INERIS (F), TNO (B) or HLUG (D). These uncertainty levels are significantly more important than those obtained by uncertainty budgets (GUM), explaining that the latter are the ones supplied to clients in the laboratory reports." "Indeed, they do not include differences linked to DAHS, equipment or human factor in their estimation, which often leads to an important underestimation of the displayed uncertainty compared to the effective uncertainty."*

2.2 INERIS test facility

INERIS is accredited by COFRAC for the organization of inter-laboratory campaigns according to EN/ISO/IEC 17043. (See INERIS report p. 39)

The test bench of INERIS facility (see Figure 3.b-1 below) is "*designed to generate gaseous effluents of identical composition for each of the 12 sampling ports. Prior to their introduction into the loop, the gases produced by combustion in one of the three boilers fuelled with gas, light fuel oil or biomass can, if necessary, be heated, moistened and enriched by some pollutants injected through a generation system with mass-flow controllers (CO, NO, SO_2, HCl, HF, CH_4, C_3H_8, etc.) or liquid (specific VOC) to simulate gas matrices very similar to those of industrial facilities burning fuels or waste."*

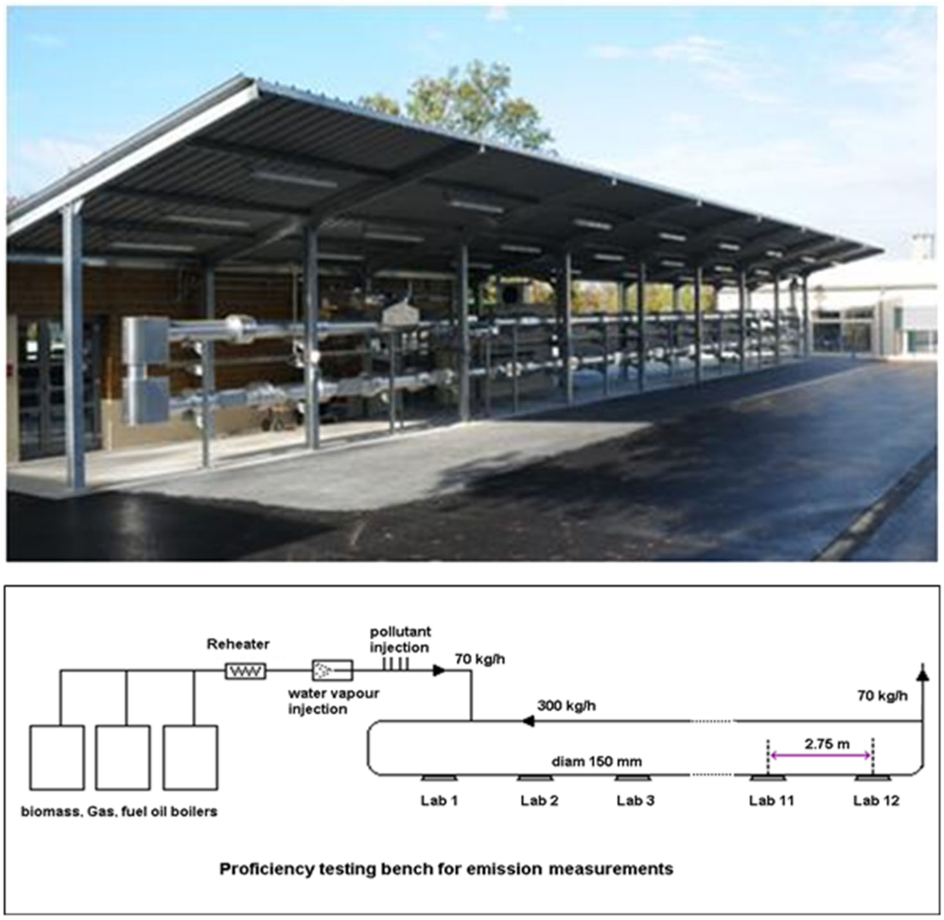

Figure 3.b-1: *INERIS test bench. (See INERIS report p. 38)*

"The Inter-Laboratory Comparisons' philosophies vary from country to country. The INERIS test bench generates real, hot, humid emissions, enriched (spiking) with the target compounds. The laboratories' results dispersions and hence the resulting estimated uncertainties are more important than those obtained on TNO or HLUG test bench, where the substances to be measured are often generated one by one in simple air, which masks some interfering effects, and at a close to ambient

*temperature, avoiding for instance the condensation risks when sampling, and hence some losses of some compounds." (*See INERIS report p. 31).

Most of the results given in the study showing the relative expanded uncertainties for different substances come from campaigns organised by INERIS between 2013 and 2016. It is important to note that the participant laboratories from France and other European countries were all accredited according to EN 17025. (See INERIS report p. 39).

2.3 Relative expanded uncertainties according to ILCs

Examples of relative expanded uncertainty for different substances are given in the following graphs. The lower the concentration, the greater will be the relative measurement uncertainty. This can be seen in the graphs showing the results of the Inter-Laboratory Comparison (ILCs) made by INERIS after having organised certification confirmation tests for the laboratories that calibrate online devices (QAL2 and AST). For each of them a trend curve is calculated. It is generally an exponential curve that gives the highest determination coefficient R^2 value and the best estimate of the expanded uncertainty expressed in relative or in absolute unit.

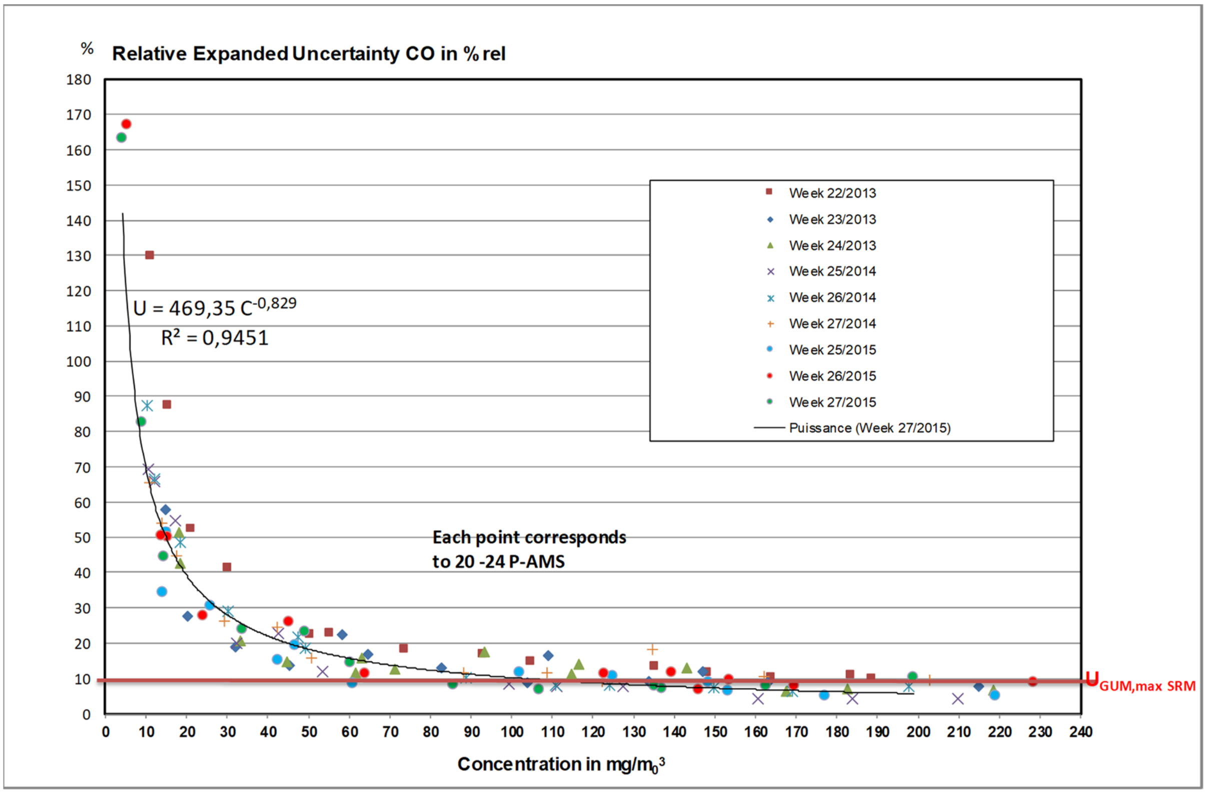

***Figure 3.b-2**: Example of the relative expanded uncertainty for CO (see INERIS report 2017, pp. 32, 40, 50 and 124): the curve showing the relative uncertainty depending on concentration is established from inter-laboratory comparison tests during 9 different sessions (weeks). Each of the 9 weeks, 10 to 12 different laboratories were implementing between 20 and 24 different SRM equipment at different concentrations. Each point on the figure corresponds to the average of the relative expanded uncertainty obtained by those 20 to 24 SRMs. When the concentration decreases, the relative uncertainty increases.*

INERIS comments as follows (see INERIS report p. 49) the above graph on CO relative uncertainty (Figure 3.b-2): *"The ILCs show that this 6% uncertainty value is not reached in practice on site below 120 mg/Nm³. (…).The Umax SRM << Umax AMS condition that should be fulfilled for AMSs' calibration by SRMs is hence not fulfilled; this can affect the calibration function and therefore the accuracy of the results given by the AMS."*

In the report summary, INERIS concludes in general terms (see report p. 16/132) that *"the relative uncertainty linked to a measurement result is constant for the upper part of the concentration range and then grows in a non-linear manner for the lower part when concentration decreases. This means that if the legislator reduces the ELVs, the associated uncertainty expressed in relative value shall be increased significantly, thus possibly preventing available techniques to comply with the requirements of legislation and standards In respect of uncertainty."*

In its Annex E, the INERIS report provides graphs showing the absolute uncertainties as a function of concentrations besides the graphs showing the relative uncertainties. See Figure 3.b-3 below.

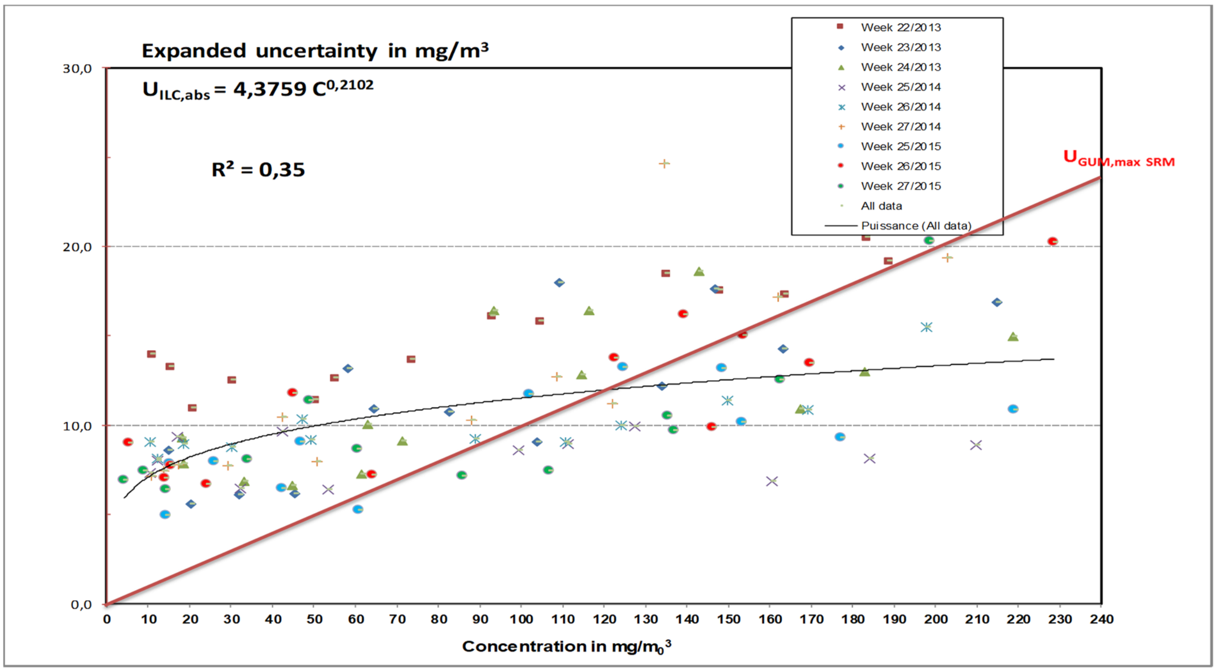

Figure 3.b-3*: The absolute expanded uncertainty for CO (see INERIS report 2017, p. 124) corresponding to the relative uncertainties shown in the previous Figure.*

In contrary to relative uncertainty that grows much faster than concentration decreases (see Figure 3.b-2) the absolute uncertainty is nearly constant when concentration decreases (see Figure 3.b-3).

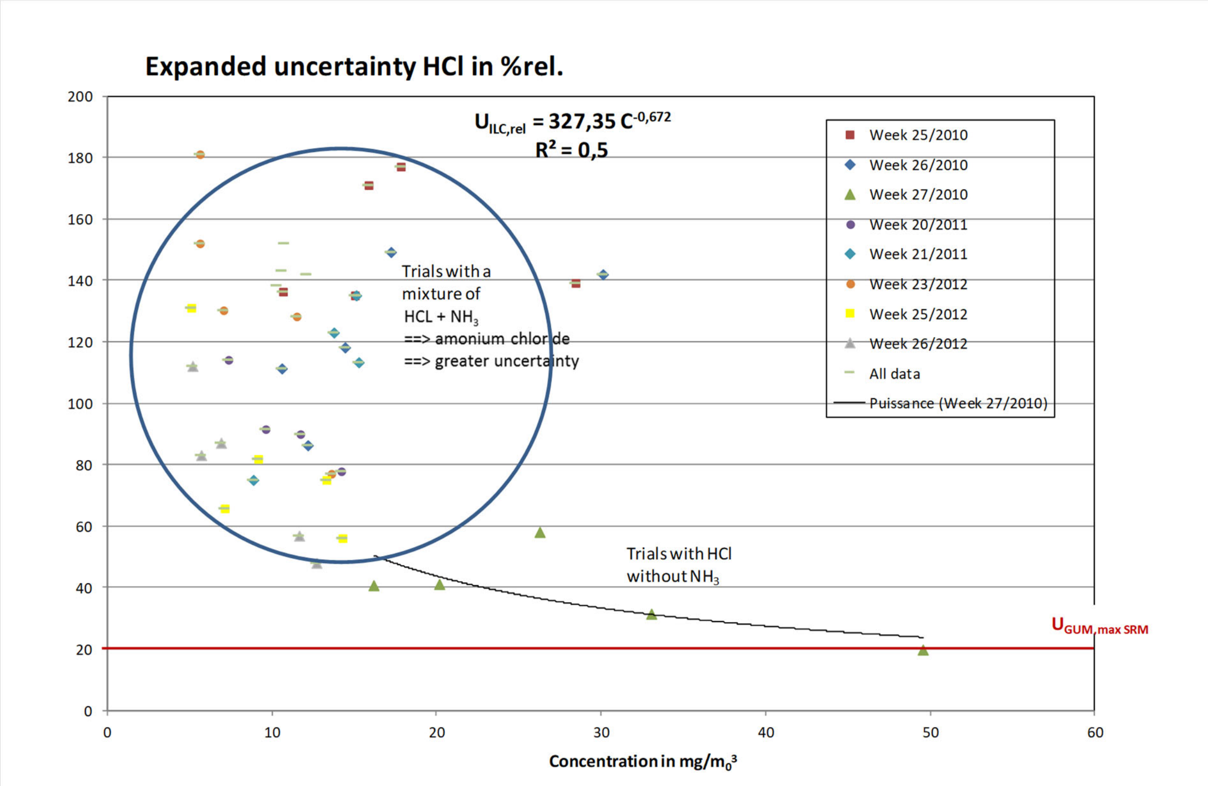

***Figure** 3.b-4:* *Example of Inter Laboratory comparison for expanded uncertainty for HCl (see INERIS report, pp. 68 & 129). The trend curve correspond to trial with HCl alone. The left part of the graph shows much higher relative uncertainties resulting from interferences between HCl and NH_3, the corresponding tests having been made with a mixture of both gases. The horizontal red line shows the maximum uncertainty required by the standard for Standard Reference Methods (SRM) for HCl (EN 1911).*

As it can be seen on the above graph (see Figure 3.b-4), the maximum uncertainties required by the SRMs standards (the red lines on the graphs) are only met at concentrations higher than the current daily ELVs of Annex VI. Moreover the presence of NH^3, leads to much higher uncertainties.

2.4 Conclusions of the INERIS study - Minimum ELVs to comply with the requirements on uncertainty of the SRM standards

The conclusions of the study are summarised in a table (see INERIS report, pp. 17-18), which indicates the minimum ELVs that would be compatible with the requirements of SRM standards. It shows that for all continuously monitored substances but NOx, the requirements of the SRMs standards are not met at the level of the current daily ELVs. (See below Table 3.b-3). Possible improvements are not foreseen before years to face this problem.

Sub-stance	Current (IED) Daily ELV [(1)]	Min ELV (5 x LoQ) (5*LoQmin - 5*LoQmed) [(4)]	Target $U_{th,SRM}$ [(5)]	Target $U_{th,AMS}$ [(6)]	$U_{pr,SRM}$ at Current ELV [(8)]	$U_{pr,SRM}$<< $U_{certif,AMS}$ [(9)]	Min ELV to comply with $U_{th,SRM}$ [(10)]
CO	**50** mg/Nm³	0.35 - 4.0 mg/Nm³	6%	7.5%	12%	No	**120** mg/Nm³
NO_x	**200** mgNO₂/Nm³	0.2 - 4.0 mg/Nm³	10%	15%	6%	Yes for C > 75 mg/Nm³	**75** mg/Nm³
TOC	**10** mgC/Nm³	0.065 - 0.2 mgC/Nm³	15%	23%	30%	No	**50** mgC/Nm³
Dust	**10** mg/Nm³	0.035 - 0.3 mg/Nm³	20%	23%	60%	No	**50** mg/Nm³
SO_2	**50** mg/Nm³	0.95 - 3.0 mg/Nm³	20%	15%	16%	No	**150** mg/Nm³
HCl	**10** mg/Nm³	0.095 - 0.9 mg/Nm³	30%	30%	100%	No	**50** mg/Nm³
O_2	-	0.02 - 0.15 % vol	6%	-	2.3%		
HF	**1** mg/Nm³	0.125 - 0.48 mg/Nm³	20% desirable	30%	100%	No	
NH_3	No IED ELV. **10** mg/Nm³ often found. In France: **30** mg/Nm³	0.185 - 1.05 mg/Nm³	20% desirable	30%	300%	No	**50** mg/Nm³
Hg	50 µg/Nm³ (periodic)	0.5 - 0.7 µg/Nm³	-	-	50%	No	-

**(4): ** Minimum ELV for LoQ_{min} and LoQ_{med}, according to the EIPPCB's rule, that BATAEL should not be under 5 times the AMS's LoQ (cf. § 2.3.2).
**(5): ** SRM's relative expanded uncertainty target, as defined in the Standard describing the SRM or in the draft revised Standard for Dust (cf. § 2.3.3), or desirable in the cases of HF and NH_3, substances for which the measurement method Standard does not set a threshold.
(6): AMS's relative expanded uncertainty target from EN 15267 Standard, corresponding to 75% of the confidence interval set by the IED (cf. § 2.3.3).
(8): Expanded uncertainty coming from ILCs (Inter-Laboratory Comparisons) organised by INERIS of for Standards validation (cf. summary sheets in Annex E and in § 4), therefore when various laboratories implement the method on site.
(9): Fulfilment of the condition that the SRM's uncertainty must be significantly lower than that of the AMS (cf. § 2.3.3).
(10): Minimum ELV fulfilling the SRM's uncertainty target set in the Standard describing the SRM.

***Table 3.b-3**: Minimum ELVs that would be compatible with the requirements of SRM standards (Excerpt of table, pp. 17-18 of INERIS 2017 report).*

2.5 Detailed conclusions for individual substances

In addition to the summarised conclusions above, more detailed conclusions are given in chapter 4 of the INERIS 2017 report.

2.5.1 Conclusions for NOx (see INERIS report 2017, p. 56)

"It is hence not advisable to lower the NO_x Daily ELV under 75 mg/Nm³, *to maintain an acceptable risk when declaring whether an AMS is compliant or non-compliant."*

2.5.2 Conclusions for CO (see INERIS report 2017, p.51)

"The ILCs organised to evaluate the SRMs also show that the required uncertainty is in fact not always fulfilled in real measurement conditions; ***even*** *for a* ***Daily ELV of 50 mg/Nm³****, the measurement uncertainty* ***is too high:*** *18 relative % for a target of 6%.* ***A Daily ELV of 120 mg/Nm³ would provide a minimised risk*** *when declaring whether an AMS is compliant or non-compliant.****"***

"Lowering the ELV under the current value of 50 mg/Nm³ therefore risks leading to biased ELV compliance/incompliance declarations, because of measurements with an uncertainty higher than the IED's 10% confidence interval."

2.5.3 Conclusions for T(V)OC (see INERIS report 2017, p. 59)

"Currently, the ***required uncertainty*** *for the SRM is* ***only reached*** *for concentrations* ***above 50 mgC/Nm³****, and the measurement uncertainty exceeds 20% at the current Daily ELV level of 10 mgC/Nm³. The analysis of QAL2 test reports shows that for concentrations under the current Daily ELV, the average concentrations measured by AMS and SRM are rarely comparable (it is not possible to tell if the difference comes from one or the other measurement method).*

A Daily ELV of 50 mg/Nm³ would enable a minimized risk when declaring whether an AMS is compliant or non-compliant. ***It is hence strongly recommended not to lower the Daily ELV under the current value of 10 mg/Nm³."***

2.5.4 Conclusions for Dust (see INERIS report 2017, p. 62)

"Analysing QAL2 test reports confirms the impossibility of establishing a calibration function for concentrations under 5 mg/Nm³."

"A Daily ELV of 50 mg/Nm³ would provide a minimal risk when declaring whether an AMS is compliant or non-compliant. ***It is hence strongly recommended not to lower the Daily ELV under the current value of 10 mg/Nm³."***

2.5.5 Conclusions for SO_2 (see INERIS report 2017, pp.65-66)

"The $U_{max\ SRM} << U_{max\ AMS}$ condition necessary for a robust QAL2 calibration at the level of the current Daily ELV of 50 mg/Nm³ for Waste Incineration is hence not fulfilled, this weakens the reliability of this calibration and therefore the accuracy of the results given by the AMS."

*"****In the current SRM*** *implementation configuration, it is hence* ***not desirable to lower the Daily ELV under 50 mg/Nm³*** *to maintain a minimal risk when declaring whether an AMS is compliant or non-compliant."*

"The ***possible improvement*** *routes are the following: (…) Use some certified GFCIR[5] analysers as an alternative method to the SRM, which would enable fulfilling uncertainty levels under 8% at 50 mg/Nm³ and would approach about 13% at* ***30 mg/Nm³****."*

[5] GFCIR : Gas Filter Correlation InfraRed

2.5.6 Conclusions for HCl (see INERIS report 2017, p. 70)

"The manual reference method fulfils an uncertainty level under 20% for Daily ELVs equal to or above 50 mg/Nm³, being for a Daily ELV equal to 5 times the current Daily ELV for Waste Incineration, with the AMSs' uncertainty being around 10% at 50 mg/Nm³. ***The $U_{max\ SRM}$ << $U_{max\ AMS}$ condition necessary for a reliable QAL2 calibration at the level of the current Daily ELV of 10 mg/Nm³ for Waste Incineration is hence not fulfilled,*** *this weakens the reliability of this calibration and therefore the accuracy of the results given by the AMS."*

In the current SRM implementation configuration, a Daily ELV of 50 mg/Nm³ is necessary to declare whether an AMS is compliant or non-compliant*. It would be desirable not to decrease ELV below 50 mg/Nm³.*

Interferences with NH_3. (See INERIS report 2017, p. 67)

"The results can be even poorer *when the installation uses ammonia or urea to abate NOx concentrations. In these conditions, an ammonium chloride aerosol is formed; it is gaseous above 180°C, but it can condensate in the sampling probe if cold points exist or it can be trapped on the filter if it is at a temperature colder than 180°C. In such cases, it was shown that towards 10 mg/Nm³, the uncertainty is not 70%, but exceeds 120%."*

2.5.7 Conclusions for HF (see INERIS report 2017, p. 73)

"The manual reference method fulfils an uncertainty level above 20% for Daily ELVs equal to or above 150 mg/Nm³, which is a Daily ELV 150 times the current Daily ELV for Waste Incineration, and the AMSs' uncertainty is about 25% at 1 mg/Nm³. Given the incompliance with the Umax SRM << Umax AMS condition to be fulfilled to calibrate AMSs with SRMs, ***the QAL2 calibration is inoperable at the current Daily ELV level for Waste Incineration for HF. A Daily ELV much higher than the current one will certainly be necessary*** *to declare whether an AMS is compliant or non-compliant."*

2.5.8 Conclusions for NH_3 (see INERIS report 2017, pp. 74 & 76)

"No uncertainty data coming from ILCs are available for concentrations lower than 5 mg/Nm³. Extrapolating based on the available data, the uncertainty at this concentration level is likely to be around 100%. Other results are available but they were obtained in presence of HCl in the matrix. Because of this, an ammonium chloride aerosol is formed; it is gaseous above 180°C, but it can condense in the sampling probe if cold points exist or it can be trapped on the filter if it is at a colder temperature than 180°C."

"At 10 mg/Nm³, the SRM's uncertainty is about 90%, while levels of 20% would be desirable *if we set a target of 50% of the legally-binding threshold for NH_3 self-monitoring for certain Waste Incineration and Co-Incineration installations."*

"The manual reference method gives results with an uncertainty at least 10 times above that of the measurements given by the AMSs at a concentration of 10 mg/Nm³, often set as a Daily ELV.

The $U_{max\ SRM}$ << $U_{max\ AMS}$ condition necessary for a reliable QAL2 calibration at the level of 10 mg/Nm³ *is hence not fulfilled, this weakens the reliability of this calibration and therefore the accuracy of the results given by the AMS*

In many QAL2 calibration cases, an important number of SRM measurements are under the LoQ, showing that the manual SRM is not suitable for QAL2 calibration at 10 mg/Nm³."

*"**A Daily ELV higher than the current one in France (30 mg/Nm³) will certainly be necessary** to declare with a minimal risk whether an AMS is compliant or non-compliant."*

2.5.9 Conclusion for Hg (see INERIS report 2017, p. 77)

"The $U_{max\ SRM} << U_{max\ AMS}$ condition necessary for a reliable QAL2 calibration at the level of the current Daily ELV of 50 µg/Nm³ for Hg for Waste Incineration is hence not fulfilled, this weakens the reliability of this calibration and therefore the accuracy of the results given by the AMS."

With the SRM, a Daily ELV above 50 µg/Nm³ would be necessary to declare with a minimal risk whether an AMS is compliant or non-compliant."

3. Complement to INERIS report

In addition to the report, INERIS provided the following table that summarises the outcome of the ILCs results obtained during the validation of the CEN standards for metals and PCDD/F.

Métaux	Uc : incertitude élargie considérée comme égale à IcR : intervalle de confiance de reproductibilité à 95 % (en toute rigueu							
	uc : incertitude-type = Uc/2							
	Uc en % rel (transparents : calculées)	IcR (norme) µg/m3	uc (calculée) µg/m3	Concentration moyenne (norme) µg/m3	Cmin (norme) µg/m3	Cmax (norme) µg/m3		
As	294	3,5	1,75	1,4	0,1	5,1		
Cd	147	11	5,5	7,9	2,5	2,9		
Co	253	3,7	1,85	1,5	0,01	4,3		
Cr	447	34	17	7,6	0,93	0,96		
Cu	106	34	17	32	8,9	89		
Mn	155	8	4	4,9	0,96	150		
Ni	393	21	10,5	5,6	0,47	50		
Pb	97	272	136	280	92	970		
Sb	122	10	5	8,2	0,91	24		
Tl	385	50	25	13,0	0,01	59		
V	270	5,4	2,7	2,0	0,09	2		
							estimation Uc pour les sommes de concentrations (calculée)	
							en mg/m3	en % rel à la valeur moyenne de la somme des concentrations
Cd+Tl (mg/m3)				0,02	0,003	0,06	0,05	245
Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V (mg/m3)				0,34	0,10	1,30	0,28	81
Sb+As+Cr+Co+Cu+Mn+Ni+V : sans Pb (mg/m3)				0,06	0,01	0,33	0,05	86

***Table 3.b-4**: Uncertainties during validation test of CEN standard EN 14385 on metals*

3.1 Uncertainties on metals and metalloids according to CEN

According to information received from INERIS in 2016 and 2017 and transmitted to the TWG on 21/10/2016 and 8/9/2017:

- According to the tests made by CEN for the validation of the standard (EN 14385) on Cd and Tl, with the sum of the mean values of 0.02 mg/Nm^3, which is the upper end of the range of the proposed BATAEL, **the uncertainty for Cd + Tl is 245%.** Moreover, the representability of this value is limited since it reflects the results of only one single test. See Table 3.b-4.
- According to the tests made by CEN for the validation of the standard (EN 14385) on Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, with the sum of the mean values of 0.34 mg/Nm^3, which is slightly above the upper end of the range of the proposed BATAEL, the **uncertainty for Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V is 81%.** Without Pb, which stands for 0.28 mg/Nm^3, the sum of the mean values is 0.06 mg/Nm^3 and the uncertainty for Sb+As+Cr+Co+Cu+Mn+Ni+V is 86%**.** Again, the representability of this value is limited since it reflects the results of only one single test. See Table 3.b-4.

3.2 Uncertainties on PCDD/F according to CEN

According to information received as well from INERIS in 2016 and 2017 and transmitted to the TWG on 21/10/2016 and 8/9/2017:

For PCDD/F, the relevant CEN Standard (EN 1948) indicates that it has been made in order to measure concentrations around 0.1 ng $_{\text{I-TEQ}}$/Nm^3 and that the validation tests were made on incinerator flue gases of around 0.1 ng $_{\text{I-TEQ}}$/Nm^3 as well.

Standard EN 1948 does not set a maximum relative uncertainty level. However, according to the tests made by CEN for the validation of the standard (EN 1948) on PCDD/F (see Table 3.b-5):

- for a concentration of **12 ng $_{I-TEQ}$/Nm^3** of PCDD/F, which is very high, the uncertainty was **36%**;
- for a concentration of **0.035 ng $_{I-TEQ}$/Nm^3** of PCDD/F, which is around the middle of the BATAEL range in long term sampling and close to the upper end of the range in short term sampling, the uncertainty reported by CEN is **140%**.

Again, the representability of this value is limited since it reflects the results of only two tests.

Concentrations en ng I-TEQ/m_0^3	U in %
0,035	140
12	36

Table 3.b-5*: Uncertainties during validation test of CEN standard EN 1948 on PCDD/F*