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

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**ANNEX 3  
Monitoring & Uncertainties  
(air emissions)**

**Annex 3.a  
The uncertainty issue**

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## Annex 3.a – The uncertainty issue

### 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**, for explanations on measurements wording.

### 1. Introduction

Thanks to its extensive experience with low emission levels, the WI sector was able to identify early on that compliance with requirements on uncertainty of measurements was becoming more and more a challenge. This aspect is especially important within the context of the implementation of WI BAT Conclusions, because BATAELs are derived from operational values that are associated with an unknown uncertainty. If, on the one hand, BATAELs are expressed without reference to an associated uncertainty, on the other, the future BATAEL-based ELVs will have to be implemented with specific compliance rules, including the ones on uncertainty.

It should be stressed that the set of compliance rules is not defined in the WI BREF and it is considered as a task for competent authorities during the implementation phase. This chapter attempts to clarify the main aspects of this complex issue.

### 2. Conditions under which BATAELs are expressed

BATAELs for emissions to air are expressed under two sets of conditions:

- 1) in NOC (Normal Operating Conditions). See **Annex 2** to this E&G-d.
- 2) in standard conditions (P, T, O<sub>2</sub>, dry).

#### 2.1 Reference conditions to express BATAELs

See the General considerations of the WI BAT conclusions. The reference conditions for air BATAELs<sup>1</sup> are the same as the conditions given in IED Annex VI, Part 3 for the same substances<sup>2</sup>.

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<sup>1</sup> The General Considerations of the WI BREF BAT conclusions read:

*“Emission levels associated with the best available techniques (BATAELs) for emissions to air given in these BAT conclusions refer to concentrations, expressed as mass of emitted substances per volume of flue-gas or of extracted air under the following standard conditions: dry gas at a temperature of 273.15 K and a pressure of 101.3 kPa, and expressed in mg/Nm<sup>3</sup>, µg/Nm<sup>3</sup>, ng I-TEQ/Nm<sup>3</sup> or ng WHO-TEQ/Nm<sup>3</sup>.*

*The reference oxygen levels used to express BATAELs in this document are shown in the table below*

Activity	Reference oxygen level (OR)
Incineration of waste	11 dry vol-%
Bottom ash treatment	No correction for the oxygen level

<sup>2</sup> IED Annex VI, Part 3 reads:

*“All emission limit values shall be calculated at a temperature of 273,15 K, a pressure of 101,3 kPa and after correcting for the water vapour content of the waste gases.*

*They are standardised at 11 % oxygen in waste gas except in case of incineration of mineral waste oil as defined in point 3 of Article 3 of Directive 2008/98/EC, when they are standardised at 3 % oxygen, and in the cases referred to in Point 2.7 of Part 6.”*

## 2.2 BATAELs derived and expressed without assessing uncertainty

In accordance with the EIPPCB proposal validated in January 2015 at the WI BREF TWG Kick-off meeting<sup>3</sup>, the operators were asked to “provide concentrations of pollutants<sup>4</sup> corrected for reference conditions but without subtraction of the confidence interval” (See Questionnaire Annex III, Instructions). They were requested to indicate the uncertainty of their instruments but since the overall uncertainty is usually not known, most of them reported:

- either the maximum relative uncertainty stipulated in IED Annex VI as 95% confidence interval,
- or the uncertainty of the online instrument as mentioned in its QAL 1 certificate, which does not include all the uncertainties of the system: DAHS (Data Acquisition and Handling System)<sup>5</sup>, onsite calibration (QAL2, QAL3, AST). See Annex 3.b.

When defining the BATAELs, the JRC-EIPPCB did not take into account the overall uncertainty of the reported emissions, nor the feasibility to perform, at BATAEL levels, measurements within a certain range of uncertainty. Thus in the revised assessment of split views rationale of 27/9/2018, JRC-EIPPCB says p. 21:

*“As laid out in IED Article 3(13), a BAT-AEL means the ranges of emission levels obtained under normal operating conditions using a (combination of) BAT. BAT-AELs are therefore set on the basis of real plant emissions and not on the basis of meeting certain measurement uncertainty requirements.”*

Thus, BATAELs are directly derived from operating values with a number of them below the LoQ of the methods<sup>6</sup>, therefore with high and unknown level of uncertainties, and are expressed without information on how the measurement uncertainty should be taken into account for compliance assessment.

<sup>3</sup> Meeting of the Technical Working Group for the launch of the WI BREF review.

<sup>4</sup> Around 350 incineration lines selected as ‘well performing’ by Member States provided about 17,520 half-hourly average values per continuously monitored substance and per line. Around 45 million individual data in total.

<sup>5</sup> EN 14181:2014 says in § 5.2, “Limitations”:

*“Figure 2 illustrates the components of the AMS covered by this standard.*

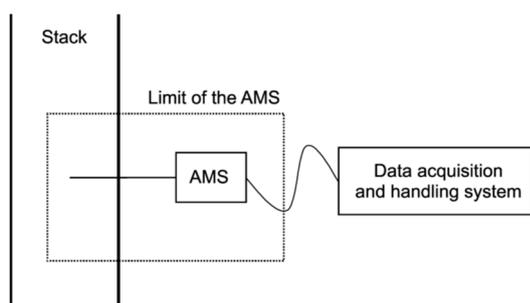


Figure 2 — Limits for the QA of the AMS excluding the data acquisition and handling system”

The standards then states:

“- NOTE 1: The influence of the uncertainty of the measurement results, which arise from the data acquisition and handling system of the AMS or of the plant system, and its determination, are not covered by this standard.

- NOTE 2: The performance of the data acquisition and handling system (DAHS) can be as influential as the AMS performance in determining the quality of the results obtained from the whole measuring system/process. There are different requirements for data collection, recording and presentation in different countries. A European Standard on quality assurance of DAHS is currently under preparation.” See Annex 3.d to this E&G-d.

<sup>6</sup> In the presentation “01. Derivation of BATAE(P)Ls” shown by the EIPPCB during the workshop on 4-5/12/ 2017 in Seville, it is said: “For the lower end of the BAT-AEL range:

➤ For the majority of pollutants, the lowest reported levels (as a yearly maximum) are often even below the LoQ of the methods. The EIPPCB has proposed pragmatic levels that are considered reliably achievable by the best performing plants irrespective of the compliance assessment regime in place“. The EIPPCB never clarified on which basis they considered these levels achievable, nor how to deal with the uncertainty of measurements at BATAEL levels.

### 3. Conditions for BATAEL-based ELVs implementation and compliance verification

Four sets of conditions should be included in permits for the implementation and compliance check of BATAEL-based ELVs:

- 1) In NOC (Normal Operating Conditions). See IED Art.15.3 and [Annex 2](#) of this E&G-d.
- 2) In standard conditions (P, T, O<sub>2</sub>, dry). Emissions must be compared to BATAELs to ensure compliance (in accordance with IED Article 15.3(a) and 15.3(b) & 14.1 (c) (ii)). Therefore, they must be expressed in reference to the same conditions as for air BATAELs (see [Section 2.1 above](#)), which are the same as the conditions given in IED Annex VI, Part 3 for the same substances.
- 3) With reference to requirements in EN standards, which themselves set conditions on uncertainty. See [Section 3.1 below](#).
- 4) Others to be determined with competent authorities (e.g. definition of valid averages).

#### 3.1 Emissions to ensure compliance with BATAEL-based ELVs to be monitored in accordance with standards referring to uncertainties

The WI BAT conclusions require (see BAT conclusion n° 4) *“to monitor channelled emissions to air (...) in accordance with EN standards”* and provides a list of standards.

##### 3.1.1 Standards on SRMs

The standards on SRMs for each individual substance require, in particular, that the relative uncertainties of SRMs do not exceed maximum values. (See [Table 3.b-1 in Annex 3.b below](#)).

##### 3.1.2 Standards for AMSs

The generic standards on continuous monitoring listed in BAT conclusion n° 4 (EN 15267-1, EN 15267-2, EN 15267-3 and EN 14181) describe the procedures to check the uncertainty required by legislation. Thus standard EN 14181 says for instance in its introduction and in its Section 5.1 General principle:

*“This European Standard describes the quality assurance procedures needed to assure that an automated measuring system (AMS) installed to measure emissions to air are capable of meeting the uncertainty requirements on measured values given by legislation, e.g. EU Directives [1], [2], [3<sup>7</sup>] or national legislation, or more generally by competent authorities”.*

*“QAL2 is a procedure for the determination of the calibration function and its variability, and a test of the variability of the measured values of the AMS compared with the maximum permissible uncertainty given by legislation. (...)”*

*The AST is a procedure which is used to evaluate whether the uncertainty of the measured values obtained from the AMS still meet the uncertainty criteria – as demonstrated in the previous QAL2 test.”*

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<sup>7</sup> [1], [2] refer to the former WID and LCP directives and [3] refers to the IED (into which these two directives were subsequently merged).

## 3.2 Other implementation and compliance conditions

### 3.2.1 Points to be clarified for BATAEL-based ELVs implementation and compliance verification

In addition to the conditions described above, competent authorities will have to define, for the implementation, monitoring and compliance check of BATAEL-based ELVs, rules on:

- Averaging calculation rules, validity rules, etc.
- Maximum uncertainties for SRMs
- Maximum overall uncertainties for online instruments.

### 3.2.2 Commission's positions on points to be clarified

It is important to stress that currently the only legal reference for this set of requirements is in IED Annex VI and the relative EN standards.

WI BAT conclusions do not contain information to set requirements on these parameters since the Commission considers that *"rules for the assessment of compliance are not within the scope of BAT conclusions"*<sup>8</sup>. which summarises a position often stated by the EIPPCB<sup>9</sup>. Indeed, in reference to IED<sup>10</sup>, the Commission considers that *"Member States have flexibility to determine how to assess compliance with the permit conditions and hence how to take measurement uncertainty into account for activities covered by Chapter II [of the IED]"*<sup>11</sup>.

Nevertheless, in its assessments of TWG member's comments on the WI BAT conclusions, the EIPPCB keeps referring for BATAEL-based ELVs compliance check to the rules defined in Annex VI of the IED.

In answer to the following requests:

*"- Add the text in the IED on the confidence interval (Eurits-51).*

*- Add a table for the confidence interval for the higher ends of the BAT-AEL ranges (FR-750)."*

The EIPPCB stated:

*"- Concerning the confidence intervals, it is an established practice not to repeat IED provisions in BAT conclusions.*

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<sup>8</sup> Letter of the Commission to CEWEP, dated 20/09/2019.

<sup>9</sup> For instance: *"Rules for compliance are implementation issues that are beyond the technical scope of the BAT conclusions."* is repeated 3 times by the EIPPCB in the Background paper of 23/2/2018 for the Final TWG meeting: pp. 16,110 and 144 about similar questions on how to calculate daily average values.

<sup>10</sup> Probably IED Article 14.1(h), which reads: *"Member States shall ensure that the permit includes all measures necessary for compliance with the requirements of Articles 11 and 18. Those measures shall include at least the following: (...) (h) conditions for assessing compliance with the emission limit values or a reference to the applicable requirements specified elsewhere."*

The point was also made clear for instance in the letter dated 11/1/2019 of the Commission to ESWET and CEWEP: *"Whilst we recognise the relevance of measurement uncertainty for assessing compliance of installations with emission limit values, the scope of the implementing acts that the Commission is empowered to adopt does not include conclusions on measurement uncertainty. Rather, measurement uncertainty is an important parameter to be taken into account in the implementation phase when compliance with the permit conditions is assessed. In accordance with Chapter II of the IED, Member States are responsible for determining how to assess compliance with the permit conditions and hence how to take measurement uncertainty into account."*

<sup>11</sup> Letter of the Commission to CEWEP, dated 20/09/2019.

- Moreover, little information is available on the confidence intervals at emission levels other than those of the IED Annex VI ELVs.”<sup>12</sup>

The Commission as well acknowledges the fact that the uncertainty issue is far from being solved at the moment. For instance, in its letter to CEWEP dated 20/09/2019, the Head of Unit in charge of BREFs says:

*“It has been recognised that there are possible different approaches to this issue [measurement uncertainty and compliance assessment rules] by Member States. In view of this the topic has been identified as a priority for our implementation support with Member States.*

*Both BAT conclusions and some parts of the IED refer to EN and/or other available standards to measure emissions. DG Environment continues to cooperate with DG GROW and CEN on work to improve standard measuring methods. It is also recognised that standard reference methods need to be validated at lower concentrations. In view of these needs, DG Environment is exploring the technical issues and to explore financing that work. The results of such work also depends on technical progress in instruments and methods. It is also to be noted that the established procedures are complex and time consuming.”*

In other words, the Best Available Techniques in monitoring do not allow for the time being and foreseeable future to meet the requirements of the monitoring standards made mandatory by the IED and the WI BAT conclusions at the low concentrations encountered in Waste incineration BATAELs.

A clear solution to this issue has not been found yet, as shown by the scattered pattern of approaches considered in different regions/Member States.

More details can be found in the following sections.

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<sup>12</sup> EIPPCB Background Paper dated 23/2/2018 for the Final Meeting of WI BREF Review, page 16.

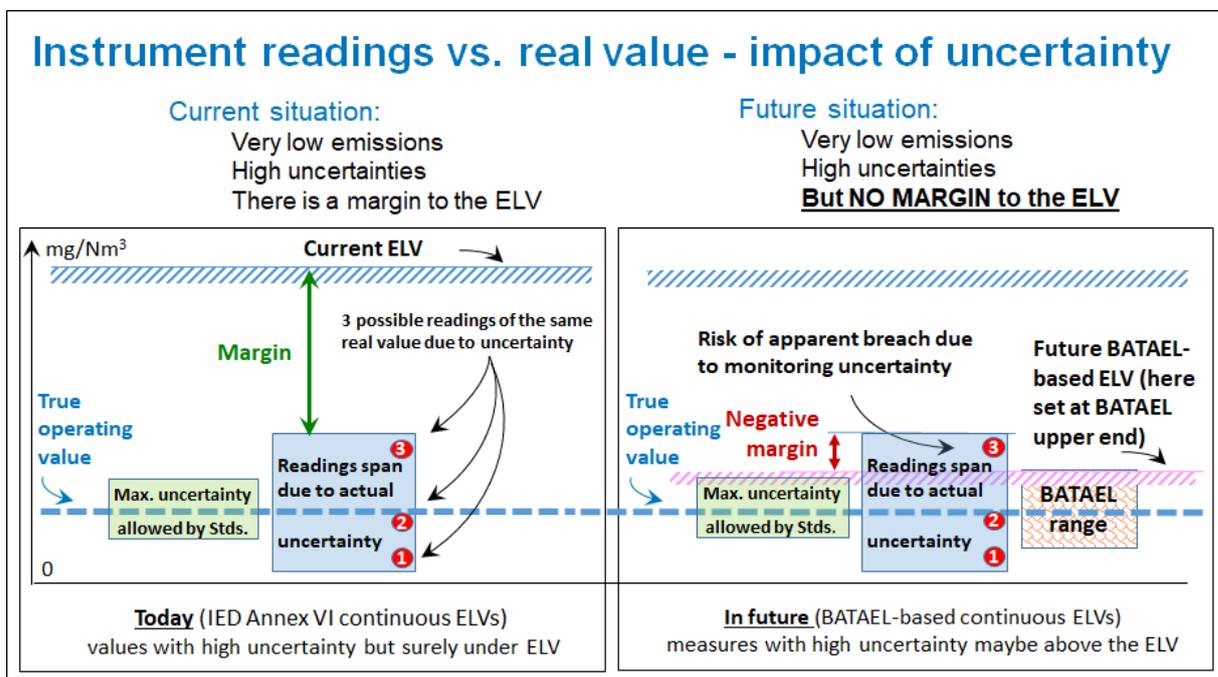
## 4. Specific study on monitoring systems performances and uncertainties

In order to get ready for discussions on BATAELs and ultimately on their implementation, CEWEP, ESWET and FEAD commissioned INERIS, the French Institute expert in measurement (see [more on INERIS in Annex 3.b](#)), to make a study on the performances of the monitoring systems at the WI BREF BATAEL emission levels.

The study, which was shared with the JRC-EIPPCB, the Article 13 Forum members and the WI BREF TWG members in 2016, shows that, at the very low level of emissions achieved by incineration plants, the accuracy of the measurement is really an issue. Indeed, the overall performances of the monitoring techniques available on the market do not meet the requirements of the standards on monitoring made compulsory by the IED in respect of the maximum levels of uncertainty:

- Already, for most of the monitored substances, at the level of the current ELVs of Annex VI of the IED;
- And, *a fortiori*, for most BATAEL ranges proposed in the Waste Incineration BAT conclusions, all of which are equal or below IED ELVs.

This situation can be pulled through for ELVs at the levels requested by IED Annex VI since operating values are in practice significantly lower than these ELVs. The margin between the two compensates for the fact that uncertainty is greater than required by the standards. However, for most monitored substances, if the ELVs are set below the BATAEL upper ends, there will be no margin, or it will be insufficient to compensate, should uncertainties be higher than required. See [Figure 3.a-1 below](#).



**Figure 3.a-1:** Schematic diagram. The Y-axis shows emission concentration. The height of the green boxes shows the uncertainty requested by the monitoring standards that should be complied with according to both IED Annex VI and the WI BAT conclusions. The real uncertainties as reported by INERIS correspond to the height of the blue boxes. The blue dashed line represent the true value (which in real life is neither known nor a constant). The red dots show 3 readings in the real uncertainty range. With the current IED Annex VI ELV, thanks to the margin between the ELV and the operating value, the operator and the regulator are certain that the values – even though not exact – are below the ELV (as shown on the left hand drawing). On the right hand side, it can be

seen (e.g. with dot n° 3) that it might not be possible to ensure that the real value (although well below the ELV in the example) as read by the monitoring system is actually below the BATAEL-based ELV.

NB: This Figure 3.a-1 is also shown as **Figure 2 in the Main E&G document**

The extreme difficulty to perform QAL2<sup>13</sup> and AST<sup>14</sup> calibration tests (which were defined for the first time by EN 14181 standards) when concentrations are very low and not changing is well known. If ELVs are lowered, it will be nearly impossible to calibrate the instruments in such cases. The use of calibration gas will most often not help since the injection should be done to reach the level of daily ELVs, which is most often already impossible<sup>15</sup> today at the level of Annex VI ELVs (See **Section 2.3 in Annex 3.c**).

The INERIS study leads to conclude (see **Section 2.4 of Annex 3.b** to this E&G-d) that, to meet the requirements of the standards in terms of uncertainty, most daily ELVs should be much higher than the IED Annex VI ELVs. Or, conversely, that the maximum permissible uncertainties (given in IED Annex VI Part 6) should be increased and that the requirements of the monitoring standards should, for most monitored substances be increased to take into account the performances of the monitoring systems available on the market at the time of the implementation of BATAELs. Indeed the time needed to improve the methods and to modify the standards is much longer than the 4 years remaining before the implementation of BATs.

A practical **proposal** is made below.

## 5. Proposals to solve the identified issues

BATAEL-based ELVs have to be set considering the need of a margin for operating contingencies and uncertainty. One may consider that, to be on the safe side, it is appropriate to set ELVs at all BATAELs lower ends and at BATAEEL higher end. However, as seen above, a number of crucial information must be taken into account when implementing the WI BAT conclusions. Setting ELVs based on BATAEL values lower than the upper ends of the ranges should require extreme caution. In other words, it may only be done when it is certain that successful calibration with reference to the chosen ELV will be achievable. This is of the utmost importance, both for the operator and for the local authority that is to ensure compliance with the ELVs.

Given the technical limitations in reference measurement methods that will remain for the foreseeable future and the time needed to publish revised monitoring standards, it is recommended:

- For all substances, except perhaps for NO<sub>x</sub> and for SO<sub>2</sub> where, according to the INERIS study, there is some flexibility, to set ELVs at the levels of BATAEL ranges upper ends.
- That the uncertainties attached to the BATAEL-based ELVs (as well as to IED Annex VI ELVs) remain the ones defined, *de facto* in absolute values<sup>16</sup>, in IED Annex VI, since, although already

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<sup>13</sup> QAL2: Quality Assurance Level 2 requested by the European standards on monitoring (EN 14181). See **Annex 1** to this E&G-d.

<sup>14</sup> AST: Annual Surveillance Test. See **Annex 1** to this E&G-d.

<sup>15</sup> Calibration gases at very low concentration with good accuracy are not available. Dilution introduces uncertainties. Reference material are not available for some pollutants such as dust. Artificially high concentration in one pollutant (the calibration gas) will mask the interferences occurring between the different substances in the real flue gas. Progress on reference materials are expected in future but not available at the moment.

<sup>16</sup> IED Annex VI, Part 8, § 1.2 requires to calculate the daily averages from half-hourly averages “after having subtracted the value of the confidence interval specified in point 1.3 of Part 6” of IED.

The maximum 95% confidence intervals of a single measured result provided in the Table displayed in IED Annex VI Part 6, § 1.3 are given in % applicable at the daily emission limit value level: “At the daily emission limit value level, the values of

too low, they are in current use and can be coped with when there is a sufficient margin between the emissions and the ELVs. (See [Table 3.a-1 below](#)).

- That, for substances for which the IED Annex VI does not provide confidence intervals, Hg and NH<sub>3</sub>, the uncertainties attached to the BATAEL-based ELVs are based on the information available today from 2 Member States as summarised in [Table 3.a-2 below](#).
- That, the rule set in IED Annex VI for checking continuous ELVs compliance is also applied to Hg and NH<sub>3</sub>: the absolute value of the uncertainty is subtracted from the measured emission short term averages before calculating the Long-Term Averages for comparison with the BATAEL-based ELVs.

This to be done in order to avoid false reports of breached ELVs due to measurement errors.

Substance		IED Annex VI daily ELV		Max. 95% Confidence interval at IED Annex VI daily ELV
		Value (see Part 3, 1.1)	Max 95% CI (see Part 6, 1.3)	
		(mg/Nm <sup>3</sup> )	(%)	absolute (mg/Nm <sup>3</sup> )
CO	Carbon monoxide	50	10%	5
SO <sub>2</sub>	Sulphur dioxide	50	20%	10
NO <sub>2</sub>	Nitrogen dioxide	200	20%	40
Dust	Total dust	10	30%	3
T(V)OC	Total organic carbon	10	30%	3
HCl	Hydrogen chloride	10	40%	4
HF	Hydrogen fluoride	1	40%	0.4

**Table 3.a-1:** Maximum uncertainties given as 95% confidence intervals of IED Annex VI daily ELVs and corresponding absolute uncertainties.

Substance		Data from Member States			Proposed Max. 95% confidence interval
		Source	Daily ELV	Max 95% CI (%)	absolute
Hg	Mercury	17. BimSchV, 2/5/2013, Germany <sup>17</sup>	30 µg/Nm <sup>3</sup>	40%	12 µg/Nm <sup>3</sup>
NH <sub>3</sub>	Ammonia	Arrêté 20/9/2002, France <sup>18</sup>	30 mg/Nm <sup>3</sup>	40%	12 mg/Nm <sup>3</sup>

**Table 3.a-2:** Maximum uncertainties given as 95% confidence intervals of daily ELVs in Germany for Hg and France for NH<sub>3</sub> and corresponding absolute uncertainties.

the 95 % confidence intervals of a single measured result shall not exceed the following percentages of the emission limit values". (See the values of the 95% CI in [Table 3.a-1 below](#)).

Therefore being % of fixed values, these maximum 95% confidence intervals are absolute values. For instance, for HCl, the maximum 95%CI is 40% of 10 mg/Nm<sup>3</sup> (daily ELV, see [Table 3.a-1 below](#)). It is therefore an absolute value of 4 mg/Nm<sup>3</sup>.

<sup>17</sup> See 17. BimSchV 2/5/2013: § 8 p. 7/24 for the daily ELV and Annex 4 p. 23/24 for 95%CI. No CI95% for NH<sub>3</sub>.

<sup>18</sup> See Arrêté 20/9/2002: Article 18 for 95%CI and Annex 1, point e for the daily ELV.