METHODS FOR APPLYING MEASUREMENT UNCERTAINTY

CURRENT PRACTICES IN EUROPE - EC REPORTS 2020

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

OVERVIEW - PRESENTATION STRUCTURE

- Report for EC: “Assessment of Compliance with ELV under IED. Current practices in Europe.”
- Report for EC: “Online real-time monitoring of industrial emissions”
- Findings from implementing BAT and BAT conclusions

REPORT ON COMPLIANCE ASSESSMENT

"Assessment of compliance with ELV under IED. Current practices in Europe."

- Report for the European Commission
- Developed as part of the project "Implementation support IED" (Service Request 12 under Framework Contract)
- Authors: Ricardo and Umweltbundesamt AT
- https://circabc.europa.eu/ui/group/438f9a4e-aecf-41a9-8a2a-4b2bca52d5c6/library/03832771-c41b-46e7-9f9e-0f7e29e7eb78/details

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

CONTENTS OF COMPLIANCE ASSESSMENT REPORT

Report covers current practices across EU MS, UK and Norway on compliance assessment.

This area has been flagged as challenging and non-uniformly implemented in Europe.

Focus: compliance assessment:

- in general for all industrial installations (Chapter II IED)
- LCP (Chapter III and Annex V IED)
- WI (Chapter IV and Annex VI IED)

Objective: identify examples of good practices → recommendations on compliance assessment

WAY OF DATA GATHERING

- Literature review:
  - IED Implementation Workshops: Copenhagen 2016, Brussels 2017, Berlin 2017
  - IMPEL – Supporting Implementation IED (2016)
  - Interpretation of WI/LCP confidence interval requirements (European Commission)
  - Industrial Emissions Directive: measurement uncertainty issues (Frank Bold, 2020)
  - Evaluation IED
- Questionnaires on current practices in Europe
  - responses from 21 MS, UK and Norway
- Webinar with Member States in March 2020

APPLICATION OF MEASUREMENT UNCERTAINTY

How are measurement uncertainty and confidence intervals taken into account in assessment of compliance of installations in different countries (EU Member States, UK and Norway)?

- Key issue of concern due to variability in approaches across EU Member States
- Different application of measurement uncertainty in compliance assessment leads to inconsistent assessment of environmental performance, and in some cases to underestimation of actual emissions
- Primarily a topic for large combustion plants (LCP) and waste incineration plants (WI), can also be relevant for other industrial installations

RELEVANT PROVISIONS FOR LCP (ANNEX V PART 3 IED)

(…)

9. At the emission limit value level, the values of the 95 % confidence intervals of a single measured result shall not exceed the following percentages of the emission limit values:

Carbon monoxide	*10 %*
Sulphur dioxide	*20 %*
Nitrogen oxides	*20 %*
Dust	*30 %*

10. The validated hourly and daily average values shall be determined from the measured valid hourly average values after having subtracted the value of the confidence interval specified in point 9.

(…)

RELEVANT PROVISIONS FOR LCP (ANNEX V PART 4 IED)

In the case of continuous measurements, the emission limit values set out in Parts 1 and 2 shall be regarded as having been complied with if the evaluation of the measurement results indicates, for operating hours within a calendar year, that all of the following conditions have been met:

a. *no validated monthly average value exceeds the relevant emission limit values set out in Parts 1 and 2;*
b. *no validated daily average value exceeds 110 % of the relevant emission limit values set out in Parts 1 and 2;*
c. *in cases of combustion plants composed only of boilers using coal with a total rated thermal input below 50 MW, no validated daily average value exceeds 150 % of the relevant emission limit values set out in Parts 1 and 2;*
d. *95 % of all the validated hourly average values over the year do not exceed 200 % of the relevant emission limit values set out in Parts 1 and 2.*

The validated average values are determined as set out in point 10 of Part 3.

For the purpose of the calculation of the average emission values, the values measured during the periods referred to in Article 30(5) and (6) and Article 37 as well as during the start-up and shut-down periods shall be disregarded.

RELEVANT PROVISIONS FOR WI (ANNEX VI PART 6 IED)

(…)

1.3 At the daily emission limit value level, the values of the 95 % confidence intervals of a single measured result shall not exceed the following percentages of the emission limit values:

Carbon monoxide	*10 %*
Sulphur dioxide	*20 %*
Nitrogen dioxide	*20 %*
Total Dust	*30%*
Total organic carbon	*30 %*
Hydrogen chloride	*40 %*
Hydrogen fluoride	*40 %*

(…)

RELEVANT PROVISIONS FOR WI (ANNEX VI PART 8 IED)

(…)

1.2 *The half-hourly average values and the 10-minute averages shall be determined within the effective operating time (excluding the start-up and shut-down periods if no waste is being incinerated) from the measured values after having subtracted the value of the confidence interval specified in point 1.3 of Part 6. The daily average values shall be determined from those validated average values.*

(…)

RELEVANT PROVISIONS FOR WI (ANNEX VI PART 8 IED)

(a) none of the daily average values exceeds any of the emission limit values set out in point 1.1 of Part 3 or in Part 4 or calculated in accordance with Part 4;

(b) either none of the half-hourly average values exceeds any of the emission limit values set out in column A of the table under point 1.2 of Part 3 or, where relevant, 97 % of the half-hourly average values over the year do not exceed any of the emission limit values set out in column B of the table under point 1.2 of Part 3;

(c) none of the average values over the sampling period set out for heavy metals and dioxins and furans exceeds the emission limit values set out in points 1.3 and 1.4 of Part 3 or in Part 4 or calculated in accordance with Part 4;

(d) for carbon monoxide (CO):

(i) in case of waste incineration plants:

- at least 97 % of the daily average values over the year do not exceed the emission limit value set out in point 1.5(a) of Part 3; and,

- at least 95 % of all 10-minute average values taken in any 24-hour period or all of the half-hourly average values taken in the same period do not exceed the emission limit values set out in points 1.5(b) and (c) of Part 3; in case of waste incineration plants in which the gas resulting from the incineration process is raised to a temperature of at least 1 100 °C for at least two seconds, Member States may apply an evaluation period of 7 days for the 10-minute average values;

(ii) in case of waste co-incineration plants: the provisions of Part 4 are met.

CALCULATION OF VALIDATED EMISSION VALUE – APPROACHES IN EUROPE

Different approaches have been adopted in Europe with regard to subtraction of uncertainty from measurements for the purpose of checking compliance with ELV:

- Approach A: subtraction of maximum allowed measurement uncertainty (measured value x maximum allowed uncertainty in %) from the measured value
- Approach B: subtraction of fixed proportion of ELV (ELV x maximum allowed uncertainty in %) from the measured value
- Approach C: subtraction of the actual measurement uncertainty of the measured value
- Approach D: no subtraction of uncertainty; validated value = measured value

IMPACT OF DIFFERENCES IN APPROACHES

Example:

NOx with 20% confidence interval

ELV: 100 mg/Nm^3

Compliance assessment											
Illustration of impact of differences in approach											
Example for NOx with 20% confidence interval											
	Measured value	**90 mg/Nm^3**		**100 mg/Nm^3**		**110 mg/Nm^3**		**120 mg/Nm^3**			
	measurement uncertainty	**Reported value to assess compliance**	**Value subtracted**	**Reported value to assess compliance**	**Value subtracted**	**Reported value to assess compliance**	**Value subtracted**	**Reported value to assess compliance**	**Value subtracted**	**Maximum to comply with ELV**	
	20% of measured value	72	18	80	20	88	22	96	24	**125**	
	20% of ELV	70	20	80	20	90	20	100	20	**120**	
	20% of measured value up to ELV, 20% of ELV above it	72	18	80	20	90	20	100	20	**120**	
	actual measurement uncertainty (assume 5%)	85.5	4,5	95	5	104.5	5,5	114	6	**105.26**	
ELV	**100**										

EXAMPLE: NOx in LCP

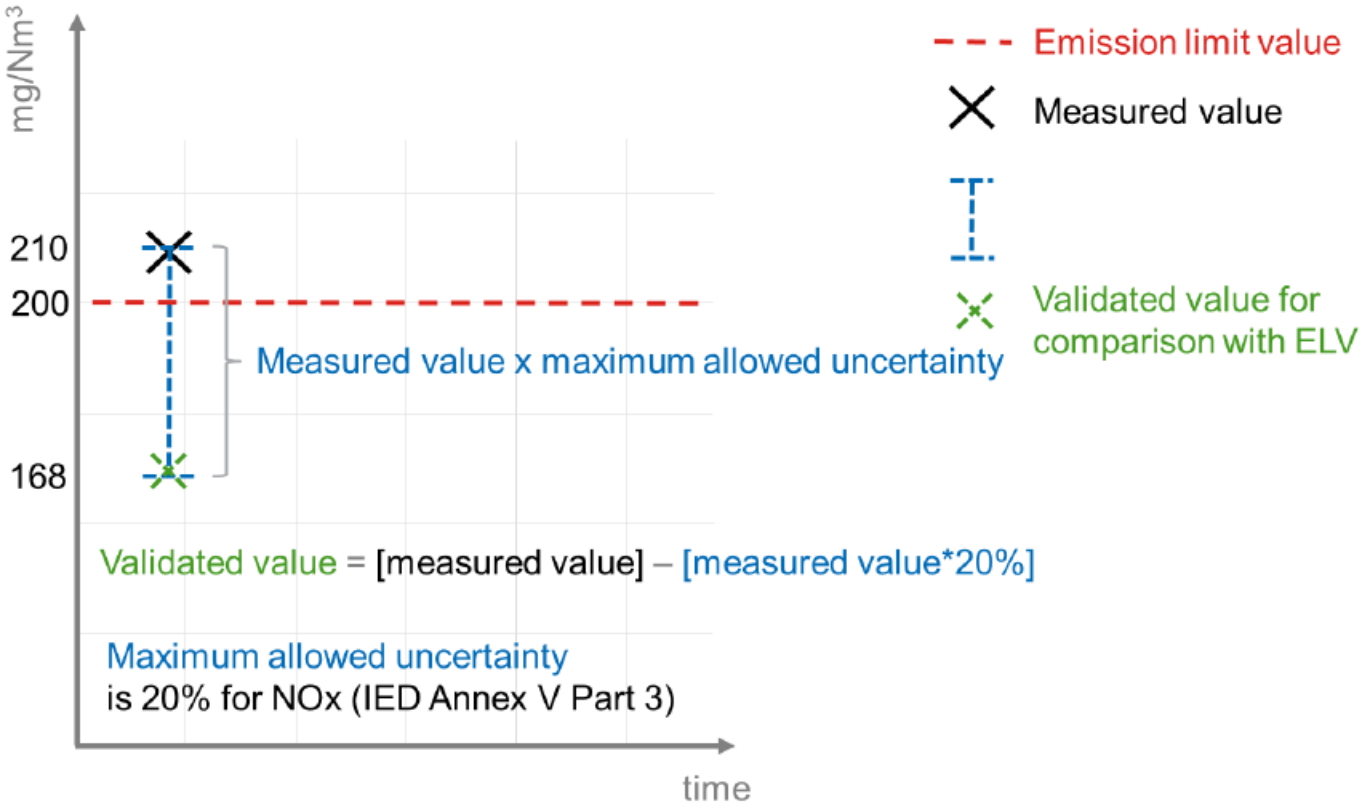
Measured value: 210 mg/Nm^3

ELV: 200 mg/Nm^3

Maximum allowed uncertainty: 20 % (IED Annex V Part 3)

Compliance with different approaches → next slides

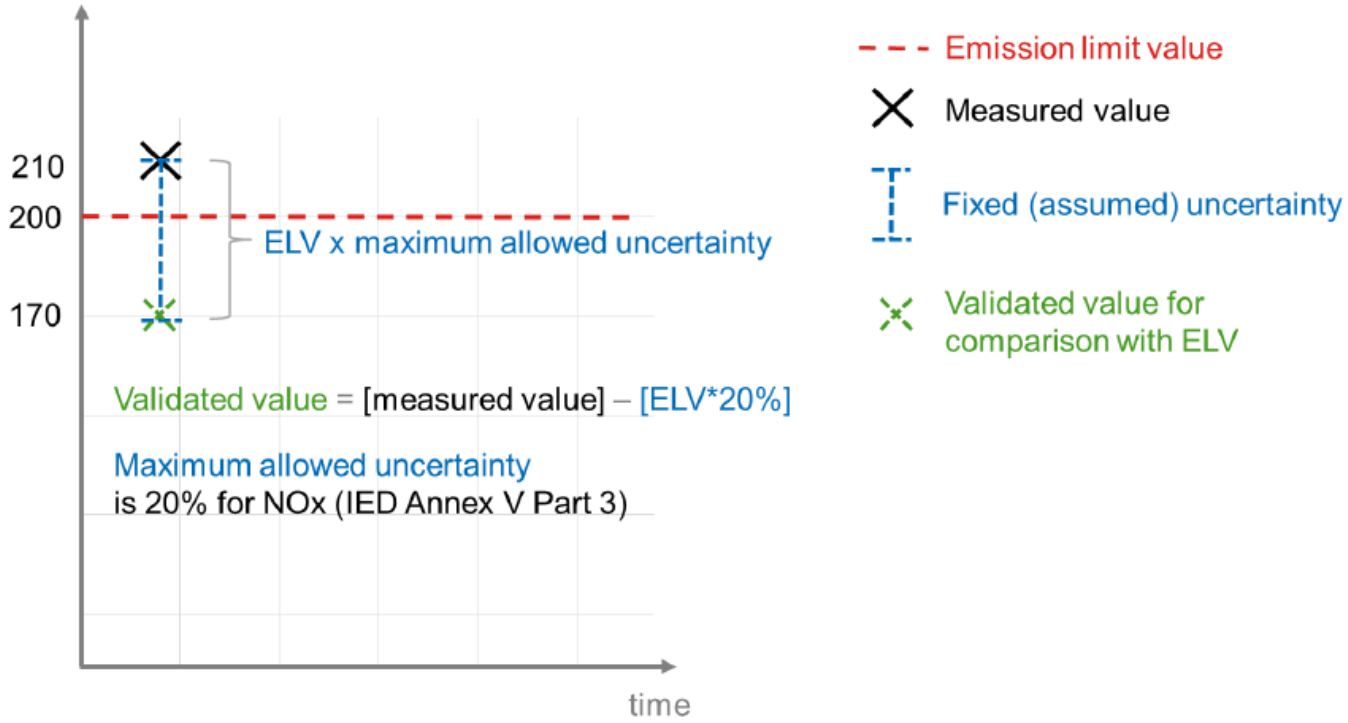
Figure 3-1 Approach A to application of uncertainty: Subtraction of maximum allowed uncertainty % from the measured value



Several Member States reported they adopt Approach A (Austria, Belgium (Flanders), Finland, Croatia, Latvia, Romania, and Slovakia, UK).

In Belgium (Flanders), 30% of the measured value is subtracted for all pollutants.

Figure 3-2 Approach B to application of uncertainty: Subtraction of fixed proportion from ELV

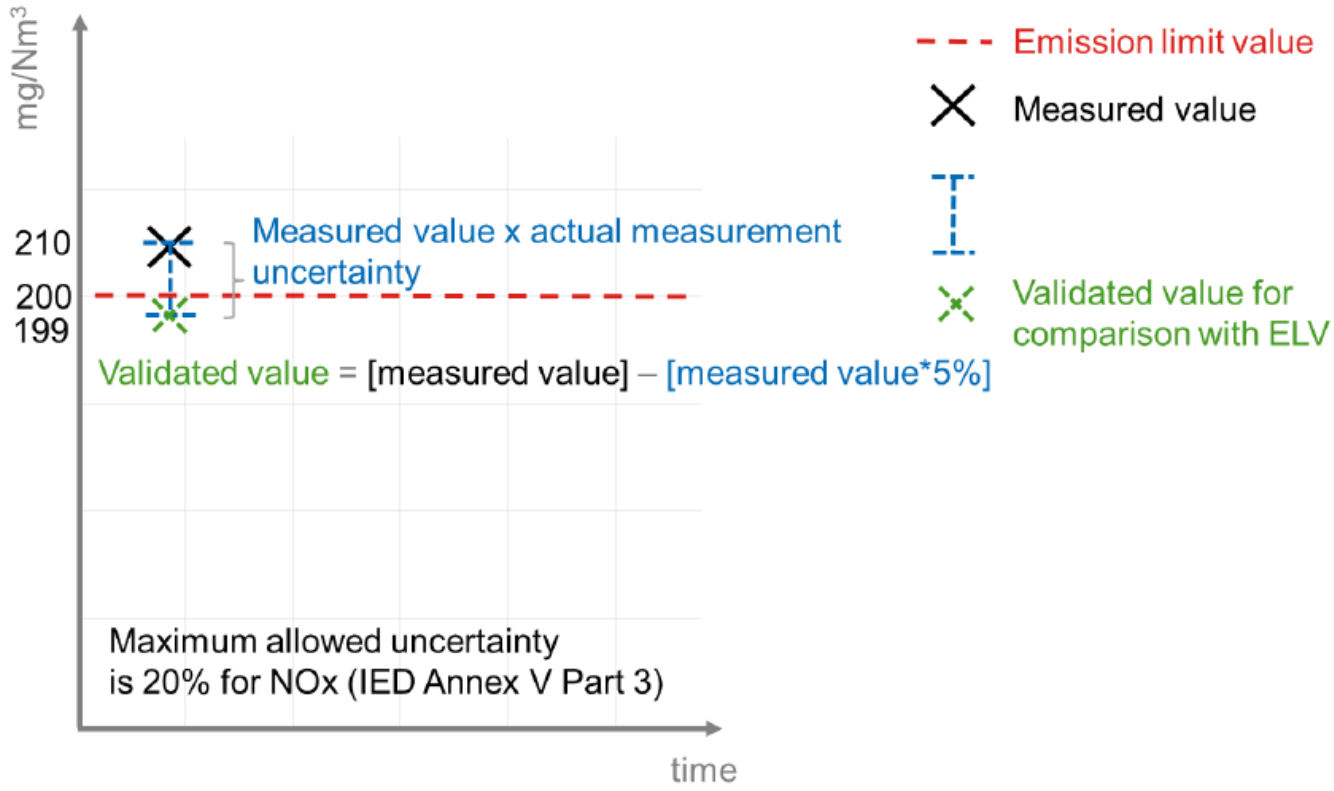


Approach taken in Austria for LCP plants and some WI plants, as well as in France: if measured data repeatedly exceeds ELV but assessed as compliant due to subtraction of uncertainty, additional inspections can be requested by the authority.

If measured value < ELV
→ Approach B results in more uncertainty being subtracted than Approach A

If measured value > ELV
→ Approach B results in less uncertainty being subtracted than Approach A

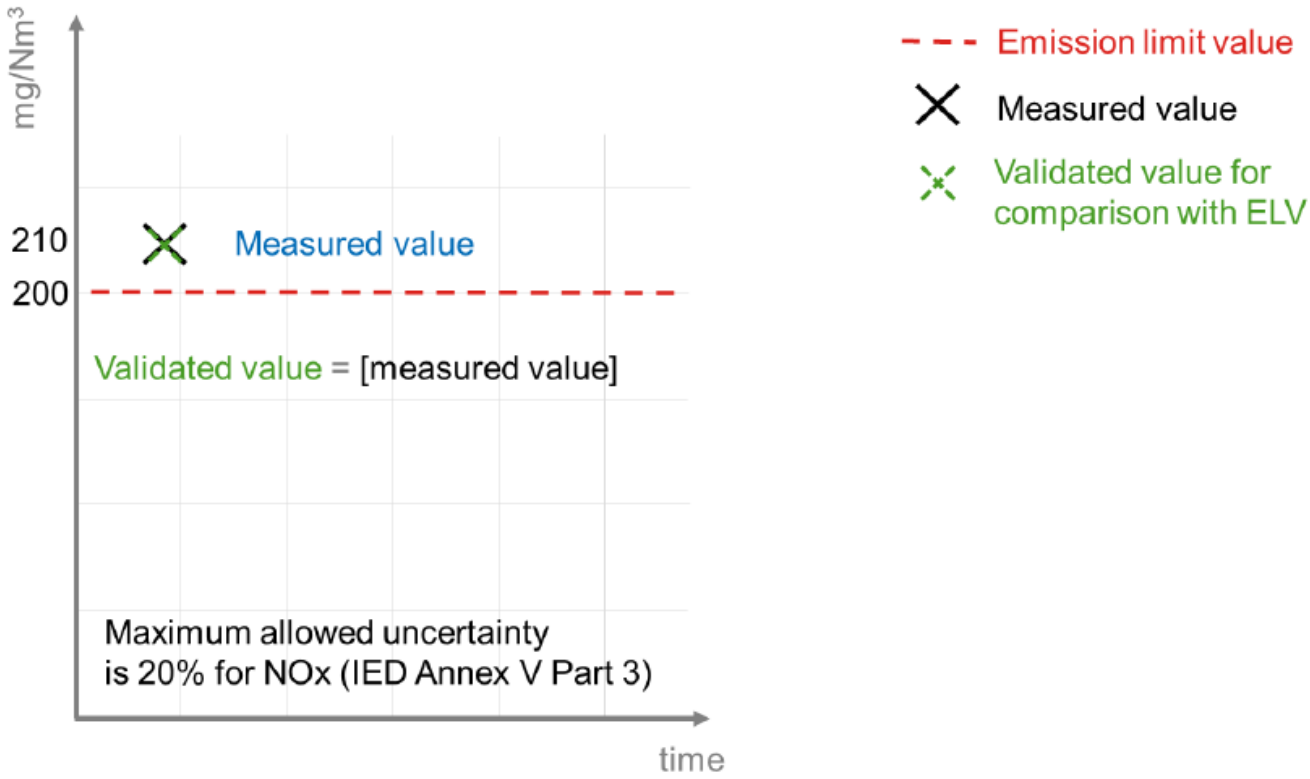
Figure 3-3 Approach C to application of uncertainty: Subtraction of actual measurement uncertainty from measured value



Approach taken in Spain, Germany, Ireland, Italy, Netherlands

Results in less uncertainty subtracted compared to Approach A and B

Figure 3-4 Approach D: not subtracting uncertainty from measured value or ELV



Approach taken in Bulgaria, Denmark, Luxembourg, Malta, Norway

OTHER APPROACHES

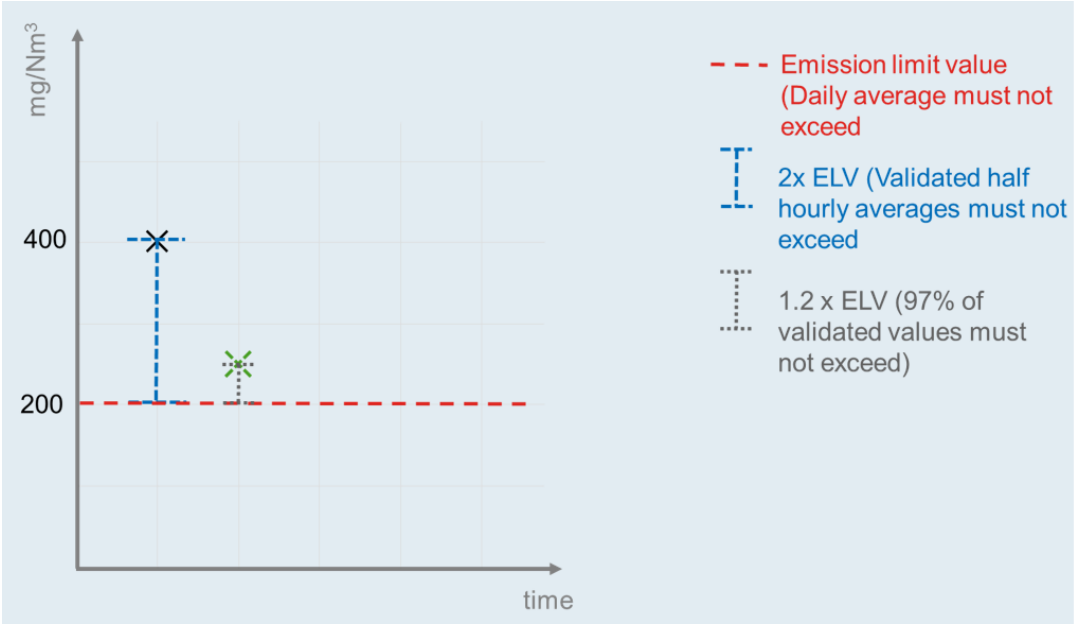
- Uncertainty intervals are only considered at the prosecution stage to determine if an environmental offence has been committed: approach taken in Sweden
- The measurement uncertainty in mg/Nm^3 is determined and only subtracted when the measured value is above the ELV (some WI plants in AT)
- If measured values are close to the ELV, sampling time is increased: approach taken in Hungary
- Combined approach (taken in Latvia):
  - Compliant if: measured value + uncertainty < ELV
  - Intermediate if: measured value – ELV < uncertainty
  - Non-compliant if: measured value – uncertainty > ELV

OTHER ALLOWANCES AND FLEXIBILITIES

Austria (for LCP):

continuous measurements:

- no validated daily average must exceed the ELV.
- 97% of validated emission values must not exceed 1.2 times the ELV.
- no validated half-hourly average must exceed double the ELV.



© Ricardo – compliance report

APPROACH IN THE NL

- Initially Approach A (subtracting the maximum allowed uncertainty) was in use in NL
- “Stichting Afvaloven Nee”: official complaint to the European Commission about this interpretation
- European Commission (DG ENV) (2017) : *“only values which have been determined on a case by case basis on the basis of measurement should be deduced from the values obtained through the measurements. This is in line with the rationale of the Directive, which is to protect human health and environment. […] Where an instrument used to measure is very precise there is less need to deduct values from the measured results compared to a situation where the instrument is less precise. […]* ***such deduction possibility must be used as restrictive as possible***. ***A practice of deduction maximum fixed values regardless of the accurateness of the instrument therefore does not sit well with the Directive***.” https://www.grienlinks.nl/wp-content/uploads/2018/10/Brief-EC-directoraat-milieu-20-07-2017-1.pdf
- Now: the actual measurement uncertainty is subtracted (Approach C)

RECOMMENDATIONS FROM EC REPORT

- A more uniform approach of compliance assessment should be applied across Europe.
- Information to be used by competent authorities to assess compliance should comprise the annual report, additional monitoring data, information on measuring method applied and results of any inspection or visits undertaken
- Validated measured values should be calculated using **Approach C: subtracting the actual measurement uncertainty of the measured value**
- Periods to be excluded from compliance assessment using continuous measurements should be periods of start-up and shut-down, severe malfunction and maintenance/repair.

ONLINE REAL-TIME MONITORING

"Technical assistance on industrial emissions – Assignment #3 Online real-time monitoring on industrial emissions"

- Report for the European Commission
- Developed as part of the project "Technical Assistance on industrial emissions" (Service Request 17 under Framework Contract)
- Authors: Ricardo, Umweltbundesamt AT and ELLE
- https://circabc.europa.eu/ui/group/438f9a4e-aecf-41a9-8a2a-4b2bca52d5c6/library/f8072f57-8a15-4d0f-8ea5-9ccac7e57e1b/details

CONTENTS OF TELEMONITORING REPORT

Report investigates application of telemonitoring (online real-time monitoring) for the reporting of data acquired by CEMS (continuous emissions monitoring system).

Key aims:

- Describe existing telemonitoring practices in countries outside and in the EU
- Describe current capabilities of telemonitoring for air and water emission data
- Summarize information on the costs, benefits, advantages and challenges
- Final Report: https://circabc.europa.eu/ui/group/438f9a4e-aecf-41a9-8a2a-4b2bca52d5c6/library/f8072f57-8a15-4d0f-8ea5-9ccac7e57e1b/details

FINDINGS OF TELEMONITORING REPORT

Telemonitoring is more advanced in non-European countries.

Described systems outside the EU: China, India, South Korea, Malaysia, USA.

Described systems in the EU: Austria (Linz), Croatia, France, Germany, Italy (Lombardy), Spain.

Different approaches:

- Approach 1 – periodic manual submission of data (Croatia, Spain (Madrid, Galicia))
- Approach 2 – periodic automatic submission of data (USA, Spain (Andalusia), Italy (Lombardy))
- Approach 3 – near real-time periodic automatic submission of data (China, Germany)
- Approach 4 – fully automated real-time data collection with access to CEMS (India, South Korea, Malysia, Austria (Linz))

SECTORS AND AIR POLLUTANTS (TELEMONITORING)

- Thermal power plants
- Industrial boilers and furnaces
- Municipal waste incinerators
- Hazardous waste incinerators
- Iron and steel production
- Non ferrous metals industries
- Cement manufacture
- Glass industries
- Ceramic industries
- Fertiliser manufacture
- Pulp and paper industries
- Tanneries
- Oil refineries
- Chemical industries
- …

- SO_2
- NOx
- PM
- HCl
- HF
- NH_3
- CO
- NMVOC / TVOC / VOC
- Hg

KEY REPORTED DRIVERS AND BENEFITS FROM TELEMONITORING

- Faster processing of citizens' complaints and better confidence in competent authorities;
- Faster identification of exceedances of emission limit values;
- Easier process in the revision of emission limit values;
- Public access to information;
- Deterring effect for non-compliance;
- Higher quality of industrial emission datasets;
- Streamlining reporting requirements;
- Overall faster decision-making process;
- Lower workload for inspections.

FINDINGS FROM IMPLEMENTING BAT AND BATc

- BATc often allow to choose between periodic and continuous monitoring
  - NFM: dust, Hg, SO_2, NOx, TVOC, HCl, HF
  - CLM: HCl, HF, TOC
  - GLS: dust, NOx, SO_2, NH_3, CO
  - WI: HF, Hg, (PCDD/F)
- Permitting authorities often implement periodic monitoring in permit - plant operator reports the results of this monitoring
- Plant operator also performs continuous self monitoring - these monitoring results are normally not reported to the permitting authorities
- Example from WI: HF and NH_3 are monitored continuously (self monitoring); the competent authority receives the results of the periodic measurement, not of the continuous measurement (see Annex VI Part 6 2.5 IED):

"*The competent authority may decide not to require continuous measurements for HCl, HF and SO_2 in waste incineration plants or waste co-incineration plants and require periodic measurements as set out in point 2.1(c) or no measurements if the operator can prove that the emissions of those pollutants can under no circumstances be higher than the prescribed emission limit values.*"

CONCLUSIONS

- Benefits of CEMs and online real-time monitoring (telemonitoring) are:
  - On-time information of permitting authority
  - Faster identification of exceedances of ELVs
  - Higher quality of emission data sets
  - Help for processing complaints from citizen
  - Lower workload for inspection
- BAT conclusions often allow the permitting authorities to choose between continuous and periodic measurement. However, better information on plant behaviour and environmental protection is received by continuous measurement.
- Application of measurement uncertainty is a key issue.
- Validated measured values should be calculated by subtracting the actual measurement uncertainty of the measured value.

CONTACT & INFORMATION

Dr. Brigitte Winter

+43 1 31304 5546

brigitte.winter@umweltbundesamt.at

Umweltbundesamt
www.umweltbundesamt.at

REFERENCES

- Ricardo (2020): Assessment of compliance with Emission Limit Values under the Industrial Emissions Directive. Current practices in Europe. Report for the European Commission. ED 11515/2020
- Ricardo (2020): Technical assistance on industrial emissions – Assignment 3 Online real-time monitoring of industrial emissions. Report for the European Commission. ED11801104/2020
- Frank Bold (2020): Industrial Emissions Directive: Measurement uncertainty issues.
- European Commission (2017): answer to complaint “Stichting Afvaloven Nee”