Improving the measurement of stack emissions – an update on standardisation and research activities in Europe

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Introduction

- Overview of regulations and standards in Europe
- Update on recent standards and current activities
- Review of development of standard for data handling systems
- Overview of some research projects NPL are leading in Europe to improve emissions monitoring
Emissions monitoring framework

Industrial Emissions Directive

Permits ELVs

Sites monitor and report data

European Standards

Requirements on quality of reported data

Requirements and default ELVs

Defines emission limit values

Requires BAT

Sectoral BREFs / BATC

Best Available Technique Reference documents BAT conclusions

SRMs
AMS Calibration (EN 14181) Certification (EN 15267) Data handling
Structure of emissions monitoring standards in Europe

Directives
BREFs
Permits

Define monitoring Requirements and data quality objectives

EN14181
Quality assurance

Reference Methods
(manual and instrument)

Test teams

EN15267
Performance Testing of AMS

certification

calibration

EN 15249
TS 15274
Test team performance
New PT standard

Accreditation
QA/QC

AMS Instruments

Data handling/reporting
(standard being drafted)

Application of ISO 17025
### CEN TC 264 active working groups working on emissions

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New standards being produced in TC 264

- Current mandated work in emissions area:
  - HCl instrumental – carrying out validation studies
  - VOC from fugitive and diffuse emissions – validation studies just completed

- New mandates
  - Long-term sampling of PCDDs/PCDFs and PCBs
  - Gaseous mercury
  - Formaldehyde

- Future mandates
  - Ammonia
  - Chlorine and ClO₂
  - HF
Other standards being developed or recently completed in TC 264

- FTIR – common standard/ TS for use of FTIR
- Predictive emission monitoring system (PEMS)
- Data handling system standards
  - Defining how reported data are calculated
- Proficiency testing schemes for emission monitoring
  - Harmonising how schemes are defined
- Revision of a number of standards
  - e.g. address changes in ISO 17025
- Guidance document on flow standard EN ISO 16911
  - CEN/TR 17078:2017
- Conversion of TS 14793 on equivalency to a full standard
  - EN 14793 – now a standard
- Instrumental SO₂ method published as TS
  - CEN/TS 17021
- New work on emissions from skylights and roof vents
Example of new associated emission limit values

- Brefs define BAT abatement technology and associated emission levels (AELs) that should be achieved
- Iron and Steel Bref (adopted 2012)
  
  Wet scrubber
  - SOx (total sulphates as SO\(_2\)) : 30-50mg/m\(^3\)
  - HF : 1-3 mg/m\(^3\)
  - HCl (total chlorides) : 1-3 mg/m\(^3\)
  
  C.f. IED : HCl 10 mg/m\(^3\)

- Coke oven gas
  - Dust : 1-20 mg/m\(^3\)

- Large combustion plant (2017)

  - NH\(_3\) : < 3–10 mg/Nm\(^3\)
  - HCl : 1-3 mg/Nm\(^3\) yearly average
Useful links

- A full list of active working groups in CEN TC 264 can be found here: https://standards.cen.eu/dyn/www/f?p=204:29:0:::FSP_ORG_ID,FSP_LANG_ID:6245,25&cs=188DC176A2CD0B647551520F9AF099B6D#1

- More information on the role and process of standardisation in CEN technical committees and working groups can be found in the following guide: ftp://ftp.cen.eu/CEN/Services/Education/Handsonguides/Hands onstandards.pdf

- Full list of BREFs and BATC http://eippcb.jrc.ec.europa.eu/reference/
CEN TC 264 WG 9 is developing a standard for data acquisition and handling systems (DAHS).

This was a missing link in the AMS QA/QC framework – EN 14181 explicitly excludes the DAHS (used to be recording system).

WG 9 has been working for a long time on this (25\textsuperscript{th} meeting, 500+ documents).

Finally Part 1 is about to go to CEN Enquiry.
Drivers for standard

- Ensure quality of reported data
- Enable manufactures to certify systems
  
  Some existing certification – eg MCERTs in UK

- Examples of issues with DAHS in the real world
  
  Site with multiple channels – no indication on output of which channel was which

  Site implementing QAL2 function 9 months late - could have had lower reported emissions for 9 months

  Site with parallel (standby) AMS – when switched between these overwrote the data from the primary AMS – lost QAL2 data

  System with the calibration function entered in two places
Split into 3 standards

- **Part 1: Specification of requirements for the handling and reporting of data** - Definition of the calculations
- **Part 2: Specification of requirements on data acquisition and handling systems** - Performance requirements for DAHS
- **Part 3: Specification of requirements for the performance test and certification of data acquisition and handling systems** - Performance testing (c.f. EN15267)

Why split the standard?
- Not just so NEN can make more money ;-)
  but mainly because a single standard was too complicated, and tried to cover too many things
- Also because most of the contention and discussion was in Part 1
Why so much discussion and debate to prepare a data handling standard?

- We had to define a lot more than expected
- Primarily because the IED does not define very much.
- Therefore many member states have implemented things slightly differently
- To define what the DAHS must calculate we actually had to define what is calculated and how

  This has significant implications for regulators

- For example –
  - 3 different ways to calculate oxygen correction
  - multiple ways to form averages
  - different approaches to subtract confidence interval – what order
  - different ways to handle missing data and minimum validity of data
  - which values to use for confidence interval
  - which order to apply calibration and averages
  - Which ELV to use
Outline of standard – Part 1

- Scope covers IED and E-PRTR reporting including mass emissions
- Data handling
  - Minimum frequency of data capture
  - Inputs – AMS, peripheral, plant and manual entered data
  - Flags – faults, calibrations etc
  - Mandatory data to store (first level data)
- Data reporting
  - Minimum data products that must be available
  - QAL3 and QAL2
  - e.g short and long term averages
- Calculations
  - How to calculate corrected standardised values, validated and calibrated
  - Definition of averaging periods
  - Time stamps
  - Terminology
  - Capping data
  - Missing values
  - Data validity
One of the issues

- FLD status
- Plant status

**Plant in reportable mode for ≥ 2/3 of STA period?**

- no
  - STA shall
    - be flagged “plant not in reportable state”
    - not be used to check ELV
    - not be used to calculate LTA
    - not count for invalidating the day

- yes

**Valid FLD while plant in reportable mode available for ≥ 2/3 of STA period?**

- no
  - STA shall
    - be flagged as “not valid”
    - not be used to check ELV
    - not be used to calculate LTA
    - count for invalidating the day

- yes

- STA shall
  - be flagged as “valid”
  - be used to check ELV
  - to calculate LTA
DAHs standard

- Hopefully **will** harmonise emissions reporting in Europe
- Will provide manufacturers of DAHSs common requirements and mean systems are same throughout Europe
- Provide industry with tools needed to reliably report data
- Give stack teams the data needed for QAL2 and AST assessments
- Provide regulators with data consistently reported and with auditing and data security issues addressed
- Define a common interpretation of the Directives
Current issues and research

- Limit of detection and limit of quantification
- Associated Emission Limit values in BREFs are lower
  
  Issues are whether existing methods are able to meet these
  
  Often outside existing validation ranges

- Ineris report on SRM performance
  

- Sampling issues
- New compounds being regulated
- Issues being addressed in research programmes
NPL Emissions Research Projects

- **IMPRESS (June 2014 – May 2017)**
  - Measurements of point (stack) and fugitive emission sources

- **Sulf-Norm (July 2016 – June 2019)**
  - Smaller project specifically addressing unconditioned vs conditioned sampling of SO\(_2\) from stacks

- **IMPRESS 2 (summer 2017 – summer 2020)**
  - Combustion emission measurements on both the industrial (Industrial Emissions Directive) and domestic (EcoDesign Directive) scale
New Facilities Delivered under stack simulators

- Netherland Gas Stack Simulator Facility
- UK Particulate Simulator Facility
New Facilities Delivered under fugitive emission test facilities

- IR camera test facility
- Controlled Release Facility (CRF)
Work to Develop Techniques / Measurement Science

- Testing equivalence of portable FTIR to the SRMs for CO, NOx, SO₂, HCl and H₂O in accordance with CEN/TS 14793

- State of UK emissions monitoring of stacks and flues: an evaluation of proficiency testing data for SO₂, NO and particulates
  - Marc D. Coleman, Rod A. Robinson, Matthew B. Williams, Martin J. Clack & David M. Butterfield
Flow and Mass emissions

- Collated industry flow measurement issues and data from NPL field campaigns.
- CFD flow modelling of specific industrially relevant cases including swirl.
- Computer model of stack emission monitoring instrument including full EN14818 quality control and calibration procedure concentration + flow
  Uncertainty in CEM over many years
- Uncertainty guidance and training
Area Source/Fugitive Emissions

- Development of protocols for DIAL, SOF, TDL and IR camera
- Input into CEN WG38 – development of standard for fugitive and diffuse emissions of VOCs
- Validation of techniques
- CRF source nodes used to release propane while embedded within the structure of a cracking/reforming plant
Sulf-Norm Project

- Sulf-Norm: *Metrology for Sampling and Conditioning SO₂ Emissions from Stacks*, started autumn 2016
- Small project focussed on sampling issues
  - Test unconditioned sampling (to set a benchmark for comparison)
  - Test conditioned sampling (chiller, permeation)
  - Particular focus on low SO₂ concentrations
- Early work nearing completion
  - Survey of European test laboratories
  - Intercomparison using VTT test bench
  - Blind testing of UK ISO 17025 accredited laboratories for sulphate analysis
- Project website: [http://empir.npl.co.uk/sulf-norm/](http://empir.npl.co.uk/sulf-norm/)
Sulphate analysis
IMPRESS 2: *Metrology for Air Pollutant Emissions*
IMPRESS-2 planned work highlights

- Assess performance of reference methods at lower concentrations
- Look at requirements for smaller ducts
- Develop methods for new species (HF, formaldehyde, ammonia)
- Further assessment of flow uncertainties including issues with wall effects, sensor obstruction in small ducts and the use of sensor arrays.
- Extend model of uncertainties to include flow sensors and calculate annual mass emission uncertainties
- Develop methods for small domestic biomass boiler testing
- Develop new techniques for isotopic CO$_2$ measurement
- Input into new standards
European regulations on emissions

- **Industrial Emissions Directive**
  - Defines pollutants, limit values and monitoring requirements
  - Requires

- Supported by Best Available Technique (BAT) Reference documents - BREFs

- **Emissions Trading Directive EU-ETS**
  - GHG trading

- **European Pollutant Release & Transfer Register (E-PRTR)**
  - Reporting requirements – subtly but operationally significantly different to regulatory reporting
  - Implements UNECE transparent reporting