Publishable Summary for 18NRM04 Heroes
Determining new uncertainty requirements for increasingly stringent legislative HCl industrial emission limits

Overview

The HCl Standard Reference Method (SRM, EN 1911), which is legislatively required for measuring industrial emissions, is unable to meet uncertainty requirements being brought in via Best Available Techniques (BAT) Conclusions documents (which set permit conditions for regulated industrial processes). This puts at risk the new regulatory framework and the ability of national regulators to carry out enforcement interventions. The project will address these issues by recommending uncertainty requirements for extending the application of the SRM with an associated underpinning evidence base; and providing an evidence base of the performance of portable optical technologies with a view to replace the SRM in the longer term.

Need

Limiting emissions of HCl from industrial processes is critical, as they are acutely toxic and impact on far more ecosystems than previously thought. Full implementation of the Industrial Emissions Directive and the BAT Conclusions documents it adopts is expected to lead to a reduction in premature deaths / years of life lost in Europe of 13 000 and 125 000, respectively. Economically, if the legislation is enforced, the European taxpayer is predicted to save €7 – €28 billion p.a.

The HCl emission limit for industrial processes regulated under the Industrial Emissions Directive used to be 10 $mg.m^{-3}$. However, BAT Conclusions documents are bringing in increasingly stringent emission limits impacting a range of industries (e.g. 2-6 $mg.m^{-3}$ for waste incineration, <1-3 $mg.m^{-3}$ for iron and steel production, 3-12 $mg.m^{-3}$ for power stations).

The legislatively required standard reference method (SRM) for monitoring HCl emissions is described in EN 1911 and is based on extracting stack gas through deionised water in glass impingers before off-line analysis, generally by ion chromatography. It is a requirement that the emission measurement meets an uncertainty of 30 % (k = 2) of the emission limit, but this is not possible at limits below 10 $mg.m^{-3}$. The method uncertainty is subtracted from the reported emission prior to comparison to the emission limit, thus ensuring any breach is 'beyond reasonable doubt' (i.e. 95 % confidence) and that there is justification for national regulator enforcement intervention. Hence, if the method uncertainty is unclear then enforcement becomes untenable.

To address these issues there have been three key needs identified, from which the project's objectives are derived:

- CEN/TC 264 'Air Quality' have listed in their future priority work document the need for "assessment of current SRM to meet stricter limit values";
- CEN/TC 264 'Task Force Emissions' – who provide recommendations to the European Commission – have stated that a regulatory guidance document is needed on, "…stationary source emissions providing information on the field of application of the methods (measurement range, validation range, uncertainty, etc.)";
- CEN/TC 264 have identified the need for work on "automated methods for measuring emissions".

Objectives

The overall objective of the project is to facilitate the monitoring and enforcement of emission limits at industrial processes regulated via BAT Conclusions documents. The specific objectives are:

1. To extend Stack Simulator capability in Europe to generate emissions in-line with industries regulated via BAT Conclusions (<10 $mg.m^{-3}$) adopted under the Industrial Emissions Directive (IED 2010/75/EU).
2. To characterise the performance of the HCl SRM (EN 1911) using the capability developed in objective 1 at BAT Conclusions processes. To characterise new uncertainty sources that become significant at low concentrations.
3. To produce a metrologically valid evidence base of uncertainty contributions to EN 1911 and from this to develop a series of recommended uncertainty requirements for regulatory monitoring.
4. To create a scientific evidence base of the performance of a range of portable optical technologies, using the extended Stack Simulator capability developed in objective 1, with a view to the future replacement of the existing SRM. This will underpin current work at CEN on CEN/TS 16429 (optical techniques) and CEN/TC264/WI00264151 (Fourier transform infrared spectroscopy).
5. To produce a National Regulator Guidance Document of recommended measurement uncertainty requirements. To disseminate this document to EU DG Environment (Directorate-General for Environment), Task Force Emissions, CEN/TC 264 'Air Quality', and more broadly, to the emission community.
6. To contribute to a revision of EN 1911 by providing the data, methods, guidelines and recommendations, necessary for new uncertainty requirements for HCl industrial emission limits, to CEN/TC 264.

Progress beyond the state of the art

This project builds, in part, on work carried out in 16ENV08 IMPRESS 2, which highlighted that uncertainties of 30 % are not possible for HCl at low emissions, developed a Computational Fluid Dynamics (CFD) model of swirling flow in stacks, and supported manufacturers in terms of highlighting quantification errors in optical systems due to pressure gradients across the optical path length (a tool to calculate this effect allowing correction is available for download). This project will now carry out work to provide practical solutions for the emissions community to facilitate monitoring and enforcement at industries regulated via BAT Conclusions.

Extension of Stack Simulator capability in Europe

This project will develop and validate extended capability of European Stack Simulators in terms of generation of gas matrices composed of low level HCl concentrations commensurate with industries regulated via BAT Conclusions documents. The validation data will be made publicly available.

Characterisation of the performance of the HCl SRM (EN 1911)

This project will create new knowledge in terms of characterisation of the uncertainty of the HCl SRM for BAT Conclusions industries. This will include work on flow calibration error, novel work using a CFD model to determine droplet distribution in a swirling flow and its impact when sampling isokinetically, and work on HCl uptake in stack sample collection as a function of glassware configuration and collection parameters.

Evidence base of uncertainty contributions to EN 1911

A new HCl SRM evidence base will be compiled from the novel work above, Stack Simulator ILC (inter-laboratory comparison) of stack testing organisations performing EN 1911, and an ILC of analytical laboratories carrying out the analytical element of EN 1911. This evidence base will underpin the uncertainty requirements for the extension of EN 1911 to industries regulated via BAT Conclusions and placed in a suitable repository locatable by Registry of Research Data Repositories (RE3DATA).

Evidence base of the performance of a range of portable optical technologies

A new evidence base of the performance of a range of portable optical technologies for BAT Conclusions industries will be compiled from a Stack Simulator trial and placed in a suitable repository locatable by

RE3DATA. This will underpin future elaboration of CEN/TS 16429 and WI 00264151 (now CEN/TS 17337) with a view to a long-term replacement for the SRM. Appropriate data from the evidence base will be presented to CEN/TC 264 and CEN/TC 264/WG 3.

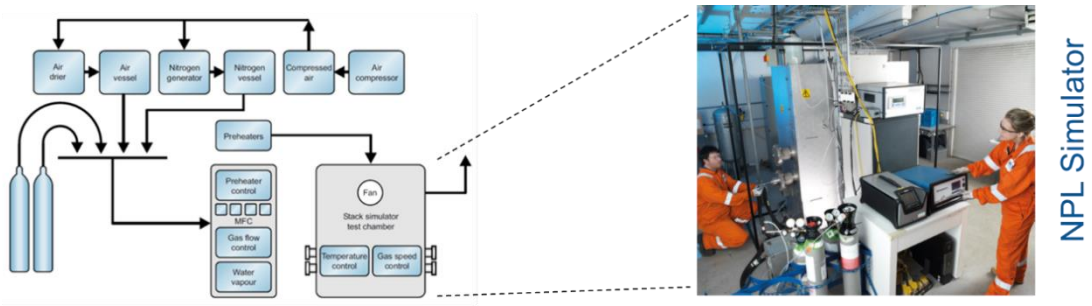
National Regulator Guidance Document

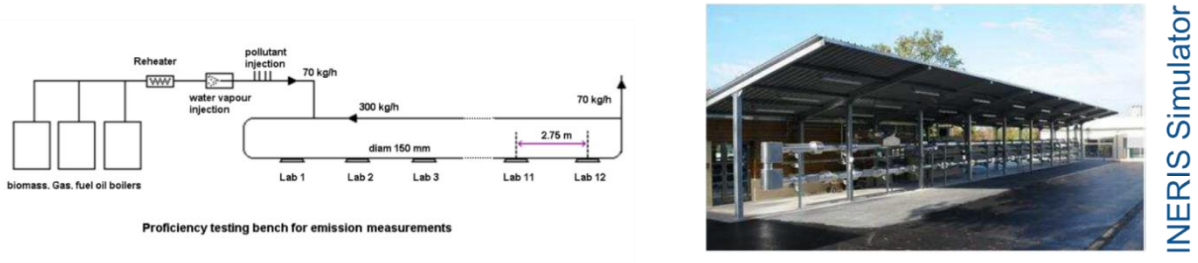
A new National Regulator Guidance Document of BAT Conclusions industries uncertainty requirements will be prepared and presented to different stakeholders e.g. IMPEL (European Union Network for the Implementation and Enforcement of Environmental Law), Task Force Emissions, CEN/TC 264, and DG Environment.

Results

Extension of Stack Simulator capability in Europe

Both the NPL and INERIS Stack Simulator facilities have been successfully extended and validated for the homogeneous generation of HCl down to 1 $mg.m^{-3}$ and 2.5 $mg.m^{-3}$, respectively (the aim of Objective #1 being <10 mg/m^3). This has been demonstrated in accordance with the homogeneity requirements set out in ISO 13528 'Statistical methods for use in proficiency testing by interlaboratory comparisons'.

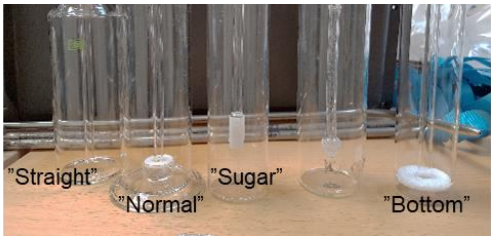


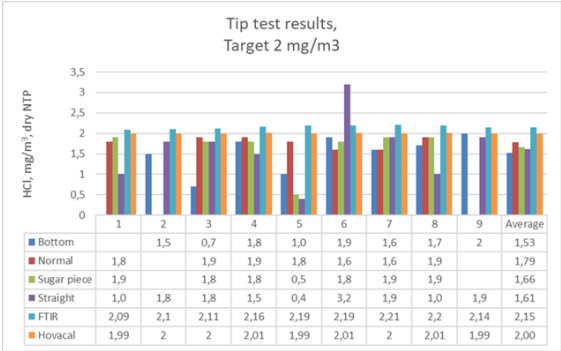


Characterisation of the performance of the HCl SRM (EN 1911)

Work has been carried out compiling historical calibration data of in-situ process plant operator emission monitoring analysers, where the calibration has been carried out via parallel measurements against either EN 1911 or an alternative method based on a portable automated measuring system (P-AMS). Analysis is still in its early stages, but so far it has been found that EN 1911 appears to read lower emissions than process plant operator analysers prior to calibration, whereas there is less evidence of a bias compared to parallel measurements against P-AMS.

Work is well underway in terms of characterising the uptake in stack sample collection as a function of glassware configuration and collection parameters. Results thus far have shown some dependence on tip configuration, however, the greater issue found at the low concentrations tested was that 10-25% of the HCl was not uptaken, i.e. a significant under-reading.





	1	2	3	4	5	6	7	8	9	Average
Bottom		1,5	0,7	1,8	1,0	1,9	1,6	1,7	2	1,53
Normal	1,8		1,9	1,9	1,8	1,6	1,6	1,9		1,79
Sugar piece	1,9		1,8	1,8	0,5	1,8	1,9	1,9		1,66
Straight	1,0	1,8	1,8	1,5	0,4	3,2	1,9	1,0	1,9	1,61
FTIR	2,09	2,1	2,11	2,16	2,19	2,19	2,21	2,2	2,14	2,15
Hovacal	1,99	2	2	2,01	1,99	2,01	2	2,01	1,99	2,00

Lastly, under this objective a CFD model has been established for modelling droplet distribution in a swirling flow. This model is currently being validated and so far, has shown good agreement with real-world data. With the model validation phase due to end soon the model will be used to probe the contribution of isokinetic sampling to the uncertainty.

Evidence base of uncertainty contributions to EN 1911

In addition to the data described above, on HCl uptake as a function of glassware configuration, further data for this evidence base will be collected over the following 9 months. The ILC of stack testing teams performing EN 1911 on the extended INERIS Stack Simulator will be held. Also, the CFD model will allow data to be collected on the effects of isokinetic sampling errors.

Evidence base of the performance of a range of portable optical technologies

Complimentary to the INERIS ILC of Stack Testing Teams performing EN 1911, data for this evidence base will be collected over the following 9 months in terms of the comparison of different portable optical technologies that will be held on the extended NPL Stack Simulator facility.

National Regulator Guidance Document

Whilst work on the Guidance Document itself will start in the latter stages of the project, some groundwork has been carried out in terms of alerting key stakeholders (see Impact below) of the project and the outputs - including the Guidance Document - that are expected.

Impact

The consortium has been active in many standardisation activities and has given presentations to different groups, as described below.

Impact on industrial and other user communities

With uncertainty requirements facilitating extension of the SRM to industries regulated via BAT Conclusions documents, national regulators will be able to carry out enforcement interventions as they will have the necessary justification that an emissions breach has occurred 'beyond reasonable doubt'. They will also be able to fully comply with the requirements of the European Pollutant Release and Transfer Register (E-PRTR) which stipulates that reported data shall be "…satisfactory with respect to its completeness, consistency and accuracy". Additionally, this will provide a monitoring and enforcement framework in which both process plant operators and stack testing organisations alike can have confidence. This will ensure the latter are implementing measurement methods that meet regulatory requirements and that the former are protected from the risk of false negatives/positives and all the reputational damage and consequential business costs that could unfairly follow. To promote the uptake of the project's outcomes by these communities, the consortium gave a presentation to SR 215 Air quality and is represented in different groups.

- Presentation 'Introducing the HEROES project' given at SR 215 Air quality, Oct 2019, Helsinki, Finland.

- Representations at: UK, French and Finnish national mirror groups; Source Testing Association.

Impact on the metrology and scientific communities

This project will deliver increased capability at NMIs and other national laboratories in terms of Stack Simulator Facilities able to generate emission matrices applicable to industries regulated via BAT Conclusions documents. Such national facilities (and others which inevitably will subsequently implement mirrored improvements) will underpin emissions accreditation in terms of appropriate proficiency testing, particularly pertinent given that between ISO/IEC 17025:2005 and ISO/IEC17025:2017 the requirement has changed from "may" include participation to "shall" include, i.e. it is clear that participation in such schemes is mandatory to maintaining accreditation. In addition, this improved capability along with other work to be carried out under the project will enable generation of two evidence bases with respect to EN 1911 and portable optical systems for BAT Conclusions industries. This will address a long-standing issue in the emissions community in that historical research carried out in support of the elaboration of documentary standards is frequently difficult to find, and in some cases seemingly lost. Hence, underpinning test data will be available to future generations ensuring the scientific justification for specified uncertainty requirements remains available for examination and ensuring a scientific traceability of documentary standard elaboration, which in itself sets a new standard.

Two training courses have taken place as part of a 3-day course 'Industrial Air Pollution Monitoring', hosted by University of Leeds Faculty of Engineering and Physical Sciences entitled:

- 'Caculations of uncertainties in stack monitoring';
- 'Understanding instrument performance standards'.

Impact on relevant standards

This project will provide input to different standardisation bodies and to HCl SRM (EN 1911). The current SRM will benefit from an Annex that will be drafted in accordance with CEN drafting rules (CEN/TS 15674) of uncertainty requirements enabling the extension of the SRM to industries regulated via BAT Conclusions documents. The associated evidence base will underpin these requirements providing the necessary defence/justification. This project will enable the documentary standard that CEN/TC 264/WG 45 is elaborating to set harmonised performance requirements for stack testing organisations in maintaining ISO/IEC 17025 accreditation for the implementation of EN 1911 at BAT Conclusions processes. The scientific evidence base of portable optical technologies will provide underpinning data for the future elaboration of prEN 16429 and WI 0264151 (now CEN/TS 17337) (CEN/TC 264/WG 3 and CEN/TC 264/WG 36) and the evidence needed with respect to discussions of which technology presents a suitable long-term replacement for the existing SRM. In the first half of the project the consortium has promoted the uptake of the project's outcomes, as described below.

- Presentation 'EURAMET Pre-Normative Metrology Research Activities' given at CEN/TC 264 Annual Plenary, May 2019, Copenhagen, Denmark.

Documentary standards impact:

- Led the publication of CEN/TS 17337 'Stationary source emissions - Determination of mass concentration of multiple gaseous species - Fourier transform infrared spectroscopy' (formerly WI 00264151). Several stack testing organisations have already successfully achieved ISO/IEC 17025 accreditation for the implementation of this standard;
- Led the soon to be published (early 2021) prEN 16429 'Stationary source emissions — Reference method for the determination of the concentration of gaseous hydrogen chloride (HCl) in waste gases emitted by industrial installations into the atmosphere';
- Contributed key annexes on proficiency testing based on different stack simulator designs to the draft prEN 17656 'Stationary source emissions - Requirements on proficiency testing schemes for emission measurements';
- Playing key roles in a 'standard for writing measurement method standards' (Task Force Emissions sub-group) and a 'standard for validating standards' (ISO/TC 146/SC 4/WG 9);

Longer-term economic, social and environmental impacts

This project will facilitate the full implementation of the Industrial Emissions Directive and the BAT Conclusions documents it adopts. The improvement of the quality and uncertainty characterisation of emissions data will ensure that data reported into the E-PRTR meets the needs of policy makers enabling them to: monitor the adequacy of society's environment; formulate appropriate future pollution reduction legislation; and track the progress of current legislation such as the Industrial Emissions Directive and the BAT Conclusions documents it adopts. This will help honour the EU's commitments under the Aarhus Convention and Kiev Protocol, which establish the legal human right to live in an “adequate environment”. Furthermore, this will also address work under the Regulatory Fitness and Performance programme (REFITT) where in the review of the E-PRTR the EU found that, "there were some concerns on coherence with data reported under related environmental legislation, such as the Industrial Emissions Directive (IED)".

- Representations at: EU Directorate General Environment; UK Regulators Network (national regulators of England, Wales, Scotland and Northern Ireland); IMPEL (European Union Network for the Implementation and Enforcement of Environmental Law).

List of publications

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Project start date and duration:	1 June 2019, 42 months	
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