

International Sampler Comparison Group (ISCG)

**Report of activities
2019-2023**



**INTERNATIONAL
SAMPLER COMPARISON
GROUP**

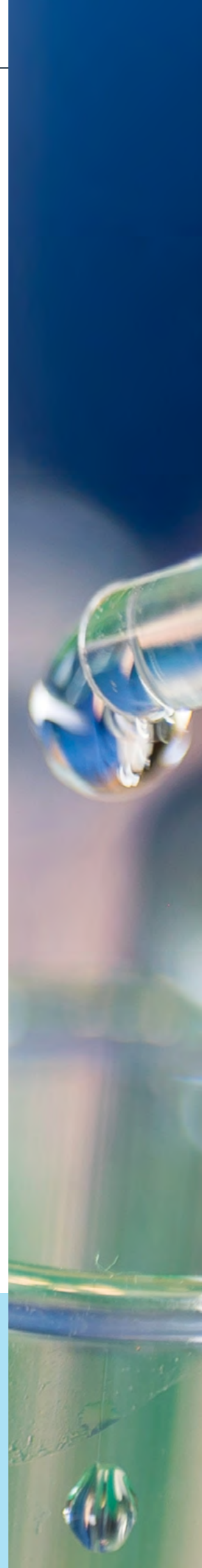
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About the International Sampler Comparison Group (ISCG)

The ISCG coordinates and communicates research to progress the science of occupational aerosol sampling. This report presents a summary of the ISCG activities from 2019 to end 2023.

URL: <https://www.ecu.edu.au/research/dust>



1. WHAT ARE THE AIMS OF THE ISCG REPORT?

- Describe the terms of reference of the International Sampler Comparison Group (ISCG) and composition of the group.
- Summarise the engagement activities of the ISCG during the period 2019-2023, these including meetings and conference presentations.
- Summarise ISCG programmes of work either completed or ongoing during the period 2019-2023.
- Summarise ancillary programmes of work not funded by ISCG but aligned with the ISCG activities.
- Summarise the planned ISCG activities for the following calendar year.

The period summarised within this report is 2019-2023. Moving forward annual ISCG reports will be issued, providing a summary of activities for the given calendar year and planned future activities.

2. WHO ARE THE ISCG?

The ISCG are a group of International experts who have agreed to:

- Develop a research plan (short / medium / long-term) for future laboratory and workplace-based studies, which will allow the assessment of the performance of aerosol sampling heads.
- Identify external funding support to allow for elements of the research plan to be funded.
- Where funds for research activities are made available through the ISCG, act as a steering committee for that project.
- Engage and involve other stakeholders who are interested in the activities of the ISCG.
- Communicate findings from ISCG's work openly (e.g., via publications, workshops, conference presentations etc) so that the wider community can benefit from the learning.

The core ISCG members are detailed in Table 1 (listed in alphabetical order).

Table 1: Core ISCG members

Name	Organisation
Delphine Bard	Health and Safety Executive (HSE), UK
Pieter Bertier	Belgian Center for Occupational Hygiene (BeCOH), Belgium
Marcus Cattani	Edith Cowan University (ECU), Australia
Karen Galea	Institute of Occupational Medicine (IOM), UK
Martin Harper	Independent, USA
John Saunders	Health and Safety Executive (HSE), UK
Darrah Kaye Sleeth	University of Utah, USA
Steven Verpaele	Nickel Institute, Belgium

3. FUNDING FOR ISCG ACTIVITIES

The core ISCG activities are funded by various associations, these including the Nickel Institute (NI), the Cobalt Institute (CI) and the International Copper Association (ICA).

Members of the ISCG are involved in other, ancillary programmes of work, funded by other organisations, which are summarised in this report for completeness.

4. ENGAGEMENT ACTIVITIES

4.1 CHRONOLOGICAL ISCG MEETINGS

- 9th May 2019 – Initial online meeting to discuss the NI expression of interest letter on the development of a sampling train.
- 10th October 2019 – International sampler comparison study meeting at Deutsche Gesetzliche Unfallversicherung e.V. (DGUV) - Alte Heerstr. 111, 53757 Sankt Augustin, Germany.
- Monthly on-line video conferencing meetings of the core ISCG group since February 2020.
- In-person / hybrid meeting of core ISCG group and guests, September 2023, Rome, Italy.

4.2 CHRONOLOGICAL INDUSTRY ENGAGEMENTS

- 28th May 2020 – Online meeting with sampler manufacturers and distributors.
- 4th September 2020 – Online meeting with industry stakeholders (metal associations).
- 30th April 2021 – Follow up meeting with industry stakeholders (metal associations).
- 31st May 2022 - Follow up meeting with industry stakeholders (metal associations).
- 31st March 2023 - Follow up meeting with industry stakeholders (consortia members NI).
- 10th June 2023 - Follow up meeting with industry stakeholders (consortia members NI).

4.3 CHRONOLOGICAL ENGAGEMENT WITH OTHER STAKEHOLDERS

- June 2019 – Meeting with IOM Singapore to engage the Asian stakeholders.
- June 2019 – Workshop for several stakeholders on particle sampling and metals analysis + introduction on sampler comparison study in Japan.
- February 2023 – IOHA (WORLD) webinar on metal exposure assessment and controls.
- March 2023 – Online presentation at the Occupational Hygiene Association of Ontario spring symposium (CAN) on *Working Together to Improve Sampling in the Workplace Aerosol Exposure*.

- May 2023 – Hybrid session at AIHce (US) on *Evaluating the performance of your aerosol sampler*.
- June 2023 – Presentation at OH 2023 (UK) on *Why you should know how your aerosol sampler is performing*.
- November 2023 – Workshop at World Congress on Safety and Health at Work (AUS) on *Innovation in particulate and metal sampling and their standardisation*.
- December 2023 – Continuous Education Session (CES) at AIOH (AUS) on *Modern sampling technologies versus traditional*.
- December 2023 – Presentation at AIOH 2023 (AUS) on *Why you should know how your aerosol sampler is performing*.
- December 2023 – Presentation at AIOH 2023 (AUS) on *Real time versus conventional sampler comparison study*.

- Aerosol dispersion (mono/polydisperse) and GMs and GSDs
- Flow rates used not provided or different from nominal
- Wall deposits were not considered in the majority of papers
- Substrate handling procedures (i.e. stored in desiccator, weighed in climate controlled room) often not provided
- Six studies provide no details on substrates used
- Details on the determination of the test aerosol concentration not provided in nine studies

This programme of work resulted in the following peer-reviewed publications:

- Hanlon J; Galea KS; Verpaele S. (2023) *Review of Published Laboratory- Based Aerosol Sampler Efficiency, Performance and Comparison Studies (1994–2021)*. Int. J. Environ. Res. Public Health, 20, 267. <https://doi.org/10.3390/ijerph20010267>.
- Hanlon J, Galea KS, Verpaele S. *Review of Workplace Based Aerosol Sampler Comparison Studies, 2004–2020*. International Journal of Environmental Research and Public Health. 2021; 18(13):6819. <https://doi.org/10.3390/ijerph18136819>.

5. COMPLETED WORK PROGRAMMES

5.1 REVIEWS OF WORKPLACE-BASED AND LABORATORY-BASED AEROSOL SAMPLER STUDIES

Narrative literature reviews were undertaken of the peer-reviewed scientific literature on personal samplers used in workplace and laboratory settings. The workplace based literature was compared to the requirements of EN13205-5, to identify potential gaps in the experimental requirements with respect to this standard. Sampler performance and comparison studies in laboratory settings were reviewed so that current knowledge could be synthesised.

The key findings for the workplace based study evaluation were:

- 2004-2020: Only 22 papers according to strict selection criteria;
- Not possible to identify any discernible trends from the studies, such as correction factors;
- Not all samplers used by industry were included;
- All papers mentioned EN13205-5 but the protocol was not strictly followed;
- Wall deposits were not considered in the majority of papers;
- Information on samplers used was limited, for example cassette materials and flow rates were not always included;
- Specific developed samplers or sampling systems were often not properly identified.

The key findings from the laboratory-based studies evaluation were:

- 1994-2021: Only 25 papers according to strict selection criteria;
- Not been possible to compare samplers across the studies;
- Specific samplers or sampling systems were not properly identified;
- Information can be lacking on a number of aspects, including:

5.2 DEVELOPMENT OF PROTOCOLS FOR STANDARDISED LABORATORY-BASED TESTING OF RESPIRABLE AND INHALABLE SAMPLERS

This work aimed to develop/harmonise protocols for testing respirable and inhalable samplers in laboratory test chambers and to carry out a preliminary validation of the protocols and was undertaken in 2021. The following objectives were:

- To develop draft protocols for testing the performance of:
 - respirable in calm air against the EN 481 and ISO 7708 conventions.
 - inhalable samplers in in calm air and in moving air against the EN 481 and ISO 7708 conventions.
- To undertake an inter-laboratory (HSE and University of Utah) sampler comparison study using procedures set out in these draft protocols.
- To deliver a web-based workshop with international experts, to share and discuss the protocols and the inter-laboratory comparison study test results.

A document was drafted, which collated:

- the draft protocols;
- the results of the inter-laboratory comparison study that were shared at the workshop;
- and the feedback received from the experts present at the workshop.

In summary, draft protocols have been drafted with valuable input gathered from the workshop. The absence of prescriptive protocols for testing respirable and inhalable samplers can potentially result in different outcomes. Differences in results have been observed between Lab 1 and Lab 2. However, this

was a very limited inter-comparison exercise involving just two laboratories using different test chambers, configurations and instruments. Therefore, there is a need for further harmonisation of the protocols and conducting larger-scale laboratory intercomparisons. An improved reference probe is also needed for the testing of inhalable samplers in calm air conditions, especially in preparation for upcoming convention changes that will require such testing.

6. ONGOING AND FUTURE ISCG WORK PROGRAMMES

6.1 COMMENTARY WITH RECOMMENDATIONS FOR SAMPLING PRACTICE FOR AEROSOLS WITHIN THE METALS INDUSTRIES

- Contracted to – Martin Harper, Independent Consultant
- Commenced – August 2023
- Due for completion – April 2024
- Estimated cost - £10.500 (excluding an open access publication fees)
- Funded by: NI, Ci and ICA

This Commentary publication will provide consensus recommendations for sampling practice with respect to aerosols within the metals industries. This will be based on the following available information:

- recently published compendia of research
- previously published research, not included in i.
- unpublished research
- previously published guidelines

This Commentary will begin with an introduction to aerosol sampler developments and how they have been linked to our understanding of the behaviour of aerosols in the environment and through the process of inhalation, but, in addition, will include how developments have been influenced by practical considerations, including cost and ease of use. The Commentary will then report on each currently available sampling device, describing first the laboratory and field research involving each and then discussing how the results of those studies may be reconciled, taking into account environmental conditions. Gaps in our knowledge will be highlighted along with the contribution of those gaps to our level of uncertainty. The Commentary will conclude with guidance for sampler selection, taking into specific environmental conditions, and how best any recommended product(s) should be used.

This publication will be completed and submitted to a peer-reviewed journal in 2nd quarter 2024.

6.2 VALORISATION OF SAMPLER PERFORMANCE DATA BY MEANS OF A SAMPLER SELECTION TOOL

- Contracted to - BeCOH
- Due to commence 2nd quarter 2024
- Due for completion – One year project
- Estimated cost – € 63.500
- Funded by: NI, CI and ICA

Previous work of the ISGC has shown that many industrial hygiene (IH) professionals do not read sampler validation studies in scientific literature. Their perception is that all samplers on the market must have been validated and that workplace specific sampler validation is not required. Sampler selection is therefore all too often based on availability and tradition. Many IH professionals also rely on the laboratories they work with for sampler selection advice. Yet, analytical experts in labs are not always sampling experts.

Hence, there is a need for a 'quick and easy' sampler selection guide. This should preferably be a tool that is always and everywhere accessible. It should provide the user information on sampler performance at different levels: from very basic level "I don't care, just tell me what to use" to specialist level, for example "I need the references for the bias map of sampler X". The tool needs to be a dynamic source of information, meaning that it should always reflect the most recent insights and not be a snapshot of the state-of-the-art, like a review paper. This tool will help in generating the awareness that not all samplers perform equally at all workplaces.

This project will commence following completion of the short commentary (as the outputs of that programme of work feed into this).

6.3 OPTIMISING LABORATORY TESTING PROTOCOLS

- Contracted to – University of Utah / HSE
- Commenced – Due to commence early 2024
- Due for completion – one year following signature of contract
- Estimated cost - £50.790

The overall objective of the project is to continue to optimise the laboratory testing protocols while making more direct connections between the lab and field work. First, we will identify the priority areas for further study regarding protocols for laboratory sampler comparison studies of both inhalable and respirable samplers based on many additional discussions that have occurred since the original workshop. Separate proposals will be developed to conduct those studies as part of future work. Next, we will seek to validate the use of the WAM by performing a series of wind tunnel tests using that device. This will help provide a clearer understanding of differences between lab and field work.

The deliverables will be as follows:

- Task 1: List of priority concerns regarding laboratory protocols for performance testing of inhalable and respirable air samplers.
- Task 2: Dataset that provides sampler variability data using the WAM inside the wind tunnel for both inhalable and respirable samplers at different particle sizes and wind speeds.

This was agreed to be funded in December 2023 and so the work activity is hoped to commence during 2024.

7. ANCILLARY WORK PROGRAMMES

7.1 PERFORMANCE OF COMMONLY USED RESPIRABLE AND INHALABLE AEROSOL SAMPLERS

This is funded by Worksafe BC.

“Does the performance of commonly used respirable and inhalable aerosol samplers enable adequate collection of workplace metals to meet occupational exposure limits?”

Grant recipient: Darrah Sleeth, University of Utah

Collaborators:

- Martin Harper, University of Florida (Zefon International)
- Steven Verpaele, NI
- Pieter Bertier, BeCOH

Project overview:

- Laboratory and field comparisons of samplers for both inhalable/total and respirable fractions
- Laboratory study conducted in wind tunnel at University of Utah using inert particles and gravimetry
- Field comparisons used the “Workplace Atmosphere Multisampler” (WAM) device that allowed 12 different samplers to sample the same atmosphere
- Sampling was conducted at 3 locations in Europe and one in North America,
- One of the European locations involved two different situations
- Pb/Zn/Cd, Mn/Fe, Co, Ni, Cu/Fe using chemical analysis

Key findings:

- Laboratory tests resulted in respirable sampler rankings that were somewhat different from field-based rankings;
- No sampler was considered to be a true reference method, and the lab had problems isokinetic samplers;
- In the field, respirable data from the multi-fraction sampler (Disposable Inhalable Sampler (DIS) with foam insert) consistently gave the highest respirable results;

- In the field, the multi-fraction sampler analysed for the inhalable fraction gave identical results to the same sampler (DIS) used without foam;
- DIS gave similar results to the IOM in the lab when tested for inhalable fraction, but much higher results in the field because wall deposits were not accounted for in the IOM.

7.2 SEQUENTIAL ANALYTICAL PROCEDURE FOR EVALUATING CHROMIUM (III) AND CHROMIUM (VI) SPECIATION AND THEIR DIFFERENTIAL SOLUBILITIES FROM AIR SAMPLES

This is funded by Worksafe BC.

“Developing a sequential analytical procedure for evaluating Chromium (III) and Chromium (VI) speciation and their differential solubilities from air samples”

Grant recipient: Hossein Kazemian, Northern Analytical Lab Services (NALS) at University of Northern British Columbia (UNBC), Canada

PhD student: Mya Schouwenburg

Collaborators:

- Martin Harper, University of Florida (Zefon International)
- Steven Verpaele, NI

Project overview:

- Evaluation of a specially cleaned PVC “Disposable Inhalable Sampler” (DIS) from Zefon/Environmental Express for:
 - Soluble hexavalent chromium
 - Soluble trivalent chromium
- Total chromium using microwave digestion procedure (without hydrofluoric or perchloric acids) developed under this project
- IC-ICP-MS method, laboratory studies include background, LOD/LOQ, and recovery with and without the presence of Fe(II)
- Project was intended to validate use of monoisotopic Cr standards per EPA 6800 to correct for interspecies conversion but this could not be accomplished in the time available
- Final report expected soon

7.3 MULTI-FRACTION SAMPLING

This is funded by Worksafe BC.

“Validating the use of a Multi-Fraction sampler for recovering inhalable and respirable dust mass, and metals in Workplace Air”

Grant recipient: Hossein Kazemian, U. of Northern British Columbia (UNBC), Canada

PhD student: Ann Duong (Northern Analytical Lab Services, NALS)

Collaborators:

- Martin Harper, University of Florida (Zefon International)
- Steven Verpaele, NI
- Pieter Bertier, BeCOH

Project overview:

- Evaluation of the PVC “Disposable Respirable Sampler” (DRS) from Zefon/Environmental Express for:
 - Inhalable mass
 - Inhalable metals
 - Respirable mass
 - Respirable metals
- Laboratory studies include background, LOD/LOQ, recovery and storage
- Field comparisons use the “Workplace Atmosphere Multisampler” (WAM) device that allows 12 different samplers to sample the same atmosphere
- Sampler compared to other inhalable and respirable samplers
- Results expected soon

7.4 ONGOING FIELD STUDIES IN WESTERN AUSTRALIAN MINING

“Comparison of conventional samplers and real time detection systems (medium and low cost) for measuring particulates and their elemental composition”

- A/Prof Marcus Cattani, the Principle Investigator is a member of ISCG
- Funding from Rio Tinto, Fortescue, and in-kind support from Edith Cowan University; GCG
- Assistance from Steven Verpaele, NI
- Preliminary results presented at AIOH 2023 for iron ore mines, more information being prepared.

7.5 RECENT PROPOSAL SUBMISSIONS

“Inhalable Sampling at High Flow Rates using the Disposable Inhalable Sampler (DIS)”

- Submitted for funding through the UNBC to Workplace BC
- Grant applicant: Hossein Kazemian, UNBC
- PhD student: Ann Duong (NALS)
- Collaborators: Martin Harper, University of Florida; Steven Verpaele, NI; Pieter Bertier, BeCOH
- Aim is to evaluate the performance of the DIS at flow rates to 10 Lpm in workplaces, in order to confirm a maximum flow rate.
- Funding decision expected soon

“Development of an automated extraction cell and validation of sample extraction protocols for the determination of soluble and insoluble metals in workplace atmospheres”

- Submitted for funding through Queen’s University to Workplace BC
- Grant applicant: Matthew Leybourne, Queen’s University, Michelle Kelvin - Senior Mineralogist, Queen’s University
- Collaborators: Steven Verpaele, NI; Pieter Bertier, BeCOH
- Aim is to develop an automated extraction system for metals speciation. The system will be tested with several samplers to evaluate their efficiency when speciation on aerosol samples is needed.
- Funding decision expected soon

8. ISCG WEBSITE

During 2023 a website was set up to further facilitate dissemination of the ISCG activities, <https://www.ecu.edu.au/research/dust>. This is hosted by ECU. Presently details of the ISCG aims, core group composition, publications and an overview of some of the ongoing activities are included. The content of the website will evolve and be updated periodically to reflect ISCG continued work.

9. FURTHER DISSEMINATION AND COMMUNICATION ACTIVITIES IN 2024

- Monthly on-line video conferencing meetings of the core ISCG group will take place throughout 2024.
- An in-person / hybrid meeting will take place at OSHA, Sandy, Utah, USA during w/c 22nd April 2024. The aims and objectives of this meeting are to view the laboratories and to allow in-person discussions with interested stakeholders based primarily in the USA (for example, NIOSH, OSHA representatives).
- ISCG will seek to present outputs of the projects at appropriate forum during 2024.



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