

**Elevating Exposure Science in
Chemical Safety Assessment and
Management - Developing
recommendations for
stakeholders**

Workshop Report No. 39



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Safety Assessment and Management -
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European Centre for Ecotoxicology and Toxicology of Chemicals
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Representatives from the European Commission, ECHA and Member State competent authorities expressed no official views or positions on the scientific matters discussed during the breakout sessions, hence their participation cannot be taken as agreement/disagreement to the views and positions expressed and documented in this report.

This workshop report is intended to accurately reflect the workshop discussions and conclusions, but it is noted that not all workshop participants provided written input.

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CONTENTS

SUMMARY	4
1. INTRODUCTION	5
1.1 <i>Background to the workshop</i>	5
1.2 <i>Workshop summary</i>	5
1.3 <i>Introductory keynote: European exposure science in a changing climate</i>	6
2. WORKSHOP PROCEEDINGS PER KEY ACTION AREA	8
2.1 <i>Key action area: Improving access to relevant exposure information</i>	8
2.1.1 Presentation summaries and Q&A/discussion	8
2.1.2 Breakout group discussion notes	10
2.2 <i>Key action area: Enhancing exposure models and advancing the use of exposure models</i>	14
2.2.1 Presentation summaries and Q&A/discussion	14
2.2.2 Breakout group discussion notes	16
2.3 <i>Key action area: New needs for circularity and sustainability</i>	18
2.3.1 Presentation summaries and Q&A/discussion	18
2.3.2 Breakout group discussion notes	19
2.4 <i>Key action area: Capacity building</i>	22
2.4.1 Presentation summaries and Q&A/discussion	22
2.4.2 Breakout group discussion notes	24
3. CONCLUSIONS	27
ABBREVIATIONS	29
APPENDIX A: WORKSHOP PROGRAMME	31
<i>Presentation abstracts</i>	33
APPENDIX B: BREAKOUT SESSIONS	41
<i>Breakout group 3a and 3b: Improving access to relevant exposure information</i>	42
<i>Breakout group 2a and 2b: Enhancing exposure models & Advancing the use of exposure models</i>	43
<i>Breakout group 1a and 1b: New needs for circularity and sustainability – discussion questions and background resources</i>	44
<i>Breakout group 4a and 4b: Capacity building</i>	45
APPENDIX C: WORKSHOP PARTICIPANTS	46
APPENDIX D: ORGANISING COMMITTEE	49
APPENDIX E: REPORT DRAFTERS	50

SUMMARY

ECETOC has made advancing and promoting the application of exposure science in chemical safety assessments a top strategic priority. Exposure science is recognised as a fundamental aspect of chemical safety assessment and management within the context of European regulations (for example REACH¹, Biocidal Products Regulation etc.).

In October 2023 a dynamic 2-day workshop brought together exposure science experts from various sectors to develop actionable recommendations for ECETOC and its stakeholders, including member companies, regulatory agencies, and academic institutions. The workshop aimed to identify the scientific and collaborative efforts needed to elevate the role of exposure science in chemical safety assessment and management.

Focussing on four key action areas - improving access to exposure data, utilising exposure models, addressing new needs arising from circularity and sustainability requirements, and enhancing human and organisational capacity building - the first day featured insightful talks and discussions, followed by focussed breakout sessions on the second day.

This report synthesises the workshop's discussions and outcomes, designed to inspire and guide future initiatives by ECETOC and other organisations.

¹ Registration, Evaluation, Authorisation and Restriction of Chemicals

1. INTRODUCTION

1.1 Background to the workshop

The EU Green Deal, including the Chemicals Strategy for Sustainability, brings a paradigm shift in European legislation relating to the use of chemicals. Achieving a comprehensive assessment of chemical safety and sustainability, while concurrently reducing reliance on animal testing and enhancing protection levels, necessitates the consideration and use of relevant and reliable exposure data, alongside hazard information.

Since 2016, European members of the International Society for Exposure Science (ISES Europe) have created a European Chapter (ISES Europe) and convened a series of workshops. These workshops have laid the groundwork for a strategy spanning 2020 to 2030², with a broad focus on recommended actions to strengthen exposure science in Europe. The ISES Europe exposure science strategy has specific working groups in the following areas: *Exposure Models; Education, Training and Communication; Human Biomonitoring; Data Repositories and Analytics; and Integrated Frameworks and Policy Efficiency*³. Each of the working groups has published at least one paper setting out their plans.

Recognising the value in advancing ISES Europe's strategic recommendations, ECETOC organised a focussed workshop to identify the scientific and collaborative efforts needed to elevate the role of exposure science in chemical safety assessment and management.

1.2 Workshop summary

The workshop, held on October 25-26 2023 in Alicante, Spain, attracted approximately 30 in person participants and 70 online participants (see Appendix C). Participants represented regulatory and policy bodies, chemical companies and trade associations, as well as academia.

The workshop programme was developed by an Organising Committee (see Appendix D) convened by ECETOC and including several members of the ISES Europe Board.

Drawing upon the ISES Europe exposure science strategy and work areas, the Organising Committee identified four key action areas deemed directly relevant to ECETOC stakeholders. Additionally, recent European policy proposals within the context of the Chemicals Strategy for Sustainability were taken into account.

The identified key action areas were:

- Improving access to relevant exposure information;
- Enhancing exposure models;

² Fantke P, von Goetz N, Jantunen M. The European exposure science strategy 2020–2030. Accessed by October 2023, <https://www.sciencedirect.com/journal/environment-international/special-issue/1074WLSM6VS>

³ ISES Europe (Europe Regional Chapter of the International Society of Exposure Science), Working groups. Accessed by October 2023. [ISES Europe | Together, we build a European Exposure Science Strategy \(ises-europe.org\)](https://ises-europe.org)

- Addressing new needs for circularity and sustainability;
- Capacity building.

While the workshop primarily focussed on human exposure, its discussions and findings hold relevance for environmental exposure science as well. This highlighted the interconnectedness between understanding chemical exposure's impact on human health and the environment, fostering synergies for holistic risk assessment and management.

The workshop took place over two days:

- Day 1 featured speakers from diverse European institutions, research centres, sector associations and industry, shedding light on **barriers and opportunities** to enhancing the role of exposure science in European chemical safety assessments;
- Day 2 brought F2F participants together in focussed breakout sessions. Reflecting on Day 1 insights they crafted a series of **practical, actionable recommendations**. These discussions not only addressed current practices but also charted pathways for future chemical management schemes, elevating the pivotal role of exposure science in Europe's chemical safety assessment landscape.

The workshop programme, including presentation abstracts, is available in Appendix A, while Appendix B offers more information on the breakout sessions. Workshop participants are listed in Appendix C.

1.3 Introductory keynote: European exposure science in a changing climate

Paul T.J. Scheepers⁴, Radboud University

Associate Professor Scheepers is president of the European Chapter of the International Society of Exposure Science (ISES Europe). Prof. Scheepers highlighted the priority areas from the ISES Europe 2020–2030 exposure science strategy: Education, training and communication (referring to Eurotox⁵ as a model for defining competencies); Exposure modelling (including availability of measured data), Human biomonitoring (highlighting Biomonitoring Application Data Sheet; 'BADS') in Scheepers et al. (2011)⁶. Policy uptake was noted as a key challenge to ensure the relevance of the strategy.

Prof. Scheepers suggested to consider the following during the ensuing workshop discussions:

- Define learning outcomes of initial training and professional development.

⁴ President of the Board of the European Chapter of the International Society for Exposure Science

⁵ Federation of European Toxicologists & European Societies of Toxicology, Main webpage. Accessed by October 2023. <https://www.eurotox.com/>

⁶ Scheepers PTJ, Bos PMJ, Konings J, Janssen NAH, Grievink L. 2011. Application of biological monitoring for exposure assessment following chemical incidents: A procedure for decision making. *Journal of Exposure Science & Environmental Epidemiology*. 21(3):247-261. doi : <https://doi.org/10.1038/jes.2010.4>.

- Data availability for predictive modelling to support risk assessment.
- Initiate a joint collaboration project to support human biomonitoring (HBM) application.
- Foster integration of exposure knowledge into company management systems (including very small companies).

2. WORKSHOP PROCEEDINGS PER KEY ACTION AREA

The following sections provide a summary of the presentations and associated discussions within each key action area, accompanied by the notes compiled from the subsequent breakout group discussions.

2.1 Key action area: Improving access to relevant exposure information

On Day 1, the presentation and discussion session was facilitated by Urs Schlüter (BAuA and member of the ISES Europe Board), and the breakout discussions on Day 2 were facilitated by Tiina Santonen (FIOH) and Maryam Zare Jeddi (Shell global Solutions International BV and ISES Europe working group chair).

2.1.1 Presentation summaries and Q&A/discussion

2.1.1.1 REACH registration dossiers as a source of exposure data

Celia Tanarro, European Chemical Agency (ECHA)

Ms Tanarro gave an overview of the exposure information present in REACH registration dossiers. Information on use (name, tonnage, use description) is present in the IUCLID dataset, and often used as a proxy for exposure. Detailed exposure information (conditions of use and exposure quantification – mostly based on Tier 1 tools) is present in the chemical safety report (CSR). ECHA uses exposure information for assessing exposure-based waiving of hazard tests. ECHA also uses exposure information in their screening strategy to identify appropriate risk management, this analysis is mainly based on use information in the IUCLID dataset. Exposure information in REACH registration dossiers is often not sufficient for other activities such as preparation of dossiers for restriction and occupational exposure limit (OEL) proposals, and usually needs to be complemented with published information on measured data, biomonitoring data and/or modelling of specific scenarios.

2.1.1.2 How to link biomonitoring data to sources of exposure to enable effective risk management

Tiina Santonen, Finnish Institute of Occupational Health (FIOH)

Dr Santonen highlighted key findings regarding use of occupational and general population HBM data in risk assessments, coming from the HBM4EU project⁷ (Santonen et al., 2022)⁸. Inclusion of HBM data was found to generally benefit risk assessment, providing more confidence in the assessment, especially when used together with other exposure data. In particular, HBM data can provide a reality check for exposure models (using either PBPK⁹ or (more often) simple TK¹⁰ approaches to convert internal exposure levels to external exposure levels). HBM data gives valuable information on total aggregate exposure, but this can equally be challenging to interpret in terms of identifying the main source(s) of exposure. Dr Santonen noted that WP6 of the Partnership for the Assessment of Risks from Chemicals (PARC) project¹¹ includes development of a model toolbox for aggregate exposure assessment, exposure assessments from which could eventually be compared to HBM data.

2.1.1.3 Exposure modelling: generating robust exposure data to increase confidence in safety decision-making. Perspectives from the agrochemical sector

Alistair Morriss, Corteva Agriscience

Dr Morriss presented a series of projects from the past 10+ years wherein agrochemical industry field study/user survey data was used to develop/refine models or generate model input data. A key attribute of these case studies was that they were conducted in partnerships between regulatory authorities, industry, and research institutes, which likely supported the eventual acceptance by regulatory authorities. Dr Morriss advised that timelines to official adoption can be extended (2-7 years), but the close collaboration, with regulatory authorities often taking the lead in data interpretation/analysis, proved highly beneficial for acceptance, as well as building overall trust, communication and transparency between industry and regulators.

⁷ HBM4EU, Human Biomonitoring for Europe, Dashboard. Accessed by October 2023. <https://www.hbm4eu.eu/>

⁸ Santonen, T., S. Mahiout, P. Alvito, P. Apel, J. Bessems, W. Bil, T. Borges, et al., by. 2023. How to Use Human Biomonitoring in Chemical Risk Assessment: Methodological Aspects, Recommendations, and Lessons Learned from HBM4EU. International Journal of Hygiene and Environmental Health. Elsevier BV. <http://dx.doi.org/10.1016/j.ijheh.2023.114139>.

⁹ Physiological based pharmacokinetic

¹⁰ Toxicokinetic

¹¹ Partnership for the Assessment of Risks from Chemicals <https://www.eu-parc.eu/>

2.1.1.4 Development of a worker's exposure data collection tool and database tool for systematic exposure data gathering for metals and metalloids

Steven Verpaele, Nickel Institute

Mr. Verpaele summarised the processes and challenges in the development of a hybrid data collection and database system to collect and store workplace exposure data for metals and metalloids. A continuous system of data collection was implemented, rather than for example one-off questionnaires, and the objective was to make the collected data uniformly aligned to standards and available/useable for multiple applications, including risk assessment. It took approximately three years to develop, including a testing phase. Mr. Verpaele highlighted the importance of including the contextual data for the exposure measurements input into the database. A quality check (e.g. use of an appropriate sampling system, sampling strategy, analytical method, etc.) is applied before entered data is approved and included in the database.

2.1.1.5 Q&A/Discussion

1. How often is exposure-based adaptation in REACH registration dossiers successfully applied? Not in the majority of cases - challenging to demonstrate no exposure in the entire lifecycle.
2. Has there been any criticism of the industry/regulatory partnerships for the agroindustry case studies? European Food Safety Authority (EFSA) generally participate as 'hearing participants'. While they do contribute, their involvement remains at an arm's length. There hasn't been any negative publicity regarding these collaborations, as they primarily operate on a technical level.
3. Clarification regarding the metals and metalloids workplace exposure database: If inputted data fails the quality check, the submitter is notified with the findings, and can resubmit the data. An exception is made for incomplete (historic) data, where certain data elements may no longer be retrievable. In such cases, the data are annotated accordingly. The database is hosted by the Nickel Institute, but access to a company's data is restricted to the company itself. Data requests can be submitted and are managed by a third party.

2.1.2 Breakout group discussion notes

Moderator: Tiina Santonen, FIOH; Rapporteur: Maryam Zare Jeddi, Shell

	1. Define quality criteria for exposure estimates in scenarios and completeness of exposure assessments (all pathways identified)
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Data quality criteria aren't well recognised in regulation. Some data types lack quality guidance. - Lack of guidance for quality evaluation (relevance and reliability) of exposure data to be used for risk assessment purposes - Lack of guidance for ensuring data quality for modelling.

Root causes	<ul style="list-style-type: none"> - Relying too much on accreditation of experts. - Lack of data quality standard for different stakeholder and different type of data (for example: In the sampling part (including questionnaires - contextual data)). - Lack of awareness about the existing guidance: There is need for systematic evaluation: what we have, what we do not have. - Lack of standard methods for quality check of conceptual data.
Candidate-solutions	<ul style="list-style-type: none"> - Systematic analysis of what kind of data should be considered as exposure information/data then as a next step define data quality requirements for them. - Define and indicate where data quality guidance is needed within research studies (e.g. create a flowchart).
Prioritised solution(s)	<ul style="list-style-type: none"> - Map available and existing quality guidelines for different aspects of exposure assessment research studies to identify where data quality guidance/criteria is needed and prioritise based on importance. - Develop quality criteria for evaluating exposure data for use in occupational biomonitoring: adapt EN689 considerations for workplace air to human biomonitoring
2. Systematic priority setting for exposure scenarios requiring measured data	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Lack of Standardisation: There's no uniform procedure for collecting and reporting exposure data across different research groups.
Root causes	<ul style="list-style-type: none"> - Lack of standardised protocols for data and meta data collection. - Limited collaboration between research entities.
Candidate-solutions	<ul style="list-style-type: none"> - Standardisation how data on exposure settings, and exposure determinants should be described.
Prioritised solution(s)	<ul style="list-style-type: none"> - Collaborative Research Platforms: Creating platforms for researchers to share and access exposure data. - Define minimum information requirements for each step in research studies.
3. Empower Data Findability, Accessibility, Interoperability and Reuse	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Lack of standardised data formats, leading to inconsistencies in data collection and representation. - Limited access to raw data, often due to restrictions or lack of a centralised platform for data storage. - Inadequate conceptual data accompanying datasets, making interpretation challenging. - Difficulty in data integration and reuse.
Root causes	<ul style="list-style-type: none"> - Privacy concerns limiting data sharing.

	<ul style="list-style-type: none"> - Lack of a centralised accepted platform for exposure data registry and storage. - Lack of minimum information requirements regarding conceptual information.
Candidate-solutions	<ul style="list-style-type: none"> - Development of robust minimum data requirements practices improving datasets. - Promote/facilitate Collaboration among researchers. - Define What do we mean with data and use harmonised terminology.
Prioritised solution(s)	<ul style="list-style-type: none"> - Development of standardised protocols (such as Biomonitoring Application Data Sheet (BADS)), data formats and guidelines for biomonitoring studies. - Support development of a centralised FAIR (Findable, Accessible, Interoperable, and Reusable) environment and health registry (FAIREHR) initiated by ISES Europe. - Developing templates for targeted communication of research results
4. Data sharing and disclosure, including legal aspects	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Legal restrictions: Some data might be classified as confidential or protected under intellectual property rights. - Concerns about misuse: data owners may be hesitant to share data due to concerns about misinterpretation or misuse. - Lack of motivation and incentive for data sharing.
Root causes	<ul style="list-style-type: none"> - Inconsistent policies: Various institutions and universities have differing policies, leading to confusion. - Lack of awareness: Many data owners are unaware of the benefits and mechanisms of data sharing. - Lack of trust.
Candidate-solutions	<ul style="list-style-type: none"> - Clear guidelines: Institutions and research institutes should provide clear guidelines on data sharing, including legal aspects. - Advancing GDPR – Legislation and auditing.
Prioritised solution(s)	<ul style="list-style-type: none"> - Develop a Platform where it is possible to indicate who has which kind of data and contact the data owners (envisaged as part of FAIREHR) - Define what are the drivers and benefits of data sharing by offering workshops and courses on the benefits and methods of data sharing (a topic that may be considered within ISES Europe).
5. European exposure mapping (inhabitants, consumers, workers)	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Lack of awareness about the available data gathered in projects like HBM4EU and PARC, exposomes that can help for European exposure mapping. - Underused opportunity.
Root causes	<ul style="list-style-type: none"> - Lack of dissemination.

	<ul style="list-style-type: none">- Lack of focused resources/ funding (not seeing the big picture).- Lack of sustainability and continuation of projects.- Lack of centralised database or linked database.
Candidate-solutions	<ul style="list-style-type: none">- More funding- Creating centralised data repository, Learn from LUDOK (the Swiss Literature Database on Air Pollution and Health) for air pollution documentation- Type of required data depends on problem formulation
Prioritised solution(s)	<ul style="list-style-type: none">- To be discussed in the ISES Europe future workshops

2.2 Key action area: Enhancing exposure models and advancing the use of exposure models

On Day 1, the presentation and discussion session was facilitated by Wouter Fransman (TNO), and the breakout discussions on Day 2 were facilitated by Celia Tanarro (ECHA) and Benjamin Spielmann (BASF).

2.2.1 Presentation summaries and Q&A/discussion

2.2.1.1 Best practice in Exposure Modelling – Thoughts from the European Exposure Science Strategy 2020–2030

Urs Schlüter, Federal Institute for Occupational Safety and Health, BAuA, Dortmund Germany; International Society of Exposure Science – Europe Chapter

Dr Schlüter started by acknowledging that ‘best practice for exposure modelling’ does not yet exist. ISES-Europe has recognised exposure modelling as a key topic, which led to the development of the ISES European Exposure Science Strategy 2020 – 2030 which identified four strategic objectives: (1) improvement of models and tools; (2) development of new methodologies; (3) improvement of model use; and (4) regulatory requirements for exposure modelling. A roadmap developed to implement the four strategic objectives of the European Exposure Science Strategy is already progressing via ISES-Europe working groups developing key action areas, including the appropriate documentation of exposure assessment by modelling, requirements of exposure modellers.

2.2.1.2 Reflections on a performance study of the TRA-Worker exposure prediction tool

Jan Urbanus, Shell

Mr Urbanus summarised recent work conducted by an ECETOC Task Force reviewing validation studies on the Worker module of the [ECETOC Targeted Risk Assessment](#), a screening exposure estimation tool now also implemented in the ECHA Chesar tool. This tool performance study found the TRA Worker tool to be conservative in most situations (for the situations covered by the validation studies), but several underestimations were identified which led to the development of an updated Worker TRA tool (v3.2). Key learnings from the performance study include the importance of the use of appropriate exposure measurements for comparison, correct use of exposure model, external consultation, and transparent documentation.

2.2.1.3 Consumer and general population exposure – challenges/opportunities

Astrid Heiland, German Federal Institute for Risk Assessment (BfR)

Generic Exposure Scenarios (GES) (covering operational conditions and risk management measures) were developed and implemented under the REACH Regulation to reduce complexity and increase consistency.

However, the ‘one fits all’ principle of GES has limitations, particularly in term of consumer exposure, as new consumer products continuously come to market and consumers change their behaviour. Recent activities at BfR have identified opportunities to refine consumer exposure assessments and reduce uncertainties, including development of updated factsheets¹², revised defaults and quality factors and implementation of new exposure scenarios in the consumer estimation tool ConsExpo. Data generation included market research and consumer behaviour surveys^{13,14}. Recommendations from these efforts include conducting further consumer behaviour surveys in particular to identify non-intended but reasonably foreseeable uses.

2.2.1.4 Q&A/Discussion

1. Screening vs higher-tier: Screening models require conservatism. ECETOC TRA, though a screening model, does give some flexibility to model users to adjust the parameters but there is the expectation that users use appropriate inputs. It was noted that the volatility bands in the Worker TRA model are broad. Use of higher tier (less conservative) models is likely more appropriate for implementation of a mixture assessment factor.
2. Model evaluation/performance assessment (e.g. using data from robot studies): The importance of availability of sufficient contextual information on the exposure measurements used for comparison was highlighted – where such information is not available assumptions need to be made.
3. Model vs modeller: Noted that appropriate model use has similar importance and impact to the model outputs themselves. There is an ISES Europe working group active on this topic. Acknowledged that whilst users of exposure models will ideally have knowledge of the workplace, this is only feasible to a certain extent (in view of the number of workplaces) and may need to accept some uncertainties, e.g. for situations of lower hazards, such as an office environment.

¹² Cieszynski A, Jung C, Schendel T, ter Burg W. 2023. Do-It-Yourself Products Fact Sheet. Default parameters for estimating consumer exposure – Updated version 2022. RIVM report 2022-0208. Bilthoven, NL, National Institute for Public Health and the Environment. <https://www.ncbi.nlm.nih.gov/books/NBK589437>. doi: 10.21945/RIVM-2022-0208

¹³ Heiland A, Oltmanns J, Bohlen M.-L, Kaiser E, Klenow S, Schneider K: Consumer behaviour - compilation and evaluation of primary data. 26th Annual ISES Meeting, 498. International Society of Exposure Science Utrecht, NL, 2016-10-09/2016-10-13.

¹⁴ Schneider K, Recke S, Kaiser E, Götte S, Berkefeld H, Lässig J, Rüdiger T, Lindtner O, Oltmanns J. 2019. Consumer behaviour survey for assessing exposure from consumer products: a feasibility study. *Journal of Exposure Science & Environmental Epidemiology*. 29(1):83-94. <https://doi.org/10.1038/s41370-018-0040-2>. doi:10.1038/s41370-018-0040-2.

2.2.2 Breakout group discussion notes

Moderator: Celia Tanarro, ECHA; Rapporteur: Benjamin Spielmann, BASF

This breakout group addressed enhancement of exposure models via questions 1 and 2 and advancement of the use of exposure models via questions 3 and 4.

	1. How can existing models and tools be improved, considering regulatory requirements?
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Documentation is often not easy to understand/ which model is of use in which situation - Model and its underlying data are often rather old - Not clear always which models are regulatory accepted - Exposure data is often not publicly available - Lack of access to measured data for validation and recalibration, and where such data is available, contextual information to validate/calibrate the models may not be sufficient
Root causes	<ul style="list-style-type: none"> - Often funding for model update and maintenance is lacking - There is no overarching user friendly guidance framework available - No clear regulatory requirements for application of models - Confidentiality issues relating to confidential business information - how to have transparent documentation and keep the intellectual property of the model
Candidate-solutions	<ul style="list-style-type: none"> - Guidance or inventory in general for "all" models needs to be developed - More funding? - Access needed by tool developers to anonymised company data to develop models further - Develop clear requirements for the recording of measured data.
Prioritised solution(s)	<ul style="list-style-type: none"> - Develop inventory for models and guidance/mapping including applicability and models gaps/needs - ISES Europe workshop taking place in March 2024 in Berlin may tackle this to some extent - ISES discussion ongoing on data monitoring and harmonising possibilities as a first step to develop harmonised requirements for production of measured data that could be later re-used
	2. Are there possibilities to harmonise models between regulations?
Current barriers and issues with the topic	<ul style="list-style-type: none"> - No guidance available in general. - Detail of use description differs sometimes. - Aggregated exposure is not considered. - Difficulty to reuse assessments between regulations.

Root causes	<ul style="list-style-type: none"> - Models are complicated and were often developed for a specific regulation - often the regulations have slightly different requirements in terms of reference values (e.g. internal vs external) etc.
Candidate-solutions	<ul style="list-style-type: none"> - Mapping of models and requirements between regulations.
Prioritised solution(s)	<ul style="list-style-type: none"> - PARC is discussing aggregated exposure and has mapped all models. - PARC members can feed to ISES exposure models.
3. How to ensure the involvement of all stakeholders in the model development?	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Not always easy to identify all stakeholders. - Absence of governance and maintenance plans when models are first being developed.
Root causes	<ul style="list-style-type: none"> - Industry and regulators do not know how products are used exactly. - Industry participation in PARC is limited to some extent – industry cannot be funded by PARC but can contribute.
Candidate-solutions	<ul style="list-style-type: none"> - Stakeholder Forum in PARC should address industry needs. - Assistance from ISES to understand who to reach out to.
Prioritised solution(s)	<ul style="list-style-type: none"> - Compile a list of contact points in industry associations and authorities within ISES. - Best practices should include reflection on model users and other stakeholders and maintenance.
4. How to promote the development of best practices for model developers? Who should be involved?	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Financing needed for model development and maintenance. - Best practices needed to sustain models in the future.
Root causes	<ul style="list-style-type: none"> - Best practices are not yet fully defined
Candidate-solutions	<ul style="list-style-type: none"> - Starting point define best practices and create some motivation to promote the use of the best practices by model developers (e.g. model overview on ISES website: new model needs to fulfil certain criteria to be added). - Evaluate documentation independently. - Best practices should include the consideration on how to finance the maintenance of the model and funding institutions should consider this as part of the requirements when granting funding
Prioritised solution(s)	<ul style="list-style-type: none"> - CEFIC LRI or ECETOC project to draft best practices for model development as a starting point for the ISES discussion. - Publish a list on ISES website with models that fulfil certain criteria.

2.3 Key action area: New needs for circularity and sustainability

On Day 1, the presentation and discussion session was facilitated by An van Nieuwenhuyse (Laboratoire National de Santé, Luxembourg and member of the ISES Europe Board), and the breakout discussions on Day 2 were facilitated by Violaine Verougstraete (Eurometaux) and Blanca Serrano (ECETOC).

2.3.1 Presentation summaries and Q&A/discussion

2.3.1.1 Material flows to identify and address exposure throughout the supply chain

Violaine Verougstraete, Eurometaux and Daniel Vetter, EBRC Consulting GmbH

Dr Verougstraete first highlighted the overall challenge of managing uncertainty in risk assessment/management, particularly for exposure. Mr Vetter set out a structured approach to gathering exposure information for REACH assessments, including a collaborative questionnaire method for gaining information from downstream users. Dr Verougstraete highlighted the materials flow analysis, from extraction to end of life/recycling, developed by the metals sector as a comprehensive tool to prioritise exposure information needs as well as risk management actions.

2.3.1.2 The Safe and Sustainable by Design framework and the opportunities to improve the exposure information

Irantzu Garmendia, European Commission – Joint Research Centre

Ms Garmendia gave an overview of the key aspects of the Commission's Safe and sustainable by Design (SSbD) framework which is being developed to support the actions defined in the Chemicals Strategy for Sustainability. The SSbD framework can be applied at the design and/or redesign stage and covers the entire lifecycle of a chemical/material, integrating safety (to humans and environment) and environmental sustainability dimensions. The SSbD framework is currently being tested via case studies which aim to inform the revision of the SSbD framework/criteria. Some challenges and opportunities already identified include: lack of application-specific exposure prediction tools; lack of tools that incorporate the functionality of chemicals/materials; leverage of existing use descriptors and use maps under the REACH Regulation.

2.3.1.3 Safe and sustainable chemicals and materials - strategic R&I approaches

Christina Markouli, European Commission Directorate-General for Research and Innovation (R&I), Industrial Transformation Unit

Dr Markouli stressed that the SSbD framework is a R&I approach and voluntary scheme, which is promoted within R&I actions across EU research programmes, and Member States, industry, academia and research organisations are invited to promote its use within their own R&I processes.

Dr Markouli drew attention to recent Horizon Europe projects relating to SSbD, including IRISS¹⁵ and PARC¹⁶ (co-funded; 2021 - 2028). One deliverable from PARC is a toolbox for SSbD, and WP4 is focused on further development of the human biomonitoring platform (generated by HBM4EU initiative), understanding presence of chemicals in the environment and exposure to humans (considering multiple sources) as well as developing innovative tools and methods to improve monitoring schemes. Horizon 2020 and Horizon Europe also funded a number of projects related to chemical safety and understanding exposure to nanomaterials.

2.3.1.4 Q&A/Discussion

1. How to balance the different aspects of the safety and sustainability elements/impacts? The aim is to integrate both aspects through all innovation stages and covering the entire life cycle, identifying hotspots and avoiding trade-offs.
2. Role of the general public in buying or using more sustainable products? Commission would like to increase citizen awareness regarding sustainability – one barrier may be increased cost of products. There is a placeholder for a Step 5 in the SSbD assessment that considers societal and economic aspects.
3. How to balance ambitious aims of the Green deal (e.g. ‘zero pollution’ and ‘toxic free’) with other important European Commission goals, e.g. transition to green energy (requiring heavy metals)? Acknowledged as a valid concern and noted that the SSbD framework aims to substitute as far possible. Eurometaux is launching a project with TNO to predict emissions of metals used in the energy transition and how this can be managed.

2.3.2 Breakout group discussion notes

Moderator: Violaine Verougstraete, Eurometaux; Rapporteur: Blanca Serrano, ECETOC

	1. Exposure information for sustainability and circularity
Current barriers and issues with the topic	<ul style="list-style-type: none"> - SSbD framework step 1 is based on hazard cut-off. - Lack of good communication on exposure. - Lack of knowledge on fate of substances.
Root causes	<ul style="list-style-type: none"> - Non-acceptance of any exposure of the general population. - Messages on hazard are more attention-grabbing.
Candidate-solutions	<ul style="list-style-type: none"> - Step one in SSbD should identify uses for hazardous substances triggering risk management.

¹⁵ The international ecosystem for accelerating the transition to Safe-and-Sustainable-by-Design materials, products and processes (<https://iriss-ssbd.eu/https://iriss-ssbd.eu/>)

¹⁶ Partnership on Assessment of Risk from Chemicals (<https://www.eu-parc.eu/>)

	<ul style="list-style-type: none"> - Improve knowledge on exposure routes. - Develop exposure scenarios for recycling. - Analytics are a piece of the puzzle. - Obtain more data on leachability. - Improve risk communication in the context of circularity. - Exposure has a role to play in the design of new recycling technologies.
Prioritised solution(s)	<p>Candidate solutions were not prioritised during the breakout group discussions, but the following were identified as priorities in the workshop write-up:</p> <ul style="list-style-type: none"> - Develop exposure scenarios for recycling - Obtain additional data on leachability - Improve risk communication in the context of circularity - Further test the SSbD framework including feasibility for substances failing Step 1 of the framework
	2. How can activities like PARC and/or other existing exposure/monitoring databases and authorities/industry benefit each other?
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Not enough transparency. - Possible overlaps. - Representativity of the findings.
Root causes	<ul style="list-style-type: none"> - Complex project. - Large number of participants. - Industry has no access to the data. - ISES has no access to data.
Candidate-solutions	<ul style="list-style-type: none"> - Cooperation with projects such as ASPIS¹⁷, RiskHunt3r¹⁸. - Working on aggregate exposure, differentiate endogenous vs exogenous. - Communicate about best practices for exposure.
Prioritised solution(s)	<ul style="list-style-type: none"> - Encourage greater collaboration and cooperation between the initiatives within PARC, ISES and ECETOC as well as with European projects such as ASPIS¹⁶ and RiskHunt3r¹⁷.

¹⁷ <https://aspis-cluster.eu/>

¹⁸ RISK assessment of chemicals integrating HUMAN centric Next generation Testing strategies promoting the 3Rs, Dashboard. Accessed in October 2023. <https://www.risk-hunt3r.eu/>

3. Exposure information to guide toxicology testing ('exposure-led safety testing strategies')	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Identification of the most relevant route. - Identification of the test concentration. - PBPK models needed. - More data necessary for refinement. - Lack of understanding of negligible exposure.
Root causes	<ul style="list-style-type: none"> - Complexity of data generation. - No buy-in from part of the regulatory toxicology community and some chemical regulators.
Candidate-solutions	<ul style="list-style-type: none"> - Added value of ASPIS, start from exposure to refine toxicology. - Risk Hunt3r work in internal exposure via in-silico, in-vitro solutions for exposure testing.
Prioritised solution(s)	<ul style="list-style-type: none"> - Understand negligible exposure. - Have a platform for PBPK models to discuss the applicability and extend it.
4. Identify new and emerging exposure scenarios	
Current barriers and issues with the topic	<ul style="list-style-type: none"> - Incomplete knowledge of all uses. - Many factors contributing to exposure. - Understand combined exposure.
Root causes	<ul style="list-style-type: none"> - Number of factors contributing to exposure. - Language barrier.
Candidate-solutions	<ul style="list-style-type: none"> - New scenarios on waste and recycling activities. - Understand background data from waste/recycling workers. - Elaborate methodologies to disentangle complex mixtures.
Prioritised solution(s)	<ul style="list-style-type: none"> - Work on elaborating detailed exposure scenarios for waste and recycling facilities.

2.4 Key action area: Capacity building

On Day 1, the presentation and discussion session was facilitated by Paul Scheepers (Radboud University), and the breakout discussions on Day 2 were facilitated by Bob Barter (ExxonMobil) and Alison Connolly (University College Dublin).

2.4.1 Presentation summaries and Q&A/discussion

2.4.1.1 Capacity Building by Advancing Exposure Science Education and Training

Alison Connolly, University College Dublin

Prof Connolly is the ISES Europe Councillor for 'Exposure Science Capacity Building, Training and Education' and chairs the ISES-Europe Education, Training and Communication working group. The exposure science strategic objectives (exposure science promotion, curriculum, recognition/identity, and dialogue) were summarised, alongside the progression made to date in mapping courses, progress in standardising exposure science terminology¹⁹ as well as creating specific and harmonised learning outcomes across different qualification levels (up to PhD)²⁰. Future ambitions include developing recognition for the discipline of exposure science, the creation of an ongoing viable exposure science educational programme, the development of certifications for exposure scientists, either via a personal qualification program or completion of an accredited exposure science course, is now under review. Prof Connolly gave an overview of development process for educational courses within academia and highlighted that cultivating relationships and consulting with future employers (public and private sector) in terms of their needs is key to informing the development of curriculums/courses/certifications.

2.4.1.2 The Human Capital view on Exposure science – Insights from our 2023 Deloitte Human Capital trend report

Nathalie Dom, Deloitte

Dr Dom shared the most relevant insight of Deloitte's work on Human Capital trends, in terms of how to foster skills and competences beyond the academic programmes and establish an identity for exposure scientists. Dr Dom noted that 80% of the 2030 workforce is already in place today, hence the importance for up-/re-skilling now. Importantly, up-/re-skilling is not limited to technical aspects but needs to encompass human and behavioural skills that follow a continuum of: being – thinking – relating – collaborating – acting. The UN SDGs recognise the importance for human behavioural skills for implementation of the goals. The organisational

¹⁹ Heinemeyer, G., Connolly, A., et al. Towards further harmonisation of a glossary for exposure science—an ISES Europe statement. *J Expo Sci Environ Epidemiol* 32, 526–529 (2022). <https://doi.org/10.1038/s41370-021-00390-w>.

²⁰ Connolly, A., Scheepers, P.T., et al. 2022. Framework for developing an exposure science curriculum as part of the European Exposure Science Strategy 2020–2030. *Environment International*, 168, p.107477. <https://doi.org/10.1016/j.envint.2022.107477>

culture or 'ecosystem' that is most conducive in this sense recognises not only the 'Who – What – When – How' of the change plan, but especially the 'Why', as this helps provide clarity of purpose and identity, and thereby commitment, to individuals.

2.4.1.3 Supply Chain Communication of Exposure Information

Giulia Sebastio, Downstream Users of Chemicals Co-ordination Group (DUCC)

DUCC is a platform where 11 EU trade associations, representing formulators of chemicals, find common positions on the implementation of chemical legislation, especially REACH and Classification, Labelling and Packaging (CLP). Ms Sebastio summarised DUCC projects relating to Use Maps, a tool used under REACH for communication of uses. Use Maps are predefined standardised sets of information containing operational conditions and risk management measures, including exposure assessment inputs (SWEDs, SCEDs, SPERCs²¹). Their utility has been evaluated in recent years and whilst they have provided benefits to both registrants and formulators some opportunities were identified to improve them. For example, provision of additional guidance, reduction of complexity/repetition and revisiting the balance between grouping uses whilst ensuring reasonable fit to company portfolios. Digitalisation is currently being explored as a solution to many of the barriers encountered.

2.4.1.4 How Small and Medium-sized Enterprise companies use (or would wish to use) chemical exposure information for decision-making

Clemens Rosenmayr, SMEunited (WKÖ (Austrian Economic Chamber), member association of SMEunited)

SMEunited takes an active role in key chemical policy groups and alliances. Mr. Rosenmayr provided perspectives on SME needs and decision making relating to chemical safety assessment. SMEs cover a wide variety of different sectors and different positions along the supply chains, including manufacturers and formulators, and their needs vary correspondingly. Commonalities, however, are limited resources for chemicals management and the need for clear guidance/tools and manageable communication of data. SMEunited identified the SCIP database²² as a valuable tool though the data as currently reported is not helpful for recyclers, as it lacks information on the route of exposure, safe management etc. The goal is to transfer the SCIP database into a decision-making tool to improve worker protection and maintain quality. The Digital Product Passport (DPP), which may eventually include exposure data, is also seen as a potentially valuable tool for decision making by SMEs.

Another European initiative highlighted by Dr Rosenmayr was ChemSkills, looking at a number of sectors of industry and how to help them map out their competency requirements.

²¹ Specific Worker Exposure Description; Specific Consumer Exposure Determinant, Specific Environmental Release Category)

²² Substances of Concern In articles as such or in complex objects (Products)

2.4.1.5 Q&A/Discussion

1. With regulatory developments moving to higher tier models and measured data (e.g. in the context of the mixture allocation factor (MAF)), is there a plan to adapt the REACH Use Map concept for higher tier models? DUCC aware of such developments and are considering, including how Use Maps could be used within SSbD assessments. SWEDs were updated so input can be reported from various higher-tier tools.
2. How to make exposure assessment more appealing? Increase awareness and appetite to a broader audience, raising the profile/identity, but also up-skilling and retainment, and ensuring that there is a defined career pathway for graduates.
3. How to improve recognition of exposure science at the academic level? ISES Europe network is already substantive and efforts are underway to improve communication on exposure science identity and acknowledgement for the field with schools/universities.
4. Impact of AI on exposure science work in terms of workforce size and training required? Can be incorporated as a useful tool to benefit of exposure scientists (e.g. to analyse big data) but the human element/skills are still needed.

2.4.2 Breakout group discussion notes

Moderator: Bob Barter, ExxonMobil; Rapporteur: Alison Connolly, University College Dublin

In contrast to the other breakout groups, this breakout group addressed the following four questions directly.

	1. How would we assess our current state in exposure capacity building, what is good about it, what is lacking?
Current state and issues with the topic	<ul style="list-style-type: none"> - Have the expertise, network, and inventory of exposure science experts and materials. - Many academics are not training consultants. - Need exposure science for circularity/sustainability
What's positive?	<ul style="list-style-type: none"> - Network is across stakeholders (e.g. academia, industry, policy-makers). - Some courses and work have already commenced. - Regulators are starting to realise the importance of exposure science. - There are some standards to work from.
What's lacking?	<ul style="list-style-type: none"> - No systematic education system for exposure science. It is a patchy network, with only sporadic or short courses available, not consistent and not widespread in the EU. Due to varying legislative requirements and goals across continents, there is a need for exposure science courses in the EU. Need inclusion of areas of EU currently lacking this topic of education and SMEs.

	<ul style="list-style-type: none"> - What are the fundamental learning prerequisites for doing exposure science. - Might not be considered important in some groups/industries (i.e. potentially regulatory agencies). Previously, regulators did not prioritise exposure data in their evaluations. Lack of legislative competency requirements for exposure science. - Need funding for these types of activities. - Exposure science is so broad, and this could be a barrier. Need for an identity and QA, certification for exposure science might fill this.
	2. What does a good solution look like
Introductory statements	<ul style="list-style-type: none"> - Trained experts widely dispersed in across sectors - Government and academia applying exposure science to problems. - Centres of expertise that industry and government can rely on to address application of exposure science needs. - Something in between?
Examples of good solutions	<ul style="list-style-type: none"> - Italy has an internal national standard on the competency of exposure assessors of the workplace. - British Occupational Hygiene Society (BOHS)/Institution of Occupational Safety and Health (IOSH)/ Society of Environmental Toxicology and Chemistry (SETAC) have good frameworks. - Exposure science courses in the US. - Short courses developed in EU.
What target group needs what solution?	<ul style="list-style-type: none"> - ISES Europe can be the body that puts forward some of these items. - Academia to provide courses. - Industry to send student to the courses, provide internships and potentially provide case studies/guest lectures. - Regulators to acknowledge the need for this competency. - REACH-Occupational Safety and Health (OSH). - ISES Europe putting out statements of issues that affect our field (e.g. efficacy of personal protective equipment (PPE) during COVID-19 pandemic) - to be seen/heard.
What solutions can be shared	<ul style="list-style-type: none"> - Companies could advertise internship possibilities for graduates on the ISES Europe website, for graduates to gain experience
	3. What are the barriers to achieving a good solution
List of (real) barriers	<ul style="list-style-type: none"> - Not acknowledged as a competency in legislation, thus, not a requirement - Funding for websites, open access articles for website and technology assistance - Need investment into these actions, which could eventually provide an income - Lack in expertise in marketing

	- Need more volunteers for the activities of ISES Europe
	4. What specific and actionable steps can be taken to address to overcome identified barriers?
	<ul style="list-style-type: none">- Define the standard of an assessor or exposure scientists.- To proceed with the certification progress to develop an identification.- Develop a registry of exposure scientists from the certification progress.- Need to identify our 'unique selling points', 'added value' of an exposure scientist.- Policy briefing of the strategy papers of ISES Europe.- Stakeholder mapping and communication as a first step.

3. CONCLUSIONS

This workshop brought together exposure science experts from various sectors to develop actionable recommendations for ECETOC and its stakeholders, including member companies, regulatory agencies, and academic institutions. The workshop aimed to identify the scientific and collaborative efforts needed to elevate the role of exposure science in chemical safety assessment and management.

Prioritised solutions per key action area are set out in the breakout group discussion summaries above.

In summary:

Recommendations relating to **improving access to relevant exposure information** included development of schemes/guidance/protocols (e.g. on data quality/information requirements) and establishment of platforms (e.g. the FAIR environment and health registry (FAIREHR)) to facilitate sharing and access to measured exposure data and data from biomonitoring studies. It is noted that there is a SETAC initiative to define quality criteria for environmental monitoring data (Criteria for Reporting and Evaluating Exposure Datasets (CREED)²³). In addition, the ISES Europe human biomonitoring working group is actively engaged in developing criteria for reporting and evaluating exposure information in biomonitoring studies.

Recommendations relating to **enhancing, and advancing the use of, exposure models** included development of an exposure model inventory (including information on applicability and whether models fulfil certain best practice criteria) as well as a registry of relevant contacts for model users/stakeholders. It was also proposed to initiate a project to draft best practice for model development, which should include considerations on funding model maintenance. A further prioritised solution was to develop harmonised requirements for production of measured data, that could be used to improve models.

Recommendations relating to **new needs for circularity and sustainability** included promotion of improved understanding of negligible exposure and application of PBPK models in moving towards exposure-led safety testing strategies. An exposure scenario for waste and recycling facilities was identified as an emerging scenario requiring development, and it was also recommended to improve risk communication in the context of circularity. It was also proposed to draft a strategic multistakeholder paper on recommendations and best practices for the elevation of exposure science in chemical safety assessment. Encouragement of greater collaboration and cooperation between the initiatives within PARC, ISES and ECETOC as well as with European projects such as ASPIS²⁴ and RiskHunt3r²⁵, also emerged as a recommendation.

²³ <https://www.setac.org/resource/creed-for-use-in-environmental-assessments-a-timely-development-update.html>

²⁴ <https://aspis-cluster.eu/>

²⁵ RISK assessment of chemicals integrating HUMAN centric Next generation Testing strategies promoting the 3Rs, Dashboard. Accessed in October 2023. <https://www.risk-hunt3r.eu/>

Recommendations on **capacity building** related to defining standards and the creation of certification processes and educational programmes for exposure assessors/scientists, as well as the development of a registry of certified exposure scientists. Outlining the 'unique selling points' and 'added value' of exposure scientists was also proposed as a mechanism to develop an identity for exposure scientists. It was also proposed to hold a policy briefing on the recent series of ISES Europe exposure science strategy papers.

The recommendations resulting from this workshop will serve as a catalyst for future initiatives within ECETOC, and other stakeholder organisations, to create focussed activities, projects and multistakeholder joint ventures, which will ultimately help to elevate the role of exposure science in chemical safety assessment and management in Europe.

A general need for further and improved cooperation of all stakeholders, including industry, regulators, academia, was identified for all key action areas and should be implemented on technical, scientific, regulatory, and political levels.

ABBREVIATIONS

BADS	Biomonitoring Application Data Sheet
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (Federal Institute for Occupational Safety and Health)
BOHS	British Occupational Hygiene Society
CLP	Classification, Labelling and Packaging
CSR	Chemical Safety Report
DUCC	Downstream Users of Chemicals Co-ordination Group
ECETOC TRA	ECETOC Targeted Risk Assessment tool
ECETOC	European Centre for Ecotoxicology and Toxicology of Chemicals
ECHA	European Chemicals Agency
ECTS	European Credit Transfer and Accumulation System
EFSA	European Food Safety Authority
ENES	Exchange Network on Exposure Scenarios
EU	European Union
FAIR	Findable, Accessible, Interoperable, and Reusable
FAIREHR	FAIR Environmental Health Study
FIOH	Finnish Institute of Occupational Health
FoBiG	Forschungs- und Beratungsinstitut Gefahrstoffe GmbH
GLP	Good Laboratory Practice
HBM	Human Biomonitoring
HBM4EU	Human Biomonitoring for Europe
IOSH	Institution of Occupational Safety and Health
ISES	International Society for Exposure Science
JRC	European commission's Joint Research Centre
MAF	Mixture allocation factor
OEL	Occupation Exposure Limit
OSH	REACH-Occupational Safety and Health
PARC	Partnership for the Assessment of Risks from Chemicals
PBPK	Physiological based pharmacokinetic modelling
PPE	Personal Protective Equipment

REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SCED	Specific Consumer Exposure Determinant
SETAC	Society of Environmental Toxicology and Chemistry
SPERC	Specific Environmental Release Categories
SRIP	Strategic Research and Innovation Plan
SSbD	Safe and sustainable by Design
SWED	Specific Worker Exposure Determinant

APPENDIX A: Workshop programme

Day 1: Exploring the challenges and opportunities - 25 October [F2F and online participants]		
09.00 – 09.30	Arrival and registration	
09.30 – 09.40	Welcome, introduction and workshop objectives	Blanca Serrano Ramon, ECETOC / Jan Urbanus, Shell and ECETOC Scientific Committee
09.40 – 10.00	Keynote: European exposure science in a changing climate	Paul Scheepers, Radboud University
Key action area 1: New needs for circularity and sustainability		
10.00 – 10.20	Material flows to identify and address exposure throughout the supply chain	Violaine Verougstraete, Eurometaux
10.20 – 10.40	The Safe and Sustainable by Design framework and the opportunities to improve the exposure information	Irantzu Garmendia, European Commission - JRC REMOTELY
10.40 – 11.00	Safe and sustainable chemicals and materials - strategic R&I approaches	Christina Markouli, European Commission REMOTELY
11.00 – 11.20	Panel/Q&A with speakers	Speakers from session Moderator: An van Nieuwenhuysse, Laboratoire National de Santé (LU)
11.20 – 11.50	Coffee break	
Key action area 2: Enhancing exposure models		
11.50 – 12.10	Best practice in Exposure Modelling – Thoughts from the European Exposure Science Strategy 2020–2030	Urs Schlüter, BAuA
12.10 – 12.30	Reflections on a performance study of the TRA-Worker exposure prediction tool	Jan Urbanus, Shell
12.30 – 12.50	Consumer and general population exposure – challenges/opportunities	Astrid Heiland, German Federal Institute for Risk Assessment (BfR)
12.50 – 13.10	Panel/Q&A with speakers	Speakers from session Moderator: Wouter Fransman, TNO
13.10 – 14.10	Lunch	
Key action area 3: Improving access to relevant exposure information		
14.10 – 14.30	REACH registration dossiers as a source of exposure data	Celia Tanarro, ECHA
14.30 – 14.50	How to link biomonitoring data to sources of exposure to enable effective risk management	Tiina Santonen, FIOH

14.50 – 15.10	Exposure modelling: generating robust exposure data to increase confidence in safety decision-making. Perspectives from the agrochemical sector	Alistair Morriss, Corteva REMOTELY
15.10 – 15.30	Development of a worker's exposure data collection tool and database tool for systematic exposure data gathering for metals and metalloids	Steven Verpaele, Nickel institute
15.30 – 15.50	Panel/Q&A with speakers	Speakers from session Moderator: Urs Schlüter, BAuA
15.50 – 16.10	Coffee break	
Key action area 4: Capacity building		
16.10 – 16.30	Capacity Building by Advancing Exposure Science Education and Training	Alison Connolly, University College Dublin
16.30 – 16.50	The Human Capital view on Exposure science – Insights from our 2023 Deloitte Human Capital trend report	Nathalie Dom, Deloitte
16.50 – 17.10	Supply Chain Communication of Exposure Information	Giulia Sebastio, Downstream Users of Chemicals Coordination Group (DUCC) REMOTELY
17.10 – 17.30	How SME companies use (or would wish to use) chemical exposure information for decision-making	Clemens Rosenmayr, SMEunited (WKÖ, member association of SMEunited)
17.30 – 17.50	Panel/Q&A with speakers	Speakers from session Moderator: Paul Scheepers, Radboud University
17.50 – 18.00	Information on dinner and Brief introduction to Day 2	Jan Urbanus, Shell

Day 2: Developing practical, actionable recommendations for stakeholders - 26 October [F2F participants]

09.00 – 09.10	Welcome and Introduction to Day 2 – Refresh and more info on process	Jan Urbanus, Shell
09.10 – 11.00	Breakout group 1a: New needs for circularity and sustainability	Moderator: Violaine Verougstraete, Eurometaux Rapporteur: Wibke Lölsberg, BASF SE
	Breakout group 2a: Enhancing exposure models	Moderator: Celia Tanarro, ECHA Rapporteur: Benjamin Spielmann, BASF
	Breakout group 3a: Improving access to relevant exposure information	Moderator: Tiina Santonen, FIOH Rapporteur: Maryam Zare Jeddi, Shell

	Breakout group 4a: Capacity building	Moderator: Bob Barter, ExxonMobil Rapporteur: Alison Connolly, University College Dublin
11.00 – 11.15	Coffee	
11.15 – 13.00	Breakout group 1b: New needs for circularity and sustainability	Moderator: Violaine Verougstraete, Eurometaux Rapporteur: Wibke Lölsberg, BASF SE
	Breakout group 2b: Advancing the use of exposure models	Moderator: Celia Tanarro, ECHA Rapporteur: Benjamin Spielmann, BASF
	Breakout group 3b: Improving access to relevant exposure information	Moderator: Tiina Santonen, FIOH Rapporteur: Maryam Zare Jeddi, Shell
	Breakout group 4b: Capacity building	Moderator: Bob Barter, ExxonMobil Rapporteur: Alison Connolly, University College Dublin
13.00 – 14.15	Lunch	
14.15 – 15.15	Plenary feedback from breakout groups and share second opinions / Q&A	Rapporteurs per breakout group, All
15.15 – 15.30	Coffee break	
15.30 – 15.50	Priority setting and commitment conversation	Jan Urbanus, Shell
15.50 – 16.00	Summarise and close	Blanca Serrano Ramon, ECETOC

Presentation abstracts

European exposure science in a changing climate

Paul T.J. Scheepers, PhD - Radboud University

Abstract: In this contribution some of the challenges for exposure science were discussed related to the changing climate and the need to adopt more sustainable solutions to our current ways of life. The changing climate itself cannot be undone or reversed but our footprints can be further reduced. Like many colleagues with other backgrounds, exposure scientists will try and contribute to resolve the many problems at hand. Exposure scientists' contributions can support safe and sustainable by design solutions and actions to strengthen prevention and increase resilience for human health and the environment. As laid out in the 'European Exposure Science Strategy 2020-2030' there is a role to play for exposure science, specifically in Europe. This strategy identifies priority areas where actions are needed. We would like to have an impact in the following areas: education, training and implementation, exposure models, exposure data repositories

and analytics, human biomonitoring programmes, policy uptake, and funding and international cooperation. In this presentation the activities in each of the five priority areas will be discussed in their scientific, societal and technological contexts.

REACH registration dossiers as a source of exposure data

Celia Tanarro, ECHA

Abstract: Registrants under REACH provide information regarding substances use and exposure as part of the registration dossier including the Chemical Safety Report (CSR) where relevant. The information provided in the dossier can be used by ECHA (and MS) to support a number of processes that require exposure information such as prioritisation, support of restriction proposals or OEL setting. Additionally, the dossier information can potentially be used for screening proposes, for instance to identify priority substances for other regulations or to estimate the impact of new or updated requirements under chemicals regulations.

How to link biomonitoring data to sources of exposure to enable effective risk management

Tiina Santonen, Finnish Institute of Occupational Health (FIOH)

Abstract: Biomonitoring (HBM) can be a powerful tool in quantifying the total exposure of different population groups, including workers, to chemicals. One of its benefits is that it considers all exposure routes and sources - including those which cannot be easily modelled. In case of cumulative substances like PFAS and lead its benefits are clearly demonstrated, too. However, the fact that it provides information only on total exposure may cause challenges for identifying the most relevant exposure sources and selecting appropriate risk management measures. Therefore, to identify exposure routes, biomonitoring should not be done in isolation, but biomonitoring results need to be considered together with information on available external exposure measurements, modelling data and other contextual information. PBPK modelling might be needed to convert external levels to internal levels. Although quantitative estimates on the relative contribution of different exposure routes or sources might not always be possible to achieve based on HBM data, integrating HBM data to other information is often sufficient to give indication on the main exposure sources, allowing targeting of risk management measures. Biomonitoring can also serve as a kind of reality check for exposure estimates made based on modelling data. Examples from HBM4EU and PARC projects on the use of HBM for characterising exposures and risks both in occupational and environmental context were given.

Exposure modelling: generating robust exposure data to increase confidence in safety decision-making. Perspectives from the agrochemical sector

Alistair Morriss, Corteva Agriscience

Abstract: Key considerations when generating exposure data are: i). The exposure scenario being monitored is reflective of reality. ii). Studies using human volunteers are ethically sound. iii). The data is generated according to international quality criteria (GLP) and guidance on methodology (e.g. OECD) and iv). The data will meet regulatory requirements for acceptability.

Over the last 10+ years the agrochemical industry has engaged with European regulators on a range of projects to review and model existing exposure data (operator exposure models for foliar, greenhouse and seed treatment uses) and to generate exposure data to be used for modelling purposes (re-entry worker exposure data in vineyards and resident exposure via drift). Other projects have relied on industry submitting published data to a regulator for review with minimal direct collaboration (dermal absorption data). The key objective of this work has been to develop robust regulatory tools and increase confidence in safety decision making. The presentation briefly discussed the ‘success’ stories and when things hadn’t gone quite to plan (from an industry perspective) and concluded by considering key learning points for future projects.

Development of a worker's exposure data collection tool and database tool for systematic exposure data gathering for metals and metalloids

Steven Verpaele, Nickel institute

Abstract: The Nickel Institute developed the hybrid data collection and database system to collect and store workplace exposure data for metals and metalloids. The system allows you to provide in the online part detailed information about your organisation or company, sites, workplaces, control measures and sampling and analysis details combined with cost data. In the offline part, all measured data together with all contextual information required for performing workplace exposure assessment needs to be provided. The online part allows all users to predefine many obliged information that remains constant in time and is linked with the offline data collection sheet where further input of exposure data and information related to the specific time when the exposure data was collected. This approach reduces the burden for high quality data submission.

The benefits of an exposure database are many-fold. It enables the storage and selective retrieval of occupational exposure data which can be used to inform policymaking and standard-setting bodies and show trends in exposures categorised into the various industries, processes, and jobs at which the exposures occur. The data can also be used in risk assessment and risk management activities. The presentation provided information regarding data collection and the minimal required contextual information when measuring and documenting workers’ exposure to metals and metalloids.

Best practice in Exposure Modelling – Thoughts from the European Exposure Science Strategy 2020–2030

Urs Schlüter, Federal Institute for Occupational Safety and Health, BAuA, Dortmund Germany; International Society of Exposure Science – Europe Chapter

Abstract: Exposure models are essential in almost all relevant contexts for exposure science. To address the numerous challenges and gaps that exist, exposure modelling is one of the priority areas of the European Exposure Science Strategy developed by the European Chapter of the International Society of Exposure Science (ISES Europe). A strategy was developed for the priority area of exposure modelling in Europe with four strategic objectives. These objectives are:

- (1) improvement of models and tools,
- (2) development of new methodologies and support for understudied fields,
- (3) improvement of model use and
- (4) regulatory needs for modelling.

In a bottom-up approach, exposure modellers from different European countries and institutions who are active in the fields of occupational, population and environmental exposure science pooled their expertise under the umbrella of the ISES Europe Working Group on exposure models. This working group assessed the state-of-the-art of exposure modelling in Europe by developing an inventory of exposure models used in Europe and reviewing the existing literature on pitfalls for exposure modelling, in order to identify crucial modelling-related strategy elements.

Decisive actions were defined for ISES Europe stakeholders, including collecting available models and accompanying information in a living document curated and published by ISES Europe, as well as a long-term goal of developing a best practice in exposure modelling.

Alongside these actions, recommendations were developed and addressed to stakeholders outside of ISES Europe. Additionally, to the four strategic objectives, the working group developed an action plan and roadmap for the implementation of the European Exposure Science Strategy for exposure modelling. This strategic plan will foster a common understanding of modelling-related methodology, terminology and future research in Europe, and have a broader impact on strategic considerations globally.

Reflections on a performance study of the TRA-Worker exposure prediction tool

Jan Urbanus, Shell

Abstract: A task force of ECETOC conducted a study on the performance of Targeted Risk Assessment (TRA v3.1) tool for estimation of dermal and inhalation exposures of workers in chemical handling scenarios. The TRA is a, tier-1, screening model intended to provide conservative exposure estimates (at the 75th percentile) for use in initial chemical safety assessment. The study found that the TRA was conservative in 80-90% of workplace situations with publicly available measured data sets, by overestimating the measured exposure. Several tool settings associated with underestimations were identified using regression calculations and subsequently changed in an updated version v3.2 in 2023 of the tool to further decrease the number of underestimations. The detailed results of the study have been published in ECETOC technical reports and a peer-reviewed scientific paper.

During the study, several challenges had to be navigated, notably:

- absence of a formal protocol for evaluation of occupational exposure models
- lack of a definition of the term ‘conservatism’ in the context of assessment of exposure and risk
- appropriate criteria for selection and curation of comparison material
- the choice of the analytical strategy including interpretation of results

The presentation described how these challenges were addressed as a contribution to potentially further improved guidance on (occupational) exposure model evaluation and acceptance testing.

Consumer and general population exposure – challenges/opportunities

Astrid Heiland, German Federal Institute for Risk Assessment (BfR)

Generic exposure scenarios are very common for covering many consumer products with a handful of data. However, the “one fits all”-principle has limits, especially if regulatory measures should be derived. In addition, new consumer products conquer the market, with new (advanced) materials or compositions. Consumers change their behaviour over time for various reasons.

In 2015, the Research and Advisory Institute for Hazardous Substances (FoBiG) conducted a project in cooperation and on behalf of the BfR [1] to establish an inventory of exposure parameters (frequency, duration, amount of products used, and product use location) for mixtures regulated under REACH. Overall, only 37 relevant consumer studies were identified that allowed extraction of parameter values, resulting in 822 datasets. Our findings strongly call for further surveys focusing on consumer behaviour, in particular for uses with non-intended but reasonably foreseeable contact. Therefore, a feasibility study of consumer behaviour was initiated in 2016 [2] to evaluate the usefulness of various survey methods depending on six sentinel consumer product types. By considering these results, the BfR regularly carried out studies on consumer behaviour patterns. These studies are complemented by market surveys and chemical analyses of selected consumer products.

The data make it possible to move on to more realistic exposure estimates by using refined models, standardisation of exposure scenarios for fact sheet development [3] embedded in exposure calculation tools (ConsExpo Web), the assessment of already implemented risk management measures, and tailored regulatory actions. Examples were given in the presentation.

[1] Heiland A, Oltmanns J, Bohlen M.-L, Kaiser E, Klenow S, Schneider K: Consumer behaviour - compilation and evaluation of primary data. 26th Annual ISES Meeting, 498. International Society of Exposure Science Utrecht, NL, 2016-10-09/2016-10-13.

[2] Schneider K, Recke S, Kaiser E, Götte S, Berkefeld H, Lässig J, Rüdiger T, Lindtner O, Oltmanns J. 2019. Consumer behaviour survey for assessing exposure from consumer products: a feasibility study. *Journal of Exposure Science and Environmental Epidemiology*, 29 (1), 2019, 83-94.

[3] Cieszynski A, Jung C, Schendel T, ter Burg W. 2023. Do-It-Yourself Products Fact Sheet. Default parameters for estimating consumer exposure – Updated version 2022. RIVM report 2022-0208. Bilthoven, NL, National Institute for Public Health and the Environment.

Material flows to identify and address exposure throughout the supply chain

Violaine Verougstraete, Director EHS, Eurometaux and Daniel Vetter, EBRC

Summary: Achieving Europe’s climate and digital transition objectives will require the use of hazardous substances for which there are no feasible alternatives to date. The shift towards more sustainable technologies may even increase volumes of such substances (e.g. metals and inorganics). There are valid concerns that the increased use of “(eco)toxic” metals as well as their circularity -linked to recycling- would increase releases and possible impacts on health and environment. To defend a management model based on the control of risks (rather than focused only on hazard), industry needs to demonstrate control of exposure and emissions, supported by high quality representative exposure assessments.

Exposure data need to show a good understanding of today's exposures, risks, and their control, complemented with a good knowledge and management of expected future emissions and/or trends ("today and tomorrow"), across the supply chain and covering the lifecycle. Materials/mass flows can help in identifying volumes, use patterns and exposures/emissions that are to be expected, help focus on adapted risk management measures but also promote the relevance of exposure assessment/ exposure control measures to reach the toxic-free environment status the EU aims at.

The Safe and Sustainable by Design framework and the opportunities to improve the exposure information

Irantzu Garmendia, European Commission – Joint Research Centre

Summary: The European Green Deal is the climate neutrality, a circular economy and a zero pollution/toxic free ambition of the European Commission and it defines clear goals to put the European economy and society on this path towards a sustainable future.

Among the environmental strategies, contributing to its objectives the Chemical Strategy for Sustainability identifies a number of actions to better protect the human health and the environment. It identifies as key enabler to achieve its objective the development of a framework to ensure the placement on the market of chemicals, materials and products that are safe and sustainable by design (SSbD).

Safe and sustainable chemicals and materials - strategic R&I approaches

Christina Markouli, European Commission Directorate-General for Research and Innovation (R&I), Industrial Transformation Unit

Summary: The European Commission published in 2022 the Strategic Research and Innovation Plan (SRIP) for safe and sustainable chemicals and materials and the Recommendation on the assessment framework for 'safe and sustainable by design' chemicals and materials. During this presentation both actions will be introduced with an update on progress done since their publication and the next steps.

Capacity Building by Advancing Exposure Science Education and Training

Alison Connolly, University College Dublin

Abstract: Advances in exposure science strongly rely on input from well-trained and experienced experts, but there is a lack of formal education and training programmes solely dedicated to exposure science in Europe. The ISES Europe Education, Training and Communication working group was established in 2018 with the goal of anchoring exposure science in academic research and education. To address this challenge, essential building blocks were identified, including developing a tiered education/training scheme with ECTS equivalent points/certificates. The groups' ambitions are to create purposely trained experts within the discipline. However, there is a need to develop a curriculum that yields credible, well-defined career pathways in exposure science. A framework has been outlined with harmonised learning outcomes, specified under eight different requirements and categorised based on knowledge, skill and competence.

The Human Capital view on Exposure science – Insights from our 2023 Deloitte Human Capital trend report

Nathalie Dom, Deloitte

Abstract: In our Deloitte Human Capital trends, we surveyed over 10,000 professionals across global business organisations from 105 countries to hear from real people about what's top of mind when it comes to work, the workplace, and the workforce. 23% of those surveyed were Board and C-Suite members. This survey data is complemented by interviews with leaders in various industries to provide a truly global, cross-industry representation of these trends.

So, what did we find?

The greatest barrier to achieving organisational outcomes is being overwhelmed by too many changes at once... but the dissolution of the boundaries we once assumed to be fixed is creating new opportunities for organisations and employees who are prepared to show up in fundamentally different ways.

If the past century of work was based on the view that work was fixed and repeatable, the next century will be based on the view that work is fluid and agile. The boundaries that once dictated when, where and how work was completed are falling away, shaken up by advancing technologies, changing working needs and greater discontinuity and disruption.

In this presentation, we zoomed in on the most relevant insights of the Human Capital trends in the context of the ECETOC challenges on how to foster an increased level of focus, skills and competences, how to establish and identity for exposure scientists, and how to define and acknowledge exposure science as an independent and interconnected field that is key in protecting human and ecosystem health and creating a sustainable world.

Supply Chain Communication of Exposure Information

Giulia Sebastio, Downstream Users of Chemicals Co-ordination Group (DUCC)

Abstract: DUCC is a platform of 11 European associations which represent “downstream” industries ranging from cosmetics and detergents to aerosols, paints, inks, toners, pressroom chemicals, adhesives and sealants, construction chemicals, fragrances, lubricants, crop protection and chemical distributors industries. Since its creation in 2001, the group's main objective has been to contribute, with a common voice, to the successful implementation of the requirements of the REACH and CLP Regulations.

DUCC actively participated during the legal process for the adoption of REACH, making and advocating several concrete proposals, such as:

- Supporting exposure-driven, tiered risk assessment approach as promoted by ECETOC.
- Proposing mechanisms for involvement of Downstream Users in registration dossiers, particularly on exposure assessment.

- Was one of the founding members of the Exchange Network on Exposure Scenarios (ENES) and a main contributor to the Chemical Safety Report/Exposure Scenarios Roadmap (CSR/ES Roadmap) activities.

DUCC now continues to actively engage to the implementation activities organised by the European Commission and by ECHA, in the context of the ongoing REACH revision.

Given the longstanding experience of DUCC and its members in the topic of supply chain communication of exposure information, the presentation expanded on the 'barriers' that have been faced on improving the use of exposure information. DUCC shared its experience of building and better use of Use Maps, a cornerstone of the DUCC initiatives. The final reflection will be: how can communication of exposure information, support the future system?

How Small and Medium-sized Enterprise companies use (or would wish to use) chemical exposure information for decision-making

Clemens Rosenmayr, SMEunited (WKÖ, member association of SMEunited)

Abstract: The needs for communication of exposure data along the value chain vary greatly for SMEs. It will depend on their position in the value chain and activity. This presentation will focus on joint challenges and differences between these companies. It will also reflect on the type of data these companies need and put up for discussion possible solutions.

APPENDIX B: BREAKOUT SESSIONS

The breakout group discussions took place on Day 2 of the workshop and were arranged around the four key action areas of the workshop. Workshop participants could choose in which breakout groups they participated. Each breakout group had a dedicated moderator, to chair the discussions, and a rapporteur, to present the discussion outcomes in the afternoon plenary session.

Breakout groups 1-3 were provided with a list of discussion topics and addressed the following, per discussion topic:

- Consider current barriers/issues with the topic
- Analyse root causes (for example, using the “5 why’s” method from continuous improvement)
- Brainstorm candidate solutions
- Prioritise one or more solutions to candidate workshop *practical* recommendation

Breakout group 4 addressed a sequence of four questions directly.

Breakout groups 1a – 4a ran in parallel in the first Day 2 session and breakout groups 2b – 4b ran in parallel in the second Day 2 session.

The below sections present the discussion topics addressed for breakout groups 1-3 and the questions addressed by breakout group 4, as well as the reading lists. The discussion topics, questions and reading lists were provided to workshop participant in advance of the workshop.

Note: the order of the below sections is as listed in the workshop programme. The workshop write-up in this report uses a different order.

Breakout group 3a and 3b: Improving access to relevant exposure information

Breakout group	Discussion topics	Moderator/Rapporteur
3a and 3b: Improving access to relevant exposure information	<p>Data quality</p> <ol style="list-style-type: none"> 1. Define quality criteria for exposure estimates in scenarios and completeness of exposure assessments (all pathways identified) 2. Systematic priority setting for exposure scenarios requiring measured data <ol style="list-style-type: none"> a. Use of measurement data to read across to other scenarios <p>Data accessibility</p> <ol style="list-style-type: none"> 3. FAIR HBM data repository and accessibility <ol style="list-style-type: none"> a. Data from research b. Data from agencies (incl. IP-CHEM, e-CHEM) c. Data from companies 4. Data sharing and disclosure, including legal aspects 5. European exposure mapping (inhabitants, consumers, workers) 	<p>Moderator: Tiina Santonen, FIOH</p> <p>Rapporteur: Maryam Zare Jeddi, Shell</p>

Reading list

Advancing exposure data analytics and repositories as part of the European exposure science strategy 2020-2030 (2022). <https://doi.org/10.1016/j.envint.2022.107610>

Feasibility study on a common open platform on chemical safety data (2022) doi:10.2779/365711 [link](#)

Developing human biomonitoring as a 21st century toolbox within the European Exposure Science Strategy 2020-2030 (2022). <https://doi.org/10.1016/j.envint.2022.107476>

FAIR environmental and health registry (FAIREHR)- supporting the science to policy interface and life science research, development and innovation

<https://www.frontiersin.org/articles/10.3389/ftox.2023.1116707/full>

Extrapolating the Applicability of Measurement Data on Worker Inhalation Exposure to Chemical Substances (2020) <https://doi.org/10.1093/annweh/wxz097>

Is the EU chemicals strategy for sustainability a green deal? Bridges et al., 2023 (<https://doi.org/10.1016/j.yrtph.2023.105356>)

Breakout group 2a and 2b: Enhancing exposure models & Advancing the use of exposure models

Breakout group	Discussion topics	Moderator/Rapporteur
2a: Enhancing exposure models	<ol style="list-style-type: none"> 1. How can existing models and tools be improved, considering regulatory requirements? 2. Are there possibilities to harmonise models between regulations? 	Moderator: Celia Tanarro, ECHA
2b: Advancing the use of exposure models	<ol style="list-style-type: none"> 3. How to ensure the involvement of all stakeholders in the model development? 4. How to promote the development of best practices for models developers? Who should be involved? 	Rapporteur: Benjamin Spielmann, BASF

Reading list

Fransman, W. (2017). "How Accurate and Reliable Are Exposure Models?" *Ann Work Expo Health* **61**(8): 907-910, <https://doi.org/10.1093/annweh/wxx068>.

Schlüter, U., et al. (2022). "Exposure modelling in Europe: how to pave the road for the future as part of the European Exposure Science Strategy 2020–2030." *Journal of Exposure Science & Environmental Epidemiology* **32**(4): 499-512, <https://doi.org/10.1038/s41370-022-00455-4>.

Schlüter, U. and Spinazze, A. (2023). "Understanding the limitations and application of occupational exposure models in a REACH context." *J Occup Environ Hyg* **20**(8): 336-349., <https://doi.org/10.1080/15459624.2023.2208188>.

Possible options for improvement are listed on the ISES Europe Homepage: <https://ises-europe.org/group/exposure-models>

Lamb, J., et al. (2017). "Between-User Reliability of Tier 1 Exposure Assessment Tools Used Under REACH." *Ann Work Expo Health* **61**(8): 939-953, <https://doi.org/10.1093/annweh/wxx074>.

Breakout group 1a and 1b: New needs for circularity and sustainability – discussion questions and background resources

Breakout group	Discussion topics	Moderator/Rapporteur
1a and 1b: New needs for circularity and sustainability	<ol style="list-style-type: none"> 1. Exposure information for sustainability and circularity 2. How can initiatives like PARC and/or other existing exposure/monitoring databases and authorities/industry benefit each other? 3. Exposure information to guide toxicology testing ('exposure-led safety testing strategies') 4. Identify new and emerging exposure scenarios 	<p>Moderator: Violaine Verougstraete, Eurometaux</p> <p>Rapporteur: Blanca Serrano, ECETOC</p>

Reading list

Topic 1:

- Portfolio Sustainability Assessment v2.0 <https://www.wbcsd.org/Programs/Circular-Economy/Resources/Portfolio-Sustainability-Assessment-v2.0>
- Strategic Research and Innovation Plan for safe and sustainable Chemicals and Materials (2022): <https://data.europa.eu/doi/10.2760/487955>
- Safe and sustainable by design chemicals and materials – Framework for the definition of criteria and evaluation procedure for chemicals and materials (2022) [link](#)

Topic 2:

- PARC, <https://www.eu-parc.eu/what-we-do>
e.g. IPCHEM: <https://ipchem.jrc.ec.europa.eu/>

Topic 3:

- Wolf et al. 2020 (<https://DOI.org/10.1002/ps.5793>)
- Cronin et al. 2022 (report from EPAA Partners Forum, Nov 2022; <https://doi.org/10.1016/j.yrtph.2023.105483>)
- ASPIS research consortium (<https://aspis-cluster.eu/working-groups/>)

Topic 4:

- HBM4EU e-waste study: Occupational Exposure of Electronic Waste Workers to Phthalates and DINCH in Europe (2023, not yet peer-reviewed) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4532444
- Occupational health and safety, metal exposures and multi-exposures health risk in Canadian electronic waste recycling facilities <https://doi.org/10.1016/j.wasman.2023.04.026>

Breakout group 4a and 4b: Capacity building

Breakout group	Discussion topics	Moderator/Rapporteur
4a and 4b: Capacity building	<ol style="list-style-type: none"> 1. How would we assess our current state in exposure capacity building, what is good about it, what is lacking? 2. What does a good solution look like (is it trained experts widely dispersed in industry, government and academia applying exposure science to problem, is it centres of expertise that industry and government can rely on to address application of exposure science needs, or is it somewhere between?) 3. What are the barriers to achieving the good solution (need to draw participants out on specifics, for example funding is not a good answer, lack of exposure scientists evaluating funding proposals would be a better answer). 4. What specific and actionable steps can be taken to address to overcome identified barriers? 	<p>Moderator: Bob Barter, ExxonMobil</p> <p>Rapporteur: Alison Connolly, University College Dublin</p>

Reading list

Framework for developing an exposure science curriculum as part of the European Exposure Science Strategy 2020-2030 (2022). <https://doi.org/10.1016/j.envint.2022.107477>

Towards further harmonisation of a glossary for exposure science – an ISES Europe statement (2022). <https://doi.org/10.1038/s41370-021-00390-w>

[Sustainability through the Human Capital lens | Deloitte Belgium](#)

APPENDIX C: Workshop participants

First name	Surname	Affiliation	Online/F2F
Femke	Affourtit	National Institute for Public Health and the Environment (RIVM)	Online (Day 1)
Gerald	Bachler	DuPont	Online (Day 1)
Steffen	Bade	BASF	Online (Day 1)
Catherine	Barratt	Unilever	F2F (Day 1 and Day 2)
Bob	Barter	ExxonMobil Technology and Engineering Company	F2F (Day 1 and Day 2)
Sivani	Baskaran	Norwegian Geotechnical Institute	Online (Day 1)
Renske	Beetstra	RIVM	Online (Day 1)
Emily	Bird	Ricardo	Online (Day 1)
Emma	Bleasdale	Innospec	Online (Day 1)
Laura	Boden	BfR, Germany	Online (Day 1)
Luca	Campisi	Flashpoint srl/University of Pisa	Online (Day 1)
Roberto	Carletti	ENEA	F2F (Day 1 and Day 2)
Pepa	Cecil	Self Employed	Online (Day 1)
Jacek	Cieřła	Bureau for Chemical Substances	Online (Day 1)
Alison	Connolly	University College Dublin	F2F (Day 1 and Day 2)
James	Dawick	Innospec	Online (Day 1)
Jodie	Denmark	Ricardo Energy and Environment	Online (Day 1)
Carolina	Di Paolo	Dow	Online (Day 1)
Nathalie	Dom	Deloitte	F2F (Day 1)
Carolin	Dumke	BAuA Dortmund, Germany	Online (Day 1)
Jenny	Eklund	Nynas	Online (Day 1)
Nadine	Engel	Evonik	Online (Day 1)
Carolin	Ewers	CFCS-Consult GmbH	Online (Day 1)
Zahra	Farmani	Evonik Oxeno	Online (Day 1)
Frank	Faulhammer	BASF SE	Online (Day 1)
Läetitia	Fievez-Fournier	TotalEnergies	Online (Day 1)
Wouter	Fransman	TNO	F2F (Day 1 and Day 2)
Stefano	Frattini	ECHA	Online (Day 1)
Marta	Gabriel	INEGI, Institute of Science and Innovation in Mechanical and Industrial Engineering	Online (Day 1)
Karen	Galea	IOM	Online (Day 1)
Irantzu	Garmendia	European Commission-JRC	Online (Day 1)
Sophie	Garrett	RPA	Online (Day 1)
Albania	Grosso	AG-HERA Consulting	F2F (Day 1 and Day 2)
Stefan	Hahn	Fraunhofer ITEM	F2F (Day 1 and Day 2)

First name	Surname	Affiliation	Online/F2F
Anetta	Hałajewska-Wosik	Bureau for Chemical Substance	Online (Day 1)
James	Hanlon	Ricardo	Online (Day 1)
Astrid	Heiland	German Federal Institute for Risk Assessment (BfR)	F2F (Day 1 and Day 2)
Oliver	Henschel	BASF SE	Online (Day 1)
George	Hinkal	Concawe	Online (Day 1)
Heli Miriam	Hollnagel	Dow Europe	Online (Day 1)
Charles	Humfrey	The Lubrizol Corporation	Online (Day 1)
Agnieszka	Jankowska	Bureau for Chemical Substances	Online (Day 1)
Lauren	Kavanagh	Innospec Limited	Online (Day 1)
Petra	Kern	Procter & Gamble Services NV	F2F (Day 1 and Day 2)
Dalen	Kjersti Steinsvåg	Equinor ASA	Online (Day 1)
Stefanie	Klenow	BfR	Online (Day 1)
Dorothea	Koppisch	Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA)	Online (Day 1)
Eva	Kumar	Finnish Institute for Health and Welfare	Online (Day 1)
Joanna	Kupny	Diversey	Online (Day 1)
Sriranjan	Kurubaran	Dr Knoell Consult Ltd	Online (Day 1)
Katia	Lacasse	Cefic	Online (Day 1)
Lara	Lamon	esqLABS	F2F (Day 1 and Day 2)
Sergio	Léon Pérez	ECETOC	F2F (Day 1 and Day 2)
Miranda	Loh	Institute of Occupational Medicine (IOM)	Online (Day 1)
Silvia	Maberti	ExxonMobil	Online (Day 1)
Christina	Markouli	European Commission	Online (Day 1)
Lauren	McAnally	Innospec	Online (Day 1)
Leona	Merolla	Syngenta	Online (Day 1)
Jessica	Meyer	Federal Institute for Occupational Safety and Health (BAuA)	Online (Day 1)
Cécile	Moreau	LyondellBasell	F2F (Day 1 and Day 2)
Sabrina	Moro Iacopini	ENEA	Online (Day 1)
Alistair	Morriss	Corteva Agriscience	Online (Day 1)
Francesca	Mostardini	Policy regulatory	Online (Day 1)
Ilse	Ottenbros	TNO	Online (Day 1)
Alicia	Paini	esqLABS GmbH	Online (Day 1)
Raffaella	Papagna	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA)	Online (Day 1)
Marina	Pereira	Croda International	Online (Day 1)
Giulia	Pizzella	Eni	Online (Day 1)
Tom	Rakovicky	ICON	Online (Day 1)
Carlos	Rodriguez	Procter & Gamble	Online (Day 1)

First name	Surname	Affiliation	Online/F2F
Eva	Rogasch	Federal Institute for Risk Assessment	Online (Day 1)
Clemens	Rosenmayr	SMEunited (WKÖ, member association of SMEunited)	F2F (Day 1 and Day 2)
Alan	Rovira	Shell	Online (Day 1)
Andrea	Salvadori	ECETOC	F2F (Day 1 and Day 2)
Tiina	Santonen	Finnish Institute of Occupational Health	F2F (Day 1 and Day 2)
Daniel	Sättler	German Environment Agency (UBA)	Online (Day 1)
Jean-Francois	Sauvé	INRS	Online (Day 1)
Barbara	Savary	INRS	Online (Day 1)
Paul	Scheepers	Radboud University	F2F (Day 1 and Day 2)
Urs	Schlüter	BAuA	F2F (Day 1 and Day 2)
Giulia	Sebastio	Downstream Users of Chemicals Co-ordination Group (DUCC)	Online (Day 1)
Ovnair	Sepai	UK Health Security Agency	F2F (Day 1 and Day 2)
Blanca	Serrano	ECETOC	F2F (Day 1 and Day 2)
Monica	Sica	Evonik Operation GmbH	Online (Day 1)
Peter	Sladen	Vitis Regulatory	Online (Day 1)
Karen	Smet	Ineos Oxide	Online (Day 1)
Jenny	Smith	Health and Safety Authority	Online (Day 1)
Benjamin	Spielmann	BASF SE	F2F (Day 1 and Day 2)
Andrea	Spinazzè	Università degli Studi dell'Insubria	Online (Day 1)
Keiko	Suzuta	NIMS	Online (Day 1)
Celia	Tanarro	ECHA	F2F (Day 1 and Day 2)
Wouter	ter Burg	RIVM	F2F (Day 1 and Day 2)
Cornelia	Tietz	Cefic	Online (Day 1)
Adrian	Tristram	ExxonMobil	F2F (Day 1 and Day 2)
Jan	Urbanus	Shell	F2F (Day 1 and Day 2)
An	van Nieuwenhuysse	Laboratoire National de Santé, LU	F2F (Day 1 and Day 2)
Violaine	Verougstraete	Eurometaux	F2F (Day 1 and Day 2)
Steven	Verpaele	Nickel Institute	F2F (Day 1 and Day 2)
Daniel	Vetter	EBRC Consulting GmbH	F2F (Day 1 and Day 2)
Maisarah	Waras	Advanced Medical and Dental Institute, Universiti Sains Malaysia	Online (Day 1)
Nasution	Wilmot	ECETOC	Online (Day 1)
Maryam	Zare Jeddi	Shell Global Solutions International BV	F2F (Day 1 and Day 2)
Mengying	Zhang	Procter & Gamble	F2F (Day 1 and Day 2)
Hicham	Zilaout	Cosanta BV / Stoffenmanager	Online (Day 1)

APPENDIX D: Organising committee

Paolo	Boffetta	Università di Bologna, IT
Heli	Hollnagel	Dow, CH
Peter	Fantke	DTU, DK (<i>initial phase</i>)
Kevin	Pollard	ECHA, FI
Urs	Schlüter	BAuA, DE
Benjamin	Spielmann	BASF, DE
Celia	Tanarro	ECHA, FI
Jan	Urbanus	Shell, NL
An	van Nieuwenhuysse	Laboratoire National de Santé, LU
Andrea	Salvadori	ECETOC, BE
Anne	Vallès Meunier	ECETOC, BE
Blanca	Serrano Ramón	ECETOC, BE
Lucy	Wilmot	ECETOC, BE

APPENDIX E: Report drafters

Jan	Urbanus	Independent consultant, BE
Sergio	Leon Perez	ECETOC, BE
Maryam	Zare Jeddi	Shell Global Solutions International BV, NL

Report reviewers

Adrian	Tristram	ExxonMobil, UK
Celia	Tanarro	ECHA, FI
Violaine	Verougstraete	Eurometaux, BE
Alison	Connolly	University College Dublin (UCD), IE

Members of the ECETOC Scientific Committee

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Responsible Editor:
Blanca Serrano Ramon
ECETOC AISBL
Rue Belliard 40
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