NORMAN
Network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances

Meeting Report of Working Group on Emerging Substances in the Indoor Environment Amsterdam (Netherlands), 8–9 December 2014

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Kick-off meeting of the NORMAN working group (WG) on Emerging Substances in the Indoor Environment: Free University (VU), Amsterdam, W&N Building, Room C541-543		
Day 1: 8 December 2014		
13h00 – 13h30	Welcome and introduction Overall aim to establish the WG on the indoor environment	*Pim Leonards, IVM* *Eva Brorström-Lundén, IVL* *Adrian Covaci, UA*
13h30 – 13h45	NORMAN's view and expectations	*Valeria Dulio, INERIS*
13h45 – 14h15	Knowledge gaps that require filling for better regulation of "industrial" chemicals in the indoor environment"	*Stellan Fisher, KemI*
14h15 – 14h45	Emissions and fate of organic chemicals indoors – overview of modelling approaches	*Anna Palm Cousins, IVL*
14h45 – 15h15	GCxGC-MS analysis of samples of relevance for indoor emissions	*Peter Haglund, UmU*
15h15 – 15h45	**Coffee break**	
15h45 – 16h15	Target and non-target screening analysis of emerging substances in indoor air and dust; sampling method harmonisation	*Pernilla Bohlin Nizzetto, NILU*
16h15 – 16h45	Standardisation of sampling and analytical approaches for an assessment of indoor exposure	*Jana Klanova,* Lisa Melymuk *Recetox*
16h45 – 17h15	Assessing human exposure to legacy and emerging flame retardants	*Cynthia de Wit, ITM, SU*
17h15 – 17h45	The MISSEisse project	*Jana Weiss, IVM*
17h45 – 18h00	Ineris work on indoor air	*Marc Durif, Ineris*
18h00 – 18:10	Wrap-up and summary	

Kick-off meeting of the NORMAN working group (WG) on Emerging Substances in the Indoor Environment: Free University (VU), Amsterdam, W&N Building, Room C541-543	
Day 2: 9 December 2014	
9h00 – 12h00	**Discussions and planning of future activities of the WG**
	- Proposals based on the presentations - Set-up of a strategy plan for the indoor environment group - An interlaboratory study for non-target screening in indoor dust - Future workshop (NILU)
12h00	**End of meeting**

Meeting report

Eva Brorström-Lundén, Anna Palm Cousins, Pim Leonards, Adrian Covaci

I. Introduction

Eva Brorström-Lundén (EBL), *IVL Swedish Environmental Research Institute,* welcomed the core group members of the NORMAN Working Group (WG) on the Indoor Environment to this first workshop and thanked the host, Pim Leonards and his team, for inviting the WG to VU in Amsterdam.

EBL stated the main purposes of this first meeting to be:

- to establish the NORMAN WG on the Indoor Environment and
- to set up the strategy and to identify important issues and future aims.

She also gave a description of the background for the establishment of the WG and mentioned key topics to be addressed.

Background to the formation of the working group

Articles and consumer products used indoors may contain a variety of both well-known chemicals and emerging substances. Chemicals emitted indoors will be present in indoor air and dust, which will become important pathways of chemical exposure for humans, but may also act as sources of exposure in the outdoor environment.

Key topics for the NORMAN WG on the Indoor Environment

Key topics to be addressed by the WG are e.g:

- to identify emerging substances of concern for the indoor environment and to investigate which emerging substances are currently analysed in indoor air and dust
- harmonisation of sampling and measurement methods
- organisation of interlaboratory studies in dust (ILS) (target and non-target)
- identify indoor emissions of emerging substances e.g. from products and articles
- identification of important pathways of chemical exposure for humans indoors and pathways to the outdoor environment
- policy issues: links between policy and science.

The first day of the workshop was devoted to individual presentations by core group participants to outline the main interests and experience of those present. The second day was devoted to discussions and planning of future activities in the WG.

All presentations can be found on the www.norman-network. A brief summary of the presentations and the outcome of the discussions are given below.

II. Individual presentations

Valeria Dulio (VD), *INERIS, Executive Secretary of the NORMAN network*, presented NORMAN's expectations of the WG. NORMAN aims to cover all environmental compartments and this is the first non-water-related WG and was as such most welcomed by VD. NORMAN expects a clear scope and a roadmap for the WG including:

- Activities that can stimulate synergies among different projects;
- Activities whose final results can be addressed to policy-makers, because NORMAN's mission is to bring messages from the scientific community to policy;
- Activities focused on the link between environmental pollution and human health issues.

VD further mentioned that although NORMAN is not a funding agency for projects, the network provides seed money for limited tasks, decided upon by the NORMAN Steering Committee(SC), if it is considered beneficial for

the aims of the network. Communication from the new WG is expected to be carried out via the NORMAN Bulletin and contributions to the NORMAN website, while keeping the Executive Secretary informed.

Stellan Fischer (SF), *Swedish Chemicals Agency,* discussed knowledge gaps that require filling for better regulation of "industrial" chemicals in the indoor environment. The presentation included the topics *chemical fate in the indoor environment*, *dust as a complex matrix*, *scenarios of interest* and *identification of sources*. Important differences between preparations and articles were also discussed. SF highlighted important aspects of the indoor environment where better knowledge is required, from his perspective:

- The source of a detected substance
- Release processes from solid goods
- New use or part of an old stock
- Combined exposure (e.g. occupational, food)
- Release triggering factors (e.g. abrasion, temperature fluctuation)
- Chemical origin (isomer mixtures, impurity, degradation products).

The nature and movement of particles and dust is important and SF suggested a mass balance study of particles during vacuuming. Furthermore he could foresee more in-depth studies of dust properties, focusing on changes in dust properties with age, and also the implications of dust properties in terms of sampling. In addition, processes related to release mechanisms of particles are of interest, e.g. release from solid goods, is there a difference in release from new or old goods? And what are the triggering factors? SF also emphasised the importance of involving chemical authorities in e.g. the identification of unknown substances and the identification of sources.

Anna Palm Cousins (APC), *IVL Swedish Environmental Research Institute,* talked about recent modelling approaches to understanding the fate of organic chemicals in the indoor environment. APC mentioned work conducted in the ChEmiTecs project – Organic Chemicals Emitted from Technosphere Articles – and INFLAME, where emissions from products have been measured and modelled, and comparison has been made between molecular emissions, abrasion and direct migration to dust, indicating that the latter may be a dominant release pathway for hydrophobic substances. Existing indoor models range from being very room-specific to capturing an entire city and include indoor matrices such as air (gas and particles), surfaces (covered by organic film layers), dry dust, carpets, polyurethane foams (PUFs) and humans. Emissions in the indoor environment may be estimated either by calculating backwards on the basis of levels found in indoor air and dust or by using more mechanistic approaches adapted to the indoor conditions (e.g. temperature, ventilation rates). Future challenges are related to standardisation/characterisation of matrices, such as dust and organic film, and to investigation of indoor particle dynamics as well as the link between indoor fate and human exposure.

Peter Haglund (PH), *Umeå University (UmU),* gave a presentation on the analytical challenges of samples with relevance for indoor emissions. These challenges are related to complex matrices (dust, materials), low concentrations of numerous organic compounds and many isomeric target substances. Often suspect analysis is used, based on previous knowledge of what can be expected to be found indoors i.e. in indoor air, dust, sewage water, sludge, ventilation air, or based on modelling exercises. An alternative is non-target screening, looking for "everything in anything". PH mentioned a recent project where non-target screening was conducted by UmU in the city hall of Umeå using a GC-GC-TOF-MS system. The main findings in the indoor samples were phthalate esters, organophosphates, brominated flame retardants, bacteria, sterols and petroleum compounds. The method will now be applied to wastewater treatment plants influents and effluents. There, are, however many "unknown unknowns" to be identified. For non-target screening, PH pointed out e.g. the need for non-discriminating sample preparation, better software for 3D separations, efficient workflows for unknown unknowns and future safe data storage.

Pernilla Bohlin Nizzetto (PBN), *Norwegian Institute for Air Research (NILU),* introduced the participants to NILU's ambitions to place NILU on the "indoor map". PBN mentioned that NILU has recently initiated some projects on indoor environmental issues, concerning e.g. VOCs in indoor air, phthalate esters in bedroom air and their connection to occurrences of asthma and eczema (collaboration with C-G Bornehag at the University of Karlstad). PBN talked about different analytical methods, such as targeted analysis of SVOCs, including e.g. PFCs, bisphenols and phthalates for sampling air, dust and window films and non-targeted analysis or suspect screening in children's rooms and in blood of journalists and pregnant women. NILU sees a need for harmonisation of sampling methods, especially in dust, including evaluation of variability/comparability and sampling guidelines.

Jana Klanova (JK) and Lisa Melymuk (LM), *Recetox*, talked about sampling and the process to select the most appropriate sampling matrix for indoor concentration measurements. At RECETOX, sampling has been carried out in various matrices such as indoor air, indoor particles, floor dust, window wipes and skin wipes. JK also

highlighted the need for calibration of passive sampling devices, such as PUF/XAD/Silicon rubber for indoor air. There is also a need for determination of chemical contents of materials and consumer products as well as determination of volatilisation and leaching. Sampling strategies e.g. choice of target substances as well as "type" of indoor environment was discussed. Further areas of interest are linking external to internal exposure as well as exploring particle-size distribution in the indoor environment. LM talked about a project aiming to assess sampling techniques in indoor environments and to understand the distribution of SVOCs in indoor environments. The SVOCs investigated were legacy compounds, current use/emission compounds and novel halogenated flame retardants (NFRs). LM concluded that dust concentrations within rooms are highly heterogeneous and using window films for sampling is problematic due to limited sample size and possible photo-degradation. She also concluded that particle-size distribution of SVOCs indoor is compound-specific.

Cynthia de Wit (CdW), *ACES, Stockholm University (SU)*, presented research on human exposure to legacy and emerging brominated flame retardants with the overall goals of furthering understanding of human exposure to chemicals from emissions; and linking exposure to possible adverse effects. CdW presented a project "Estimating external exposure from dust and air in Stockholm" and gave the main conclusions; BFRs were found in dust from all micro environments and BDE-209 was predominant PBDE. Emerging BFRs are replacing legacy BFRs in Europe as well as in the US, which is reflected in the levels found. Inhalation and dust ingestion are minor exposure routes for PentaBDE and HBCD compared to diet for median exposures. Toddlers are exposed via dust ingestion to a higher degree than adults. Other projects presented by CdW were about "Linking external and internal exposure in a mother-toddler cohort" and "Linking external and internal exposure in an adult cohort from Oslo (A-TEAM)" and "Studying emissions from indoor environments to outdoors (INFLAME)". Current topics of interest at SU are dust ingestion, how to determine the rate and which method to use. CdW further raised the policy issue and posed the question of which directives are of interest. Is there a need for an indoor directive on SVOCs? It might be difficult to implement, at least in private homes.

Jana Weiss (JW), *IVM, VU, The Netherlands* talked about the project MIxture aSSessment of Endocrine disruptors – MISSE. JW gave the following background:

- Exposure via dust is a relevant pathway for many EDCs.
- Cats have been shown to be exposed to dust containing chemicals due to their behaviour pattern.
- Cats have a reported high incidence of feline hyperthyroidism.
- Cats can work as a model to evaluate external exposure experience by small children.
- There is a need to determine the chemical composition of indoor mixtures of anthropogenic chemicals to allow assessment of the health risk of the cocktail.
- MIxture assessment of Endocrine Disrupting Compounds (EDC) with emphasis on thyroidogenicity - using cats as model for human indoor exposure (FORMAS grant 2012-2017).

The ultimate aim of MISSE is to investigate the level of exposure to EDCs via household dust and how that affects thyroid hormone functions in cats. Further, this will indicate the level of toddlers' and small children's exposure to these chemicals.

Marc Durif (MD), *INERIS*, talked about INERIS work on the indoor environment, so far mainly focusing on volatile organic chemicals, including the impact of petrol stations on indoor air as well as exposure from printing. Furthermore, exposure to particles in cars and trains has been studied and they have explored the use of GPS to estimate indoor exposure while driving. INERIS is also working on monitoring techniques and sampling devices, and has studied pesticides in indoor air. INERIS is conducting continuous monitoring, as well as exposure chamber measurements. It has run campaigns on VOCs in indoor air in schools. INERIS has also set up an indoor air kit, and has studied the release of NO_2, CO, PM, PAHs and benzene in connection with indoor wood burning. As mentioned above, VOCs have been the main focus at INERIS, but it has also started to look at PBDE exposure in French offices and has developed an artificial deposition surface used to measure indoor particle deposition.

III. Discussions and planning of future activities

After the individual presentations, a discussion was initiated about future prioritisations and strategies for the working group.

One topic brought up was harmonisation of measurement methods for air and dust. The need to harmonise the sampling methods for dust was highlighted as particularly important, to include the design of sampling equipment as well as pre-treatment and characterisation of dust samples.

Another topic was uploading, onto the NORMAN EMPODAT database, data on emerging chemicals present indoors. It is desirable to incorporate indoor matrices in the NORMAN database, and it was considered important to build a flexible system which allows future expansion of the database to include additional parameters as progress continues and new data are added. There is a need to prioritise metadata for inclusion in the database. Examples mentioned were organic carbon (e.g. TOC), type of building, place sampled (near source, settled dust... etc.), sieved/un-sieved. The possibilities for future inclusion of exposure studies were also discussed, whereby environmental factors are linked to effects on human health.

Relevant emerging substances important for the indoor environment have to be identified. The WG agreed that special emphasis should be put on "Chemicals of emerging concern" (CEC). Non-target data should be added to the database. Some of the participants brought up the prospect of storing full-scan MS chromatograms in the database to allow for future data analysis.

The need for interlaboratory studies (ILS) on target and non-target analyses of dust was identified and will be an important task for the WP on dust.

In the context of NORMAN's role as a link between science and policy, it was thought important for the WG to prioritise chemicals and to set up a NORMAN list of emerging substances in indoor air and dust. Whether the prioritisation should be based on occurrence/use and/or properties, and which properties, were discussed. Important aspects that were brought up were, for example, use pattern, bio-accessibility and bio-accumulation potential.

The role of wastewater treatment influents/effluents/sludge and their connection to the indoor environment was also discussed. It was proposed that WWTP data may be relevant for composing so-called suspect lists of priority substances indoors. Influents to WWTPs also represent an important pathway out of the indoor environment. It was agreed that WWTPs are not part of the indoor environment and should thus not be included (e.g. in the database) but that they can be considered for purposes mentioned above.

Finally, the importance of the links between policy and science in the field of the indoor environment was emphasised.

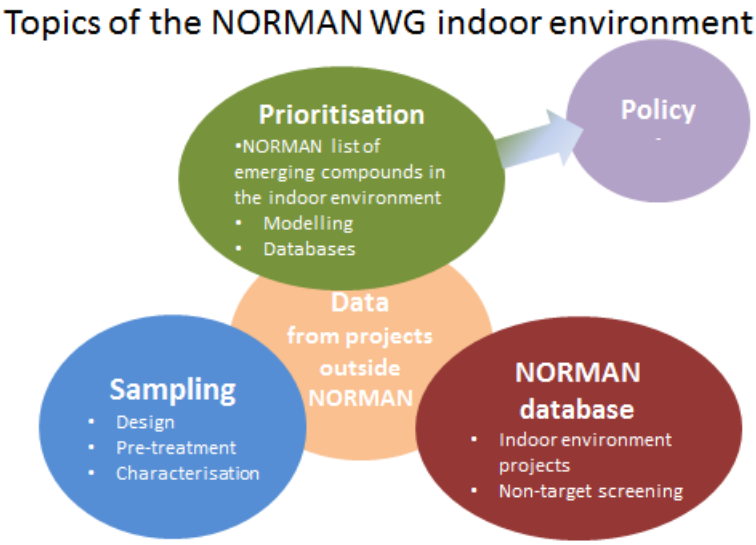
III.1.Activities and strategy of the WG

The NORMAN WG on the indoor environment will act as a key player in the research area of "Chemicals of Emerging Concern" (CECs) and the indoor environment and will be an important link between policy and science. It is therefore important that scientists as well as industry and stakeholders are involved in the WG.

Information on activities and results from the WG will be put on the NORMAN website, presented at NORMAN GA meetings and in reports e.g. from WG meetings. Workshops with invited speakers from different disciplines will be organised by the working group.

The activities identified for the working group and links between different topics are illustrated in the figure below and are summarised in the points below:

- Sampling: harmonisation of measurement methods for air and dust;
- Interlaboratory studies (ILS) on target and non-target analyses;
- NORMAN database: uploading data on emerging chemicals present indoors;
- Identification of emissions of emerging substances indoors e.g. from products and articles;
- Identification of important pathways of chemical exposure for humans indoors and pathways to the outdoor environment;
- Prioritisation: set up a NORMAN list of emerging substances in indoor air and dust;
- Policy issues: links between policy and science.



IV. DECISIONS AND EXCPECTED OUTCOMES 2105

- The Working Group on Emerging Substances in the Indoor Environment will be launched on the NORMAN website (responsible: Eva B-L, Valeria Dulio).

- The work on the NORMAN database will be initiated (Eva, Pim, Adrian and Jaroslav)
  - The need for metadata
  - Consider multiple purposes of the database (trends, comparisons, modelling and links to human health.

- Initiate work sampling protocols
  - Develop protocols for targeted analysis 2016 onwards
    - ILS according to protocols.

- There will be an Interlaboratory Study on Non-target Analysis in Dust (in connection with Interflab2)
  - Samples will be prepared/provided by Miriam Diamond/Lisa Melymuk
  - Samples will be analysed during autumn 2015
  - Evaluation during 2016.

- A workshop on the indoor environment will be organised by NILU
  - To target policy-makers, building industry etc.
  - Workshop to be held before the summer 2015 (preliminary date).

Annex I – List of participants

Names	Organisation	Country
Cynthia de Wit	ACES, SU	Sweden
Jaroslav Slobodnik	EI	Slovakia
Valeria Dulio	INERIS	France
Marc Durif	INERIS	France
Eva Brorström-Lundén	IVL	Sweden
Anna Palm Cousins	IVL	Sweden
Pim Leonards	IVM, VU	The Netherlands
Luisa Lucattini	IVM, VU	The Netherlands
Jana Weiss	IVM, VU	The Netherlands
Pernilla Bohlin Nizzetto	NILU	Norway
Jana Klanova	RECETOX	Czech Republic
Lisa Melymuk	RECETOX	Czech Republic
Adrian Covaci	University of Antwerp	Belgium
Peter Haglund	UmU	Sweden