ISES Europe Training Series

DoE 3: Exposure Modelling

Module 5: Validation & Evaluation, Advantages & Limitations, and Conclusions

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Hello and welcome to this Domain of Expertise number 3 on exposure modelling within the ISES Europe Training Series. Before I start, I need to show this legal notice with the fair-use disclaimer as well as the copyright notice.
This slide shows a complete overview of all the training videos provided on the ISES Europe website. As I mentioned, we are now in Domain of Expertise number 3 on exposure modelling, which consists of five different modules, and I hope you have already been able to watch modules 1 to 4, because we are now in module number 5. This module focuses on validation and evaluation of exposure models, the advantages and limitations of exposure models, and finally some overall conclusions.
My name is Wouter Fransmann. I work for TNO, a research organisation in the Netherlands, and together with Natalie von Goetz we provide these five modules in the exposure modelling training series. The series offers an introductory framework, meaning that some elements are simplified and we cannot cover all details and complexities. Hopefully, in the future, more in-depth training videos and lectures will become available.
The learning objective of this training series concerns exposure models: what exposure models are, how they relate to exposure measurements, and the different purposes for which they are used in various research areas. We aim to provide background knowledge on the scientific and technological principles of exposure modelling, to explain how exposure models fit into exposure assessment approaches, and to introduce different types of exposure models, including the tiered approach you have already seen in earlier modules. We also discuss exposure models for various exposure routes — inhalation, dermal, and ingestion — as well as general advantages and limitations of exposure models and other important aspects to consider when using them. We also refer to reading material that you can consult offline.

The content of this specific fifth module in the exposure modelling training series focuses on validation and evaluation of exposure models, their advantages and limitations, and a final summary of key take-home messages.

Model validation is essential and needs to be performed carefully. It can be divided roughly into accuracy on one hand and precision, or reliability, on the other. Accuracy provides insight into how close the model's exposure estimates are to the true exposure. Precision, in contrast, refers to the consistency of assessments or the ability of different assessors to reach the same conclusions. I would like to illustrate this using the three examples shown on the right side of this slide. The top example shows very good precision: all of the arrows land very close to each other, meaning all the exposure estimates are very similar. However, they are far away from the true situation — the centre of the board — meaning accuracy is poor. In the second, middle example, the arrows are much closer to the centre of the board, meaning accuracy is better, but they are more spread out, so precision is poorer than in the top example. And of course the preferred situation is the one in the bottom right, in which both precision — the arrows being close together — and accuracy — being close to the target — are high. In that case you have an unbiased situation.

A great deal of effort has been devoted to evaluating models that have been developed in the past. There are too many studies to cover here in detail, so please consult the available open-access papers, which you can freely access and explore if you want to dive deeper into these comparison and evaluation studies of different exposure models. And please keep in mind that any model that is developed, especially exposure models, is a simplification of the true situation. You always need to take into account that there is uncertainty in models, and that they can never give a perfectly accurate estimate of the true exposure.

A framework for regulatory acceptance of exposure models has been developed, called the TRAAC framework. In this abbreviation, the T stands for transparency, the R for reliability, the first A for accessibility, the second A for applicability, and the C for completeness. Each of these pillars relates to different elements that together determine the score for that pillar. Scores can be assigned for each parameter, and when you multiply all the scores together, you arrive at a final score for the model. This score gives an indication of the transparency, reliability, accessibility, applicability, and completeness of the exposure assessment model. If you want to know more about this framework, please consult the publication shown in the top right corner of the slide.

There are many advantages and also many limitations of exposure models. Advantages include that models are inexpensive and fast to use compared to conducting exposure measurement studies. Models can be applied across a very broad domain. They allow prioritisation of exposure assessments, which can help you direct your time and resources efficiently when dealing with many chemicals and many different situations in your company. Models can be used to estimate exposure prospectively for future scenarios; of course you cannot perform measurements for situations that do not yet exist. Models can also be used retrospectively for scenarios for which no data are available and for which measurements are no longer possible. They can be used when monitoring is not feasible — for example because environmental conditions are difficult, because no analytical method exists, or because there are simply too many scenarios to cover, as shown in the tiered

approach. Models can also assist when designing workplaces, for example by testing the effectiveness of different risk-management measures and seeing how they influence exposure.
However, there are also limitations. The uncertainty of model outcomes can be very large, and you need to take this into account. Models are simplifications of reality, so you should not treat model outcomes as representing the true exposure levels. Models also need to be updated when new processes and new substances appear, which means that continuous exposure measurements are needed to validate and recalibrate models.

Finally, the summary and the key take-home messages are as follows. As I just mentioned, exposure models cannot and should not replace the collection of good-quality exposure measurement data. Measurement data remain essential for monitoring new production processes, new substances, and understanding long-term trends in exposure. Validation measurements should cover a wide range of exposure scenarios and agents. The accuracy, precision, and reliability of models must be investigated carefully. Model performance varies between process activities and scenario conditions. This means that ongoing development, adjustment, and recalibration of exposure models with new measurement data are essential to ensure adequate characterisation and control of exposure to hazardous substances. Exposure model results may be affected by factors such as the professional experience and judgement of the user of the model and the information available about the scenario. Therefore, it is very important that all tool users receive comprehensive training in the use of the exposure model or tool, and that clear guidance is provided. And last but not least, exposure models and tools require robust and sustained funding and maintenance to ensure their long-term availability for everyone.

This was the final module in this exposure modelling domain of expertise. Please visit the ISES website for further training videos and additional details on specialised training materials. We thank you very much for joining module 5 in this series. We appreciate your participation and attention, and we encourage you to look at the other training videos on the ISES website and explore the further reading material if you wish.

