NanoFASE Deliverable D4.4

Catalogue of potential accidental releases and accidental release model

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Research Report Summary

A diversity of approaches is used in the NANOFASE WP4 to estimate mostly continuous emissions from the activities that compose the ENM life-cycle based on predictive models for release assessment. In this deliverable 4.4, qualitative and quantitative information on accidental releases is obtained that could be incorporated in models at various scales of analysis.

Literature and databases were analysed to identify the accidents that are known to have involved the release of ENM such as release of TiO2 and ZnO from road transport accident, release of up to 5t of carbon black from industrial plants, release of chemical precursors (TiCl4, SiCl4) transformed in contact with air into nanoparticles.

To be able to predict the types of events that could involve the release of ENM in industry, a generic risk analysis, was undertaken by starting with three well documented ENM manufacturing processes, TiO2, SiO2 and Carbon black, and followed by a more systematic approach, inspired by the ARAMIS methodology developed for SEVESO industries [6]. The process steps that are the most prone to major accidental releases are those that follow the generation of the ENM, mostly transformation (e.g. grinding), transport, storage and handling steps that are not specific to a given type of ENM but rather generic.

Hazardous properties that contribute to the hazard of a major release were listed. Dustiness was identified as a key property. Yet research and development are still needed for developing dustiness test and interpretation framework that fulfil the needs of accidental release risk analysis.

Most of the nanopowder related scenarios involve one of the following physical mechanisms: pressurised ENM laden jet, fall from height, lift by wind. The mechanism of pressurised ENM laden jet, was modelled by CFD at INERIS during the NANOFASE project in a framework of Hong Duc Le's PhD thesis. The CFD model takes in

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consideration the various physical phenomena that have an influence over agglomeration after the release. The literature on fall from height and lift by wind was also analysed. These two phenomena are rather complex and additional research work is needed to develop robust models for accidental release scenarios.

Concerning the estimation of likelihood, three different exploratory approaches are proposed. The first concerns releases from industrial plants and is based on exploitation of the E-PRTR database and use of proxies. At a global scale, the accidental releases represent only 0.1% of the total releases. But at single plant scale, in several cases, the amount released surpassed by far the total annual chronic releases. The second approach concerns road accidents. Based on this method accident probability can be allocated to a road segment in a release and fate model.

The last approach is inspired by methods developed in the nuclear industry to estimate the likelihood of major nuclear accidents and releases of radionuclides. A comprehensive literature review was undertaken to list all these methods and identify their limits. These methods were applied in the case of ENM releases on the basis of accident scenarios listed in the report. Preliminary results are presented in this report that confirm the low, yet non-negligible probability, of major ENM releases. This showed the feasibility of such an approach to derive probability distributions for major releases that can then serve as an input for release and fate models. So far, the very limited number of recorded events generates a very high uncertainty, which makes the use of the results questionable, but with time the relevance should increase, especially if efforts are made in the reporting of ENM accidental releases.

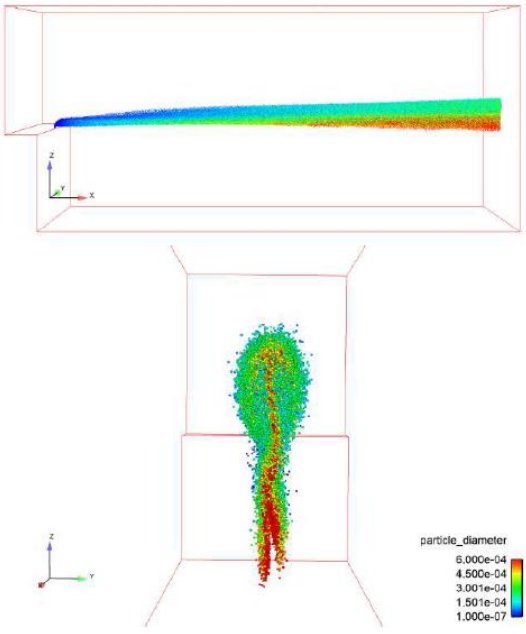

Figure 1: example of CFD simulation of a particle laden jet near the release source. Colours correspond to the size of agglomerates resulting from agglomeration processes in the near field (H.D. Le, PHD Thesis, INERIS, 2018)

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