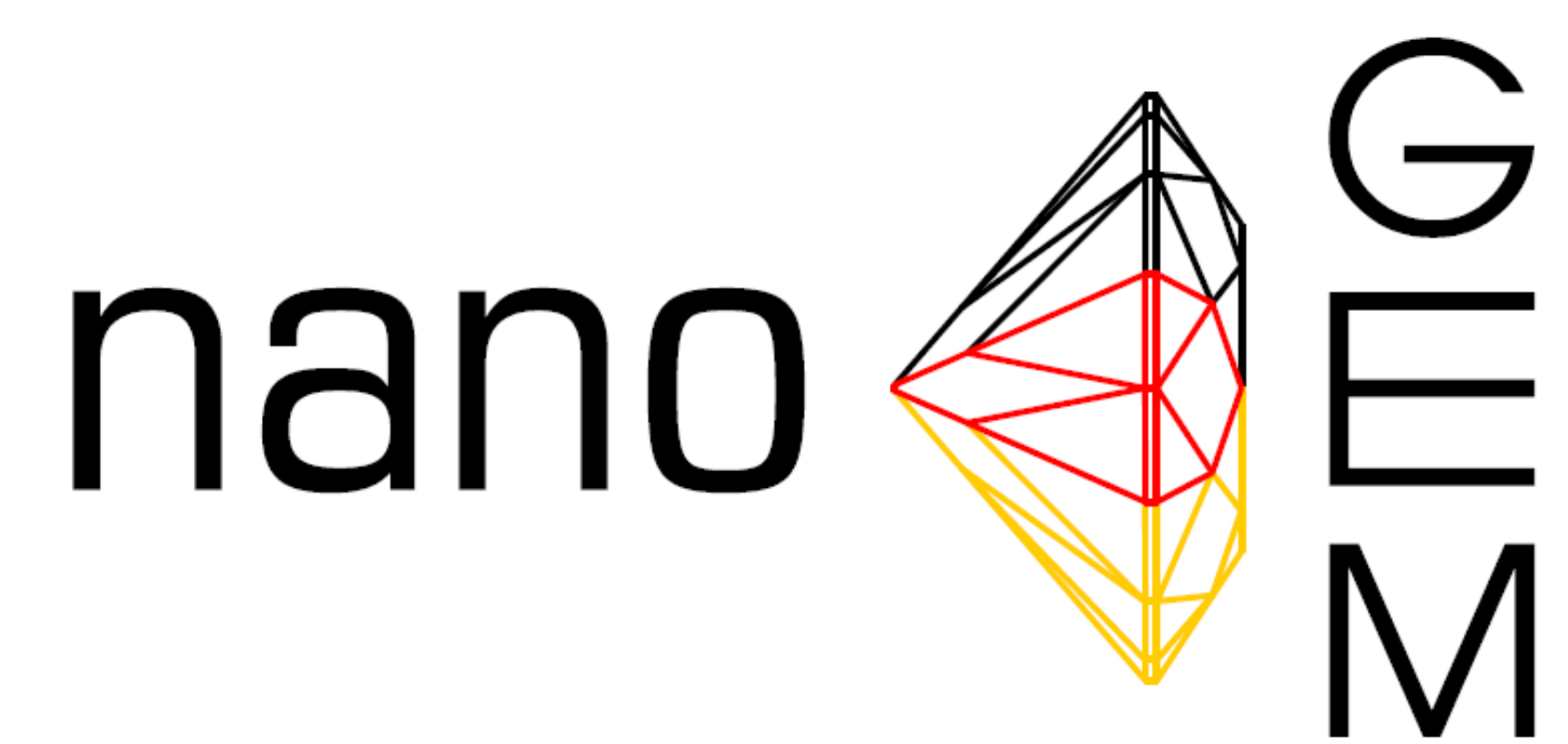


Assessment of exposure to airborne nanomaterials using a pragmatic, tiered approach



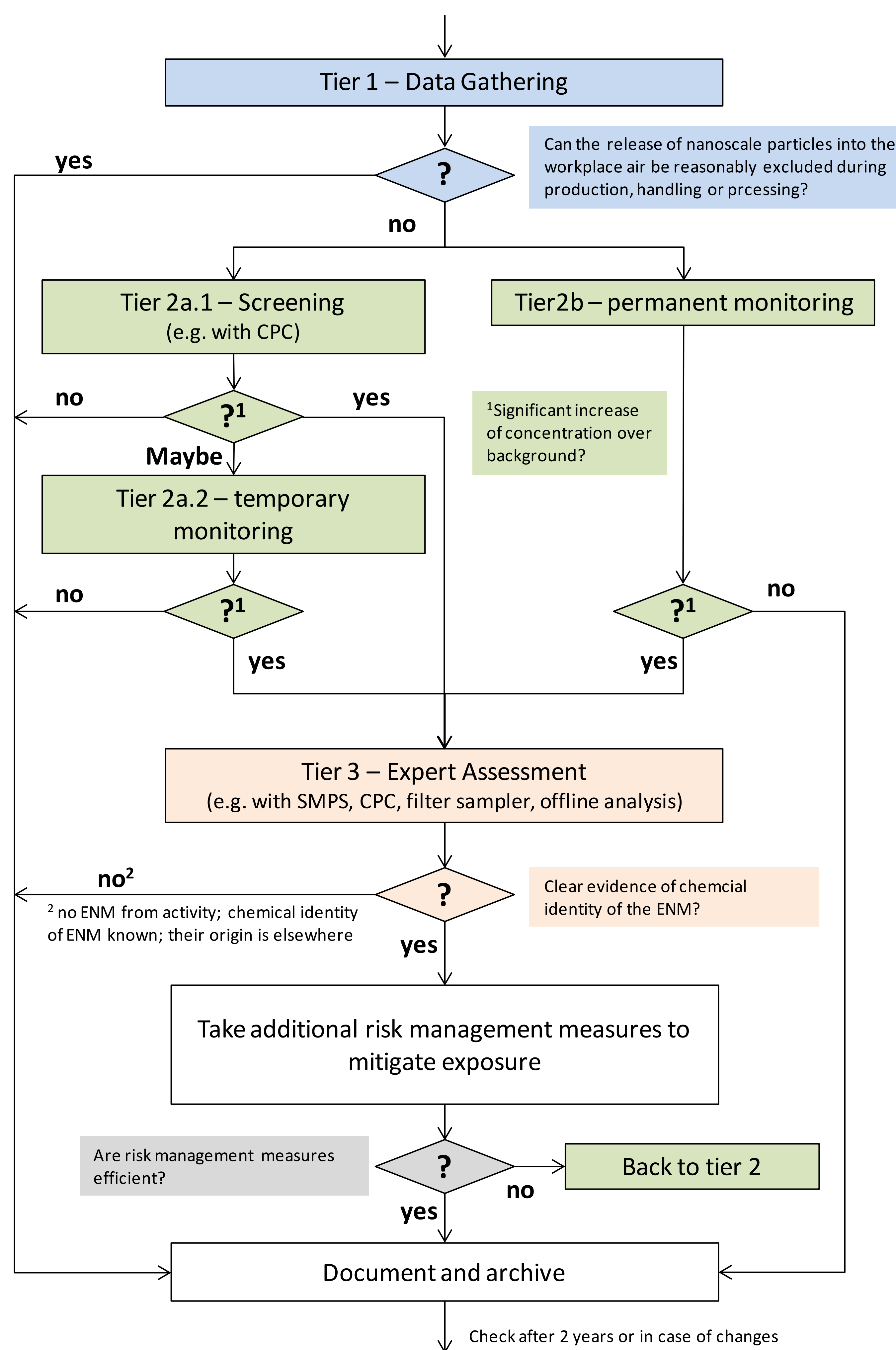
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Motivation and Introduction

- Exposure to airborne engineered nanomaterials (ENMs) has to be assessed in view of risk assessment
- Highest probability for exposure to airborne nanomaterials in workplaces where they are produced, handled or used
- Assessment of exposure specifically to nanomaterials requires their distinction from ubiquitous background particles
- Currently, no ENM specific measurement device exists
- Definitive differentiation can only be done by particle sampling and consecutive electron microscopic and/or chemical analysis, which is complicated and cumbersome
- A more pragmatic approach is required to simplify exposure assessment
- To feed data into (international) exposure databases, a harmonized approach for assessing and evaluating exposure data is required
 → standard operation procedures for pre-normative harmonization

The Tiered Approach



Tier 1

Data gathering on whether nanomaterials are being used in a particular workplace and if there is a chance that they are released. If release of and consequently exposure to nanomaterials cannot be excluded, Tier 2 is recommended.

Tier 2

Tier 2 foresees a simplified exposure assessment. This can be

- Screening (Tier 2a.1), i.e. checking of potential particle sources for increased particle concentrations by means of a portable nanoparticle concentration monitor (e.g. handheld CPC or diffusion charger; Asbach et al., *Ann. Occ. Hyg.* **56**: 606-621, 2012), or
- Monitoring, which is done by an exposure monitor (e.g. diffusion charger), either permanently (Tier 2b) or temporarily (Tier 2a.2) installed in a workplace. Tier 2a.2 may come into play to verify screening measurements without the need for extensive measurements (Tier 3)

Background concentration must either be measured or known from experience to judge whether the measured exposure concentration C_E is significantly above the background concentration C_B . This is the case if the net exposure concentration is larger than three times the standard deviation σ_B of the background measurement

$$C_{net, E} = C_E - C_B > 3 \cdot \sigma_B$$

If the net exposure concentration exceeds this threshold, an extensive exposure assessment following Tier 3 is recommended.

Tier 3

Exposure assessment according to Tier 3 is extensive and can include

- Particle number size distributions in micron and submicron size range
- Particle number and surface area concentrations
- Particle mass concentrations (respirable, inhalable, PM_{10} , etc.)
- Particle sampling onto substrates and/or filters for consecutive morphological and chemical analysis → definitive proof for presence or absence of ENMs
- Active measurement of background concentration
 - Simultaneously in a representative background location with a second set of equipment
 - Sequentially before and after work process with the same set of equipment

Standard Operation Procedures

Standard operation procedures (SOPs) have been written for all measurement steps in the tiered approach as well as for data evaluation and all measurement instrument used in routine by nanoGEM partners. The SOPs are freely available at:

http://www.nanogem.de/cms/nanogem/upload/Veroeffentlichungen/nanoGEM_SOPs_Tiered_Approach.pdf

Based on a suggestion by the German Chemical Industry Association VCI: <https://www.vci.de/Downloads/Tiered-Approach.pdf>

Conclusions and Outlook

- The presented tiered approach is pragmatic, because Tier 1 and Tier 2 provide rather simple means for estimating whether nanomaterials are released
- An extensive measurement campaign according to Tier 3 is only needed, if Tier 2 reveals a statistically significant increase over the background concentration
- Hence, the tiered approach greatly simplifies exposure assessment and helps saving time and money
- Standard operation procedures (SOPs) were written for all steps in the tiered approach and are freely available for use
- SOPs are currently under revision based on first field experiences
- The tiered approach will be used and further developed in various exposure assessment campaigns
- SOPs have been widely distributed to other national and international projects as well as international standardization (CEN) and harmonization activities (e.g. OECD, nano Safety Cluster)