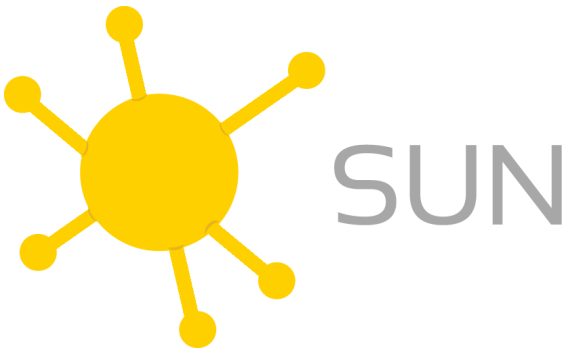

Deliverable report for

SUN

Sustainable Nanotechnologies

Grant Agreement Number 604305

Deliverable D 5.2

Templates and SUN data libraries for NOAA inhalation, dermal and dermal-to-oral exposure measurements, process-specific release potentials and exposure protection measures

Due date of deliverable: 31/01/2015

Actual submission date: 25/05/2015

Lead beneficiary for this deliverable: TNO

Dissemination Level:		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	X

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1. Description of task

SUN Task 5.6 entails the development and validation of a 3-step tiered approach framework for NOAA (Nano-Objects and their Aggregates and Agglomerates) occupational and consumer exposure assessment and management. Deliverable 5.1 presents the "Basic framework for the SUN qualitative to quantitative modeling-based assessment of consumer and worker inhalation, dermal and dermal-to-oral exposure to NOAA". D5.1 describes existing conceptual and established models for exposure assessment and concludes with a selection of models to be starting points for development of the 3-Tier route-specific modeling-based SUN exposure assessment framework and input requirements. D5.2 describes the data-libraries anticipated to support the model development and use of the 3-Tier SUN exposure assessment framework models. The principles of the SUN model-based exposure assessment framework and data libraries were already anticipated from the start of the SUN proposal. As depicted in Figure 1.1, data-libraries on consumer and occupational exposure data, respectively, were anticipated to support Tier-2 (semi-quantitative exposure assessment models) and for occupational exposure assessment, also Tier-3 (quantitative exposure assessment), whereas libraries on the protection efficiencies of engineered controls and personal protection equipment and source-strength (release and emission-rate) were anticipated for Tier 3 models. Based on the D5.1 review and now planned model development some of these libraries may be of use even in lower Tiers, at least to scale and exposure estimates, or to be used as direct exposure information for read-across.

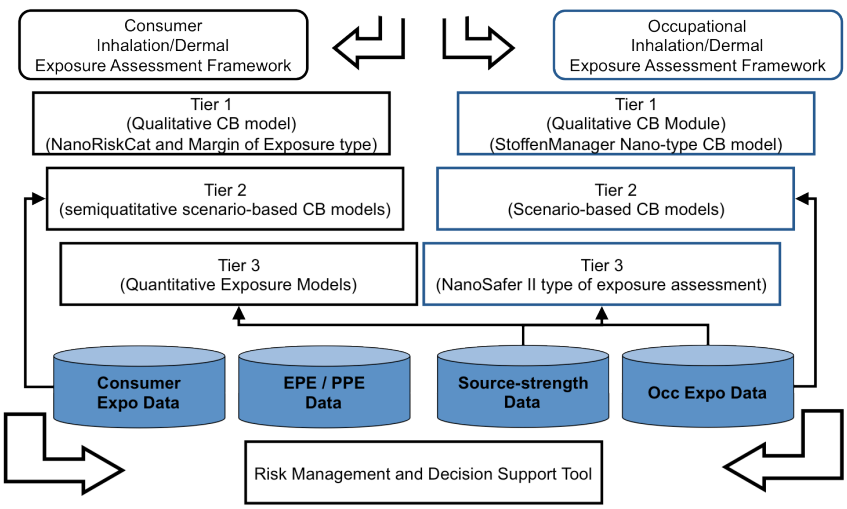


Figure **1.1**: The conceptual vision for the SUN exposure assessment framework consisting of three Tiers with "tools" for each exposure route and supporting data libraries for exposure assessment and risk management.

In this deliverable (D5.2), existing templates and libraries on NOAA consumer and occupational exposure and substance/activity-specific release rates for inhalation, dermal and dermal to oral exposure and exposure protection measures are summarized, and evaluated considering nanospecific information requirements. The focus is on existing data resources where it was evident that a library did not exist on consumer exposure and release from processes and use of NM or NM-based products. Data library formats suitable for the SUN exposure assessment framework models are identified and modified or developed to comply with the data requirements for D5.3.

The deliverable is completed with contributions from:
Task 5.1 Establish data-libraries on existing consumer and occupational exposure and substance/activity-specific release rates for inhalation, dermal and dermal to oral exposure. Participants: TNO (leader), IOM, DTU and NRCWE NFA.

Task 5.5 Establish and expand data-libraries on the protection efficiency of Engineering Controls (e.g. fume hoods, local exhaust ventilation) and PPE (e.g. masks, gloves) to NOAA in dust, powder and liquid matrix. Participants: TNO (leader), IOM and NRCWE NFA.

And feeds into:
Task 5.2 Expand the data-libraries on substance-specific dustiness data and specific airborne emission rates for key occupational and consumer use activities
Participants: BASF, NRCWE NFA (leader), TNO and DTU

Task 5.3 Expand the data-library on substance, product and article-specific dermal and dermal-to-oral contact exposure
Participants: IOM (leader), TNO, DTU and NRCWE NFA

Task 5.4 Complete occupational inhalation and dermal exposure measurements with high-level contextual information. Participants: TNO (leader) and NRCWE NFA

Task 5.5 Establish and expand data-libraries on the protection efficiency of Engineering Controls (e.g. fume hoods, local exhaust ventilation) and PPE (e.g., masks, gloves) to NOAA in dust, powder and liquid matrix. Participants: TNO (leader), IOM and NRCWE NFA

and the modeling-based exposure assessment framework:

Task 5.6 Develop and validate a 3-step tiered framework for NOAA occupational and consumer exposure assessment and management, including development of qualitative to quantitative dermal and dermal-to-oral exposure models, and a high-tier aerosol dynamic model. Participants: NRCWE NFA (leader), TNO, DTU, IOM and UNIVE

2. Description of work & main achievements

The aim of D5.2 is to deliver templates and SUN data libraries for data collection and to support exposure assessment using the SUN exposure assessment framework models. Existing templates and data libraries are described and evaluated. Three libraries were developed as part of the SUN project, or in parallel, with little current experience on potential missing parameters and applicability. Needed adjustments found for the existing templates and data libraries are reported and will be addressed in the future work for completion of tasks. The following templates and libraries are described and evaluated:

1. **Worker inhalation exposure**
   - ***Nano Exposure & Contextual Information Database (NECID):*** Database for collection of contextual information and exposure data collected in workplaces.
   - ***MARINA exposure scenario library***
2. **Dermal Exposure**
   - ***DeRmal Exposure Assessment Method (DREAM)***
3. **Oral exposure**
   - ***Database of dermal and oral transfer efficiencies***
4. **Release and source strength library**
   - **Dustiness library:** Library for the collection of information from dustiness measurements
   - **DTU Environment Database Library on Release from Consumer products:** Database including data regarding consumer exposure.
   - **Processes release library**: Library for collection of data and information from experiments on emission and release or measurements thereof.

5. **Consumer exposure**
   Nanodatabase: Database including data regarding consumer products.
6. **Exposure management**
   Exposure Control Efficacy Library (ECEL): Library including data regarding exposure control measures and their efficacy.

2.1 Worker inhalation exposure

Workers can be exposed to NOAA during work which can result in exposure through inhalation. At present, a database and a data library specifically addressing NOAA exposure are available:

- Nano Exposure & contextual Information Database (NECID)
- Marina exposure scenario library

2.1.1 Nano Exposure & Contextual Information Database (NECID)

For future research in studying exposure to manufactured nanoparticles, agglomerates and aggregates (NOAA), an occupational exposure database is needed. Developing such a database on an international level will enable and facilitate the future sharing of exposure data on NOAA. For this purpose, a *Partnership for European Research in Occupational Safety and Health* (PEROSH) group led by IFA and TNO developed the NECID database. It supports the user to fulfill the requirements on information gathering for occupational exposure assessment and provides a general overview of results of exposure measurements of nanomaterials in different exposure situations. The exposure data of different research institutes in different countries will be collected and stored in a harmonized way. Doing so, NECID will provide a sustainable source of information for risk management and the development of occupational exposure benchmark levels/limits.

The intended user group comprises research institutes and might be extended to third parties. In the project different user-specific rights and legal agreements for the handling and storage of data and the required IT security are addressed – as they play a critical role for a multinational database and the possibility of data sharing. Within NECID the user decides who will have access to the data.

NECID is specifically developed to collect NOAA exposure data. In short the following data can be included in NECID:

- *Measurement series information*: General information regarding study ID, measurement strategy, used NOAA, name of the measurement campaign, duration of the campaign.
- *Activity*: Description of the activity, duration, used NOAA, automation level, work pattern, exposure pattern, exposure situation.
- *Second source*: Type of secondary source, place of secondary source and distance to secondary source.
- *Premises*: General information on the premise where the measurement took place (e.g. type, confidentiality level, number of workers, number of unexposed workers, branch code, number of shifts per day).
- *Location*: Description of the workplace, location type, room size, level of housekeeping.
- *Risk management measures (RMM)*: Information regarding ventilation (efficiency, number of air changes, filter used, level of segregation, air velocity), local control (type of control, filter used, efficiency, volume flow, air velocity) and indoor conditions (relative humidity, air velocity, airflow direction, temperature, air pressure).
- *Worker:* Job code, level of training regarding use and storage of *Respiratory Protective equipment* (RPE), training regarding PPE, briefing on risks.
- *Exposure (Expos) and Personal Protective Equipment (PPE):* work start and end time, level of separation/personal enclosure, type of RPE used, use of other PPE, use of goggles, use of face shield, use of hearing protection, use of helmet, type of coverall, type of gloves.
- *Material and ingredients:* Confidentiality of the information, product information (e.g. purity of material, name, product form, density, BET, particle size, coating, doping, viscosity, dustiness), ingredient information (e.g. CAS number, concentration, molecular mass, BET, coating, doping)

- *Material use rate:* type of use (input or output of used material or handled amount), used amount.
- *Sample information, sample link and analytical results:* Sampling ID, sampling duration, device used, personal or static measurement, collection media, type of sample (e.g. field sample, blank), sampling situation, flowrate, use of preseperator, used dilution.
- *Sample link:* Information regarding distances between worker and measurement device, distance worker to measurement device, distance ventilation to measurement device, near field or far field measurement
- *Analytical results:* Information regarding the analytical results for the samples,
- *Import raw data:* Option to link raw data the measurement series.

The NECID database is suitable to collect contextual information and measurement data collected in workplaces. Also, in principle, contextual information and measurement data regarding measurements performed under experimental conditions can be included in NECID.

Before NECID can be used the program should be installed on a computer. The first step is to request an account at IFA. Then a username and password is provided that should be used to login at http://necid.ifa.dguv.de/. After login the user is able to download the program on the computer. NECID can be driven under the operating systems MS Windows XP, Windows 7 (32 and 64 bit),Windows 8, Windows Server 2003 – 2008 R2. A guide to install NECID on your computer is given on the NECID website: http://necid.ifa.dguv.de/User/ErsteSeite.aspx .

Further assessment of the NECID database will be performed to investigate how well situations where exposure to NM are measured may just be due to a single or few operations as part of a sequence of use of many other chemicals, particulate materials and powders, such as paint mixtures.

Reference: http://www.perosh.eu/development-of-a-nano-exposure-and-contextual-information-database-necid/

A template of the database can be found in appendix 1a.

2.1.2 MARINA exposure scenario library form

Exposure scenarios (ES), as described by ECHA, consist of "a set of information describing the conditions under which the risks associated with the identified use(s) of a substance can be controlled. Exposure Scenarios are used as a tool for exposure assessment quantification under REACH (Registration, Evaluation, Authorisation of Chemicals). The ES include operational conditions (for examples the duration and frequency of use or the amount used, the process temperature or the pH) and necessary risk management measures (e.g. local exhaust ventilation or a certain type of glove, waste water and gas treatment)." (ECHA, 2012b).
The information contained in the ES can be used in tier-1 control-banding types of risk assessment/management tools (e.g. Nanosafer, Stoffenmanger-nano) to either assist in scaling or demonstration of similar cases for risk management. However, ES can also be used to read-across. Read-across consist of using exposure data from analogous scenarios in a conclusion on release/exposure or risk assessment. To facilitate this process the ES have to be organised in a way so that they can be easily searched.

The FP7 project MARINA (Managing the Risks of Nanomaterials) has developed an ES library which contains a catalogue of ES and contributing exposure scenarios. In such a library the user can search for a scenario similar to that under investigation and read-across the exposure information. The ES includes information on the characteristics of the nanomaterials used, life cycle stage, process step, activity, room conditions and measures to control the exposure risk. All scenarios include measured data. However, the type of measurements (particle number, particle mass, surface area) and the size fraction measured might differ between the scenarios. The library also includes a description of the data quality (high, medium, low) for each scenario. The quality assessment has been done based on the completeness and the transparency of the

nformation provided. At the moment the library includes ES for occupational exposure of a series of NM such as carbon nanotubes, CeO_2, CrO_3, TiO_2, ZrO_2, nano-Ag, nano-Cu, nano-Fe. Most scenarios are for research/small scale operations.

Further information on the MARINA project can be obtained from: http://www.marina-fp7.eu/project/
A prototype of the library can be seen at http://marina.iom-world.co.uk/default.aspx

A template of the library can be found in appendix 1b.

2.2 Consumer Exposure

At present only one data library is available:

- The Nanodatabase: public library maintained by DTU Environment that contains information about nanoproducts available on the EU market.

2.2.1 The Nanodatabase

The Nanodatabase provides an inventory of nanoproducts on the European market claimed to be based on nanotechnology or which entail nanomaterials. The database is an initiative from the Danish Ecological Council, DTU Environment and the Danish Consumer Council. DTU Environment continuously adds new products to the database and users can also report products that they think should be added to the database. The library contains a risk categorization analysis with indication of the potential risk of NOAA exposure to consumers and professional end-users.

The Nanodatabase is publicly available at www.nanodb.dk and all the information in the database can be searched for and analyzed via the analysis section of the website.

A template of the database can be found in appendix 2.

2.3 Dermal exposure

n SUN, dermal exposure assessment is of particular interest in regard to inadvertent oral exposure. Consequently, procedures to assess dermal exposure are needed to define the sources for inadvertent exposure.

2.3.1 DeRmal Exposure Assessment Method (DREAM)

The DREAM is a questionnaire developed by TNO and the Institute of Risk Assessment Sciences (IRAS) as a method to semi-quantitatively evaluate dermal exposure to substances (van Wendel de Joode, 2004).

The questionnaire is not specifically designed for evaluating dermal exposure to NOAA, but is used for this purpose in a study performed by Van Duuren et al (2010).

Reference: An occupation DREAM. Development, evaluation, and application of a DeRmal Exposure Assessment Method. Berna van Wendel de Joode. ISBN 90-393-3833-7 2004

A template of the field form can be found in appendix 3.

References:

Duuren-Stuurman, B., Pelzer, J., Moehlmann, C., Berges, M., Bard, D., Wake, D., Mark, D., Jankowska, E. , Brouwer, D. (2010). A Structured Observational Method to Assess Dermal Exposure to Manufactured Nanoparticles. International Journal of Occupational and Environmental Health, 16(4), 399-405.

Van Wendel De Joode et al., 2003) Van Wendel de Joode B, Brouwer DH, Vermeulen R, Van Hemmen JJ, Heederik D, Kromhout H. DREAM: A method for semi-quantitative dermal exposure assessment. Ann Occup

Hyg. 2003;47:71-87.

Van Wendel De Joode et al., 2005a) Van Wendel de Joode B, Van Hemmen JJ, Meijster T, Major V, London L, Kromhout H. Reliability of a semi-quantitative method for dermal exposure assessment (DREAM). J Expo Anal Environ Epidemiol. 2005a;15:111-120.

Van Wendel De Joode et al., 2005b)Van Wendel de Joode B, Vermeulen R, Van Hemmen JJ, Fransman W, Kromhout H. Accuracy of a semiquantitative method for dermal exposure assessment (DREAM). Occup Environ Med. 2005b;62: 623-632.

2.4 Oral exposure

Ingestion exposure in the workplace can occur following consumption of food or beverages which contain or are contaminated with nanomaterials. In addition, inhaled aerosols which are deposited within the ciliated airways of the respiratory tract and are cleared up to the upper airways can be swallowed. Finally, inadvertent or ingestion exposure can occur when workers touch their mouths or the area surrounding the mouth (perioral region) with contaminated hands and/or objects. During such contact, the contaminant can be transferred from the hand and/or object directly into the mouth or to the perioral region and subsequently transferred to the mouth. The latter is defined here as inadvertent (occupational) ingestion exposure.

There are currently no standard methods to measure or estimate inadvertent ingestion. This is mainly due to the fact that this exposure route is considered relatively unimportant in occupational settings compared to inhalation and dermal exposure. However, it has been estimated that 16% of the UK working population may be exposed to inadvertent ingestion exposure (Cherrie et al. 2006).

ECHA in their document on Guidance of Chemical Safety Assessment (ECHA, 2012a) states that "to some extent, it may be controlled by straightforward good hygiene practices such as segregating working and eating facilities and adequate washing prior to eating"…." Exposure through ingestion is therefore generally not considered further in the assessment of workplace exposure." The document recommends the use of ConsExpo or biomonitoring to assess ingestion exposure. However, ConsExpo only deals with exposure through direct and deliberate consumption of products or through the mouthing of products by children. It does not cover inadvertent ingestion exposure in the workplace through transfer of contaminants to the oral region. Results from biomonitoring can only be used to estimate inadvertent ingestion exposure in the absence of other pathways and routes of exposure. Otherwise it requires estimation of the inhalation and dermal exposure.

The main pathway of ingestion exposure is hand-to-mouth contact, and therefore inadvertent exposure is closely linked to dermal exposure. Hand contamination arises from transfer when touching contaminated surfaces/objects, deposition from air concentrations and direct emission (e.g. immersion, splashing). Therefore transfer efficiencies from surfaces and objects to the hands and from the hands to the mouth are important for dermal and ingestion exposure. Gorman Ng et al. (2012) developed a database of transfer efficiencies relevant for dermal and inadvertent exposure ingestion.

Gorman Ng et al. (2013) developed a screening exposure assessment tool[1]: IEAT (Ingestion Exposure Assessment Tool) that estimates the hand/object loading from the contextual information provided by the worker and uses this information to estimate the inadvertent exposure. Transfer efficiencies are obtained from a database developed by Gorman Ng et al. (2013).

2.4.1 Database of dermal and oral transfer efficiencies

The Ingestion Exposure Assessment Tool (IEAT) is a predictive exposure assessment tool that can be used to

[1] http://www.iom-world.org/research/research-expertise/exposure-assessment/ingestion-exposure-assessment-tool/

estimate occupational inadvertent ingestion exposure to liquids and solids over a full work shift. Inadvertent ngestion exposure can occur when workers touch their mouths with contaminated hands or objects while vorking.

EAT is not specifically developed for ingestion exposure to nanoparticles. The transfer efficiencies and assumptions regarding surface loading refer to conventional powders and liquid dispersions. The workers' profiles were defined from observations on general working environments and do not include observations on settings dealing specifically with nanomaterials. Transfer efficiencies describe the proportion of material that moves from one surface to another following contact. Transfer efficiencies from surfaces to the skin are of nterest when estimating dermal exposure from contact with contaminated surfaces. Similarly, transfer efficiencies between the hands, gloves, objects and the mouth and perioral area (the area surrounding the mouth) are useful to help estimate exposure by inadvertent ingestion).

The database developed by Gorman Ng (2012) includes data on 534 empirically measured transfer efficiencies reported in the peer-reviewed and grey literature of powders, liquids, solids in solutions, and biological organisms (bacteria and viruses) from the following pathways:

- Surface to hand
- Surface to glove
- Surface to clothing
- Hand to mouth
- Hand to peri-oral area -Oral to perioral
- Object to mouth
- Object to peri-oral area
- Glove to peri-oral area

The database does not include specific transfer efficiencies for nanopowders or nanoparticle dispersions. The transfer efficiencies for the powders contained in the database are classified according to the particle size as < 50 µm, 50-150 µm and > 150 µm.

The database can be downloaded from the link below:

http://www.iom-world.org/research/research-expertise/exposure-assessment/dermal-and-inadvertent-ngestion-exposure/

The template with the transfer efficiency factors in the database search function of the library can be found in appendix 4.

The Ingestion Exposure Assessment Tool (IEAT) is a predictive exposure assessment tool that can be used to estimate occupational inadvertent ingestion exposure to liquids, and solids over a full work shift. Inadvertent ngestion exposure can occur when workers touch their mouths with contaminated hands or objects while vorking. The transfer efficiencies and assumptions regarding surface loading as described above are used in the IEAT model. The workers' profiles were defined from observations in general working environments and do not include observations in settings dealing specifically with nanomaterials.

References:

Cherrie JW, Semple S, Christopher Y, Saleem A, Hughson GW, Philips A. How Important is Inadvertent Ingestion of Hazardous Substances at Work? Ann. Occup. Hyg., (2006) Vol. 50, No. 7, pp. 693–704

ECHA (2012a) Guidance on information requirements and chemical safety assessment chapter R.14: Occupational exposure estimation. European Chemicals Agency.

Gorman Ng M, Semple S, Cherrie JW, Christopher Y, Northage C, Tielemans E, Veroughstraete V. van Tongeren M. (2012). The Relationship Between Inadvertent Ingestion and Dermal Exposure Pathways: A New Integrated Conceptual Model and a Database of Dermal and Oral Transfer Efficiencies. Ann Occup Hyg 2013; 56:1000-1012.

Gorman Ng M, de Poot S, Schmid K, Cowie H, Semple S , Van Tongeren M. Properties of Liquids and Dusts: How do they influence dermal loading during immersion, deposition and surdface contact exposure pathways? *Ann Occ Hyg* (2013) Vol 57 No 5 627-639

nadvertent ingestion exposure in the workplace. Prepared by the Institute for Occupational Medicine for the Health and Safety Executive 2007. Research report RR551

2.5 Source-strength; release and emission libraries

Until now there have been no libraries or data-bases available with a systematic format for collation of data describing release or emissions of NOAA from NOAA, NOOA-based products and processes.

2.5.1 Dustiness library

A draft template for collation of dustiness data has been produced in a collaboration effort between the SUN project and the CEN Mandate M461 "DUSTINANO" project where four different dustiness test methods are under standardization. The potential CEN dustiness testing methods include a modification of the EN15051-1 rotating drum dustiness tester first described by BOHS (1985), a modification of the EN15051-2 continuous drop method (described in Dahman and Monz, 2011), the small rotating drum (Schneider and Jensen, 2008), and the Vortex shaker (Ogura et al., 2009; Ku et al., 2013). The fundamental difference between the nanospecific dustiness data and the data produced following the EN15051 standard is that the new standard will require quantification (Witschger et al., 2014) of the:

- mass-based respirable dustiness index
- number of particles generated per mass
- dustiness kinetics (the particle generation rate)
- airborne particle size-distributions

n EN15051 one should only report the gravimetric inhalable, thoracic and respirable dustiness indices. Reporting of data from all four nano-specific methods are required and considered in the template. However, as a start, the NRCWE has prepared a draft data-library with mass-based respirable and inhalable dustiness data on a total of 136 different pigment and nanomaterial powders determined using the small rotating drum respirable. The results are plotted in Figure 2.1 and illustrate an enormous dynamic range in pigment and nanomaterial powders' dustiness indices. Noteworthy, the dustiness indices exceed the upper range of dustiness to an extent that a new dustiness class should be considered. This library needs completion in accordance with the DUSTINANO/SUN dustiness library.

A template for the dustiness library data can be found in appendix 5

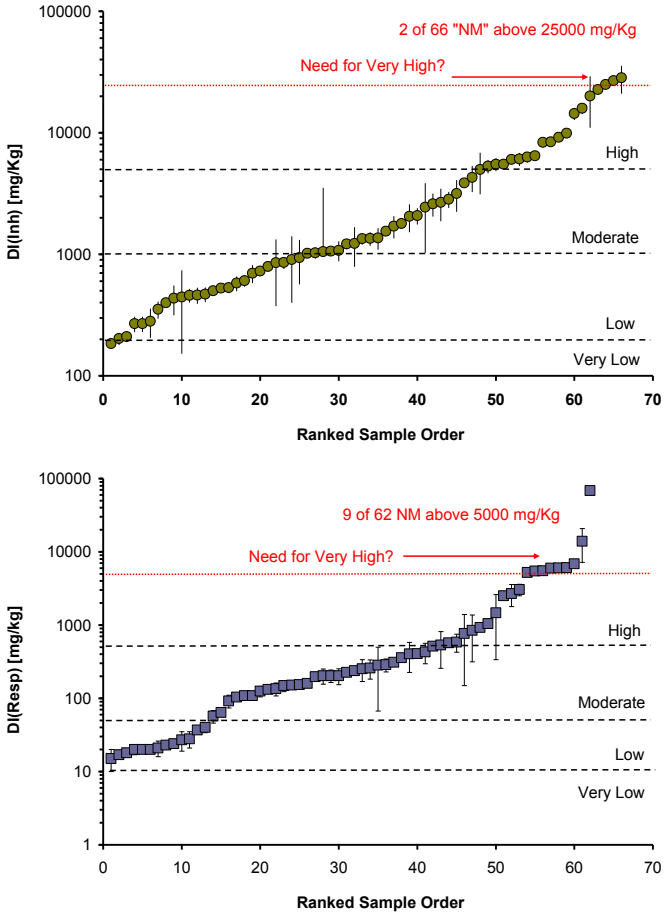


Figure 2.1. Ranked order of inhalable and respirable dustiness indices of almost 70 results above the minimum detection limit using the downscaled EN15051 rotating drum. The dustiness indices for the dustiest materials exceed the border to the high dustiness indices by a factor greater than 5, which suggests the need for an additional dustiness index.

References:

BOHS. Dustiness Estimation Methods for Dry Materials: Part 1, Their Uses and Standardization; Part 2, Towards a Standard Method. Leeds, UK: British Occupational Hygiene Society Technology Committee, Working Group on Dustiness Estimation; 1985. Report No.: 4.

Dahmann D, Monz C. Determination of dustiness of nanostructured materials. Gefahrstoffe - Reinhaltung der Luft 2011;71(11/12):481-7.

Ku BK, Deye G, Turkevich LA. Characterization of a Vortex Shaking Method for Aerosolizing Fibers. Aerosol Science and Technology 2013 Aug 27;47(12):1293-301.

Ogura I, Sakurai H, Gamo M. Dustiness testing of engineered nanomaterials. Journal of Physics: Conference Series 2009;170(012003):1-4.

Schneider T, Jensen KA. Combined single-drop and rotating drum dustiness test of fine to nanosize powders using a small drum. Annals of Occupational Hygiene 2008;52(1):23-34.

Witschger O, Jensen KA, Brouwer DH, Tuinman I, Jankowska E, Dahmann D, et al. DUSTINANO: a CEN pre-normative research project to harmonize dustiness methods for manufactured nanomaterial powders. Abstracts ed. 2014. p. T230A09.

2.5.2 DTU Environment Database Library on Release from Consumer products

A library has been developed at DTU on the NOAA release data from consumer products available from the scientific literature as part of the SUN project. The DTU Environment Database Library on Release from Consumer products contains information on:

- *Product:* identification of the nanomaterial(s), product name, product type, Product or Article Category according to REACH (PC1: Adhesives, sealants and PC35: Washing and cleaning products);
- *Experimental setup*: total content in product, results and information on release, techniques used for characterization of nanomaterials both in product matrix and in the released form.

For studies that provide enough information and data, the library furthermore describes potential exposure scenarios and provides exposure estimates according to REACH R.16 using the Tier 1 equations for consumer exposure estimation and Tier 1 tools, i.e. ECETOX TRA and ConsExpo.

The database has a number of limitations. First, the information and data provided in the database is until now based on scientific publications only which means that there might be relevant information and data available that has not been peer-reviewed and published in ISI-journals. Second, the information and data provided by each of the studies in the database rarely contain all the information entries that one could hope for, which hampers the overall usability of the study and the database to complete exposure assessments.

The DTU Environment Database Library on Release from Consumer products is not publically available, but is updated continuously and will be made available online within a short time via www.nanodb.dk .

A template of the database can be found in appendix 6.

2.5.3 PROCess RElease/EMission library (PROC-REM)

Beyond release as dust from handling of powder materials, NOAA may be liberated during, e.g., spraying and mechanical treatment of NM-enabled products and materials. Exposure to NOAA or NOAA embedded in dust during this type of work or consumer activity may also be estimated by exposure modeling. Therefore, as planned in Task 5.2, there is a need to develop a library of information that can collate existing and emerging release and emission rate data, as well as release characteristics, in a structured manner to enable direct application in exposure assessment models. However, the existence of such a data library is not known to us. Therefore, the aim of this task is to establish the draft template and first data for such a data library.

The template fro PROC-REM can be found in appendix 7 and the information requirements identified in this template is based on the output of D5.1.

2.6 *Exposure management*

2.6.1 Exposure Control Efficacy Library (ECEL)

The identification and implementation of measures to control chemical exposure in the workplace, in addition to the appropriate conditions of use, are essential for health risk management. For this purpose, Risk Management Measures (RMM) are deliberate measures with the intention to reduce chemical exposure. The Exposure Control Efficacy Library (ECEL) is a database with information on the effectiveness of different types of Risk Management Measures (RMM).

RMM effectiveness data were retrieved from the ECEL database and analyzed in 2008 (Fransman et al, 2008). Since then the ECEL database was reviewed and updated and launched as an online web-tool in December 2012. The ECEL version 1.0 contains data on the effectiveness of RMM to control inhalation (personal) exposures to airborne contaminants. It focuses on RMMs of a technical nature like suppression techniques, enclosures, (general) ventilation systems, vapour recovery systems and glove boxes. ECEL only contains data where it was possible to derive a quantitative estimate of the effectiveness of a given RMM during a specific workplace scenario. Presently, information from 67 references are available with a total of 414 entries on RMM efficiencies. For each entry in the database an ECEL card or factsheet is presented with a brief outline of the

workplace scenario and the effectiveness of the investigated RMM. This provides the ECEL user with useful information regarding RMMs, their potential effectiveness and important contextual information to make informed decisions.

ECEL version 1.0 only contains information regarding RMM to control inhalation (personal) exposures to non NOAA. Changes needed to include NOAA data in ECEL are described in appendix 6. Various structural changes in ECEL are required to ensure that the effectiveness of various nano-specific control measures can also be entered. It is important to note that only the most important variables should be entered in order to keep the database as simple as possible. However, sufficient contextual information is required to extract useful information for modeling purposes.

The ECEL database is, after a login procedure, freely available to all users via http://www.ecellibrary.com/. The library allows the user to search on various items (e.g. industry, RMM, product) to retrieve relevant information on the effectiveness of different RMM. Please note that every RMM is context-specific, and that the users of ECEL should apply their own discretion as the information presented here is intended for informative purposes only.
After login the user is provided with more background information about the selection criteria, the content of the database and the estimation of the efficiency of the RMMs.

Changes for ECEL are described in appendix8.

Reference:
Fransman W., Schinkel J., Meijster T., van Hemmen J., Tielemans E., Goede H. (2008) Development and Evaluation of an Exposure Control Efficacy Library (ECEL). Ann Occ. Hygiene 52 (7): 567-575.

Deviations from the Workplan

The deliverable was delayed due to, a.o., technical coordination issues between D5.1 and D5.2. It was decided to complete D5.1 before completion of D5.2. No deviations were made in the scientific content that will affect any other user.

Performance of the partners

All partners fulfilled their tasks in satisfactory time and quality. Due to the delay in D5.1, also D5.2 was delayed as these deliverables strongly relate to each other.

Conclusions

The Full Assembly deems this deliverable to be fulfilled satisfactory/not satisfactory.
In the latter case, please make a statement about the state of affairs regarding impact of failure, and contingency plan.

Appendix 1a. Template 'Nano Exposure & Contextual Information Database (NECID)'

Institute performing the measurements	
nstruction; - Desk Module. - This information is filled in during the preparation of the measurements. This table needs to be filled in for each institute performing measurements within the same measurement series.	
nternal code for the whole measurement series	
Name of the institute performing measurements	
Address + country of institute Contact person + contact details	
Name of fieldworker(s)	
Remarks on institute	

Measurement series	
nstruction; - Desk Module. - This information is filled in at the start of a measurement campaign	
Free text field for an internal code reference for the whole measurement series	

Measurement ID	
Study ID	
Project Name	
Project number	
Measurement strategy	File load up for additional documents or important information for measurement strategy.
Measurement of interest (3 options possible and a free text field)	☐ Fullerenes (C60) ☐ Single-walled carbon nanotubes (SWCNTs) ☐ Multi-walled carbon nanotubes (MWCNTs) ☐ Silver nanoparticles ☐ Iron nanoparticles ☐ Titanium dioxide ☐ Aluminium oxide ☐ Cerium oxide ☐ Zinc oxide ☐ Silicon dioxide ☐ Dendrimers ☐ Nanoclays ☐ Gold nanoparticles ☐ Mixture of nanoparticles ☐ Others,……..
Measurement campaign name	
Date start Measurement campaign	___:___:_____ (mm:dd:yyyy)
Date end Measurement campaign	___:___:_____ (mm:dd:yyyy)
nformation for measurement	File load up for additional documents or important information for

	measurement interpretation.
Regulation use who is allowed to publish	☐ free for publication to all ☐ free for publication to all project partner ☐ access for all project partner from date ___:___:____ (mm:dd:yyyy) ☐ access to data only after authorization by the owner institute ☐ denied, only for owner institute ☐ denied, in progress ☐ denied, no valid data ☐ no upload, local storage only

Activity Information	
Instruction; - Practical Module. - This module is filled in at the measurement location for each activity measured.	
Internal code for the whole measurement series	
Kind of activity	☐ Activity with manufactured nanoparticles (MNP) ☐ No activity with MNP
Free description of the activity and factors that influence the exposure by performing the activity	
Duration of the activity measurement (*ensure that clock time is equal to time reported on the equipment*)	Start: __:__:__ Date: __ :__:__ End: __:__:__ Date: __ :__:__
Activity duration in shift	_____ h

Description of the use of MNM during the activity	☐ none ☐ Commercial production of MNP ☐ Non-commercial production of MNP ☐ Commercial downstream use of MNP ☐ Non-commercial downstream use of MNP
Complete Activity code of the activity class and subclass, which indicates the main activity	 ACTIVITY_CLASS.pdf Choose code from pdf-file
Agitation of the product during the activity	☐ High ☐ Median ☐ Low
Source domain of the activity which describes the main exposure mechanism	☐ Point source or fugitive emission during the production phase (synthesis) ☐ Handling and transfer of bulk manufactured nanomaterial powders ☐ Dispersion of intermediates or application of ready-to-use products ☐ Activities resulting in fracturing/abrasion of manufactured NP-enabled end products
Distance of worker to the source	__ meter
Description of the pattern of work	☐ Continuous ☐ Discontinuous irregular ☐ Discontinuous regular ☐ Only manual
Level of automation of the activity	☐ Remote working ☐ Manual with restrictions ☐ Automatic ☐ Manual without restrictions ☐ Semi-automatic
Process temperature	_____˚C / _____ ˚K
Exposure pattern	☐ Continuous ☐ Intermittent ☐ Occasional

Exposure situation	☐ None ☐ Normal ☐ Post positive ☐ Intended exposure ☐ Worst case ☐ Malfunction/incidence ☐ Testing facility
Specific Activity information- Transfer *(e.g. Bagging, Dumping, Filling, Vacuum transfer, Pouring, Filling, Refueling, Loading)*	
Drop height	_____m
Description of the loading type	☐ Splash loading ☐ Submerged loading
Specific Activity information – Spraying *(e.g. Powder coating, Spraying of concrete, Spray painting)*	
Spray technique	☐ Air pressurized spraying ☐ Airless or air-assisted airless spraying ☐ Techniques with (very) good transfer efficiencies
Spray direction / orientation	☐ Downward spraying ☐ Level spraying ☐ Upwards spraying
Indication of blasting technique	☐ Wet ☐ Dry
Remarks on activity	

Secondary sources	
nstruction; - Practical Module - This information is filled in for each secondary source at the measurement location.	
nternal code for the whole measurement series	
Secondary source type	☐ Machine ☐ Worker ☐ Electro motor (drill machine,..) ☐ Diesel engine (fork lifter, truck,..) ☐ Gas engine (fork lifter, generator,…) ☐ Sprays (spraying, high pressure cleaner, atomize, humidifier,…) ☐ Condensate (solvents,…) ☐ Heater (radiant heater,…) ☐ Metal processing (welding, grinding,….) ☐ Open flame processes ☐ Other hot processes (plastic welding, foil shrinking, hot air gun,…) ☐ Other activity at the same time with ENM ☐ Other activity at the same time without ENM
Place of the secondary source	☐ Inside the workroom ☐ Outside the workroom ☐ Outdoor
Distance source to the inlet of the sampling device	__ meter
Second work pattern	☐ Continuous ☐ Discontinuous irregular ☐ Discontinuous regular ☐ Only manual

Remarks to secondary source	

Premise		
Instruction; - Desk Module. - This information is filled in during the preparation of the measurements. This table needs to be filled in for each premise where the measurements take place within the same measurement series.		
Internal code for the whole measurement series		
Name of premise		
Premise ID		
Confidentiality regarding company information	☐ Available for NECID ☐ Confidential	
Acronym		
Address + country of premise		
Name of department where the measurements take place		
Number of workers:	on the premise	
	which are exposed to nanomaterials	

Branch-code (NACE 2 code)	 NACE2.pdf Choose code from pdf-file
Number of shifts on one working day	
Duration of shift (hours)	
In-depth description of measured manufacturing process where the measurements take place	
Remarks on premise	

Time integrated/offline measurement devices						
	Instruction; - Desk Module. - This information is filled in during the preparation of the measurements. This table needs to be filled in for each measurement device measurement series					
Internal code for the whole measurement series						
Model type e.g.: (1) Impactor (2) Diffusion battery (3) Impactor + Diffusion battery (4) Respirable sampler	(5) Thoracic sampler (6) Inhalable sampler (7) PMx (8) Electrostatic precipitator (9) Thermal precipitator	**Model name e.g.:** (1.1) Dekati LPI (1.2) Berner LPI (1.3) NanoMoudi Model xx	(3.1) WRASS Naneum (4.1) Dorr-Oliver cyclone (6.1) 37-mm cassette (8.1) NAS TSI		**Serial number of device**	**Internal**
Device 1						
Device 2						
Device 3						

Device 4				
Device 5				
Remarks upon offline measurement device				

Sample information (offline measurements)				
Instruction; - Practical mode - This information is filled in during the measurements. This table needs to be filled in for each taken sample within the same measurement series				
Internal code for the whole measurement series				
Measurement date	___:___:_____ (mm:dd:yyyy)			
Measure point name				
Fieldworker(s)				
Remarks to the sampling strategy				
Air velocity at the measuring point	_____m/s			
Time integrated/offline measurement device used				
Device name + serial number:	**Classification of the sample:**	**Time of the sample (hh:mm:ss):**		**Settings:**
Device 1	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal	Start: __:__:__ End: __:__:__	Sampling specification ☐ Personal ☐ Static	Sample time interval= ___sec Flow rate = ___ L/min Dilution ___

	☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Sampling situation ☐ Random ☐ Representative ☐ Compliance	Shift/task based ☐ Shift ☐ Task	Preseperator used ___ Sample carrier_____ Collection media ____(Code from pdf-file) Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m
Device 2	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal ☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Start: __:__:__ End: __:__:__ Sampling situation ☐ Random ☐ Representative ☐ Compliance	Sampling specification ☐ Personal ☐ Static Shift/task based ☐ Shift ☐ Task	Sample time interval = ___sec Flow rate = ___ L/min Dilution ___ Preseperator used ___ Sample carrier_____ Collection media ____(Code from pdf-file) Distance of: -sample to the source ___m -worker to measurement device m

				-ventilation to measurement device m
Device 3	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal ☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Start: __:__:__ End: __:__:__ Sampling situation ☐ Random ☐ Representative ☐ Compliance	Sampling specification ☐ Personal ☐ Static Shift/task based ☐ Shift ☐ Task	Sample time interval= ___sec Flow rate = ___ L/min Dilution ___ Preseperator used ___ Sample carrier_____ Collection media ___(Code from pdf-file) Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m
Device 4	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal ☐ Activity, Static, distance to source __m ☐ Field sample	Start: __:__:__ End: __:__:__ Sampling situation ☐ Random ☐ Representative	Sampling specification ☐ Personal ☐ Static Shift/task based ☐ Shift	Sample time interval= ___sec Flow rate =___ L/min Dilution ___ Preseperator used ___ Sample carrier_____ Collection media ____(Code from pdf-

	☐ Bulk sample ☐ Field blank ☐ Labor blank	☐ Compliance	☐ Task	file) Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m
				COLLECTION_MEDIA_1.pdf
Remarks on the sample				

Time resolved/online measurement device				
	Instruction; - Desk Module. - This information is filled in during the preparation of the measurements. This table needs to be filled in for each measurement device used during the measurement series			
Internal code for the whole measurement series				
Model type e.g.: (1) SMPS (2) FMPS (3) APS (4) ELPI (5) OPS (6) LAS (7) CPC (8) Diffusion charger (9) Microbalance	**Model name e.g. :** (1.1) SMPS + C Grimm (1.2) SMPS TSI (2.1) FMPS TSI (4.1) ELPI Dekati (4.2) ELPI+ Dekati (5.1) Grimm 1109 (7.1) Grimm 5.403 (8.1) NSAM TSI (8.2) AeroTrack (8.3) LQ1-DC (8.4) NanoTracer (8.5) DiscMini (9.1) TEOM (9.2) TEOM Personal Monitor		**Serial number of device**	**Internal name/marking**
Device 1				

Device 2				
Device 3				
Device 4				
Device 5				
Remarks on offline measurement device				

Sample information (online measurements)				
Instruction; - Practical mode - This information is filled in during the measurements. This table needs to be filled in for each taken sample within the same measurement series				
Internal code for the whole measurement series				
Measurement date	___:___:_____ (mm:dd:yyyy)			
Measure point name				
Fieldworker(s)				
Remarks to the sampling strategy				
Air velocity at the measuring point	_____m/s			
Time resolved/online measurement devices used				
Device name + serial number:	**Function of the point of the sample for the main activity:**	**Time of the sample (hh:mm:ss) and sampling information:**		**Settings:**
Device 1	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal	Start: __:__:__ End: __:__:__	Sampling specification ☐ Personal ☐ Static	Sample time interval interval= ___sec Flow rate = ___ L/min Dilution ___

	☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Sampling situation ☐ Random ☐ Representative ☐ Compliance	Shift/task based ☐ Shift ☐ Task	Preseperator used ___ Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m
Device 2	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal ☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Start: __:__:__ End: __:__:__ Sampling situation ☐ Random ☐ Representative ☐ Compliance	Sampling specification ☐ Personal ☐ Static Shift/task based ☐ Shift ☐ Task	Sample time interval interval = ___sec Flow rate = ___ L/min Dilution ___ Preseperator used ___ Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m
Device 3	☐ Background, Near field approach ☐ Background, Far field approach	Start: __:__:__ End: __:__:__	Sampling specification ☐ Personal	Sample time interval interval= ___sec Flow rate = ___ L/min

	☐ Activity, Personal ☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Sampling situation ☐ Random ☐ Representative ☐ Compliance	☐ Static Shift/task based ☐ Shift ☐ Task	Dilution ___ Preseperator used ___ Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m
Device 4	☐ Background, Near field approach ☐ Background, Far field approach ☐ Activity, Personal ☐ Activity, Static, distance to source __m ☐ Field sample ☐ Bulk sample ☐ Field blank ☐ Labor blank	Start: __:__:__ End: __:__:__ Sampling situation ☐ Random ☐ Representative ☐ Compliance	Sampling specification ☐ Personal ☐ Static Shift/task based ☐ Shift ☐ Task	Sample time interval interval= ___sec Flow rate = ___ L/min Dilution ___ Preseperator used ___ Distance of: -sample to the source ___m -worker to measurement device m -ventilation to measurement device m

Location		
Instruction; - Practical mode - This information is filled in during the measurements. This table needs to be filled in for each location in which the measurements take place within the same measurement series.		
Internal code for the whole measurement series		
Name of the work area in which the activity takes place		
Description of the sampling location (e.g. welding booth no., machine operation stand,...)		
Type of location		☐ Workroom ☐ Area indoor ☐ Area outdoor
Dimensions of the work area in m.		___x ___x___ m (LxWxH) = ____m^3
Number of workers	present in the location	
	involved in the nano process	
General housekeeping		☐ Poor ☐ Average ☐ General good housekeeping practices ☐ Demonstrable and effective housekeeping practices ☐ Process fully enclosed
Remarks on location		

Ventilation		
Instruction; - Practical Module - This information is filled in for each activity measured at the measurement location. - If the operational conditions and risk management measures are equal for all the activities measured, this module needs to be filled in only once.		
Internal code for the whole measurement series		
Type of room ventilation	☐ None ventilation ☐ Natural ventilation - doors or windows open ☐ Natural ventilation - doors and windows closed ☐ Natural ventilation - outdoor working ☐ Mechanical ventilation - incoming and outgoing air ☐ Mechanical ventilation - only incoming air ☐ Mechanical ventilation - only outgoing air	
Efficacy of room ventilation system	☐ Poor ☐ Average ☐ High	
Air changes per hour		
When mechanical ventilation: filter present?	☐ No ☐ Yes	
Filter group and class	☐ Arrestance Filters	☐ G1 ☐ G2 ☐ G3 ☐ G4
	☐ Dust Spot Efficiency Filters	☐ F5 ☐ F6

		☐ F7 ☐ F8 ☐ F9
	☐ HEPA Filters	☐ H10 ☐ H11 ☐ H12 ☐ H13 ☐ H14
	☐ ULPA Filters	☐ U15 ☐ U16 ☐ U17
Recirculation of air	☐ No ☐ Yes	
Description of segregation, if applicable	☐ None segregation ☐ Partial segregation without ventilation ☐ Partial segregation with ventilation ☐ Complete segregation without exhaust ventilation ☐ Complete segregation with exhaust ventilation and no air circulation	
Time of exposure control(s)	Start: __:__:__ Date: __:__:____ End: __:__:__ Date: __:__:____	
Air velocity at the opening of room ventilation	_____m/s	
Remarks on exposure controls		

Local controls		
Instruction; - Practical Module - This information is filled in for each local control at the measurement location.		
Internal code for the whole measurement series		
Local control class	 Local control.pdf Choose code from pdf-file	
Is there filtering	☐ No ☐ Yes	
Recirculating air	☐ No ☐ Yes	
Filter group and class	☐ Arrestance Filters	☐ G1 ☐ G2 ☐ G3 ☐ G4
	☐ Dust Spot Efficiency Filters	☐ F5 ☐ F6 ☐ F7 ☐ F8 ☐ F9
	☐ HEPA Filters	☐ H10 ☐ H11 ☐ H12 ☐ H13

		☐ H14
	☐ ULPA Filters	☐ U15 ☐ U16 ☐ U17
Efficiency of this local control ventilation system	☐ Poor ☐ Average ☐ High	
Air velocity at the opening of machine ventilation	____m/s	
Air volume flow from local ventilation	_____ (unit) l/min // m³/h	
Remarks on Local controls		

Indoor climate	
Instruction; - Practical Module - This information is filled in for each activity measured at the measurement location. - If the operational conditions and risk management measures are equal for all the activities measured, this module needs to be filled in only once.	
Average relatively humidity	_____%
Air velocity at the working spot	_____m/s
Air flow direction	☐ From source to worker ☐ From worker to source
Temperature	_____ºC
Air pressure indoor	_____m/s
Remarks on indoor climate	

Worker(s) in measurement		
Instruction; - Practical mode - This information is filled in during the measurements. This table needs to be filled in for each worker in the measurements that take place within the same measurement series.		
Internal code for the whole measurement series		
Job title of the worker		
Worker number		
ISCO job code		 ISCO-08.pdf Choose code from pdf- file
Is the worker trained or untrained (experienced/inexperienced) to work with nanomaterials		☐ Trained + experienced ☐ Trained + unexperienced ☐ Untrained + experienced ☐ Untrained + unexperienced
Is the worker briefed on risks?		☐ No ☐ Yes
Is the wearer of a tight fitting face-piece clean shaven?		☐ No ☐ Yes ☐ Non-applicable
Is the worker trained on	How to wear RPE	☐ No ☐ Yes ☐ Non-applicable
	Storage	☐ No ☐ Yes ☐ Non-applicable
	Maintenance	☐ No

		☐ Yes ☐ Non-applicable
Remarks on worker		

Worker exposed time and personal protective equipment (PPE)		
Instruction; - Practical Module - This information is filled in for each worker and each at the measurement location.		
Internal code for the whole measurement series		
Time for how long the worker works this activity in his shift	Start: __:__:__ Date: __:__:____ End: __:__:__ Date: __:__:____	
Remarks on worker exposed time		
Separation / Personal enclosure	☐ No separation ☐ Partial separation without ventilation ☐ Partial separation with ventilation ☐ Complete separation without ventilation ☐ Complete separation with ventilation	
Type of respiratory protective equipment (RPE) and specific model	☐ Respirator / Filtering Face Piece	☐ FFP1 ☐ FFP2 ☐ FFP3
	☐ Respirator / Half mask, particle filter	☐ FMP1 or P1 ☐ FMP2 or P2 ☐ FMP3 or P3

	☐ Respirator / Full face mask, particle filter	☐ P1 ☐ P2 ☐ P3
	☐ PAPR, Powered Air-Purifying Respirator with half or full face mask	☐ TM1P ☐ TM2P ☐ TM3P
	☐ Respirator/powered (fan-assisted mask) with helmet or hood	☐ TH1P ☐ TH2P ☐ TH3P
	☐ Respirator/powered (fan-assisted mask) with helmet or hood	☐ LDH1 ☐ LDH2, LDM1, ☐ LDM2 or half mask ☐ LDH3, LDM3, Hood or Full mask ☐ Suit
	☐ Breathing apparatus / continuous flow airline BA,	☐ 1A or 1B ☐ 2A or 2B ☐ 3A or 3B ☐ 4A or 4B
	☐ Breathing apparatus / Half mask / Demand valve BA (Airline or self-contained)	
	☐ Breathing apparatus / Full face mask / Demand valve BA (Airline or self-contained), with positive pressure	
	☐ Breathing apparatus / Full face mask / Demand valve BA (Airline or self-contained), without positive pressure	

Specific model of RPE if other model is used	
Has the wearer of a tight-fitting face-piece undergone face-piece fit testing?	☐ No ☐ Yes ☐ Non-applicable
Other PPE on head and used with respirator/ breathing apparatus	☐ No ☐ Yes ☐ Non-applicable
Goggles /spectacles	☐ None ☐ Eye-protectors, spectacles ☐ Goggles, type 4 against dusts ☐ Goggles, type 5 against gases, fumes, aerosols ☐ Eye-shield attached to industrial helmet
Does the wearer use optic spectacles?	☐ No ☐ Yes
Does the wearer use a face shield?	☐ No ☐ Yes
Hearing protection	☐ None ☐ Hearing protection, ear plugs ☐ Hearing protection, ear muffs ☐ Ear muffs attached to industrial helmet ☐ Eye-shield attached to industrial helmet
Does the wearer use a helmet	☐ No ☐ Yes
Type of coverall	☐ None ☐ Coverall (Chemical Type 5) ☐ Non-protective work wear ☐ Coverall (Chemical Type 6) ☐ Coverall (Chemical Type 1) ☐ Coverall (Mechanical)

	☐ Coverall (Chemical Type 2) ☐ Coverall (Heat and flame) ☐ Coverall (Chemical Type 3) ☐ Other: specify ☐ Coverall (Chemical Type 4)
Type of gloves	☐ None ☐ Disposable gloves ☐ Gloves (Chemical) ☐ Gloves (Mechanical) ☐ Gloves (Heat and flame) ☐ Other: specify
Remarks on PPE	

Material information	
Instruction; - Desk Module. - Ask for MSDS and other technical information to fill in this module.	
Internal code for the whole measurement series	
Confidentiality of the material	☐ Free for NECID ☐ Only categorized material free for NECID ☐ Confidential (only for institute)
Is it a nanomaterial?	☐ Yes ☐ No
Purity of material	☐ Pure material, concentration = 100 % of this material, ☐ Ingredients
Product name	
OECD classification	☐ Fullerenes (C60)

	☐ Single-walled carbon nanotubes (SWCNTs) ☐ Multi-walled carbon nanotubes (MWCNTs) ☐ Silver nanoparticles ☐ Iron nanoparticles ☐ Titanium dioxide ☐ Aluminium oxide ☐ Cerium oxide ☐ Zinc oxide ☐ Silicon dioxide ☐ Dendrimers ☐ Nanoclays ☐ Gold nanoparticles ☐ Mixture of nanoparticles ☐ Others
Name of manufacturer/importer	
Product form	☐ Liquid ☐ Powder ☐ Solid object ☐ Fibers ☐ Paste
Product version code	
Product trade name	
Kind of density	☐ Bulk ☐ Elemental ☐ Agglomerate
Density of material	____ g/cm³ __ kg/m³
Viscosity of the product	☐ Low viscosity ☐ Moderate viscosity

	☐ High viscosity
Dustiness of the product	☐ Firm granules ☐ Granules, flakes or pellets ☐ Coarse dust ☐ Fine dust ☐ Extremely fine and light powder
Measured dustiness system	☐ Rotating drum ☐ Continuous drop
Measured dustiness	_____ mg/kg
Moisture content	☐ Dry product (<5% moisture content) ☐ 5-10% moisture ☐ > 10% moisture content
Molecular mass of the product	_____ g/mol
BET surface area	_____ m^2 / g
Initial particle size	_____nm
Volume specific surface area	_____m^2/m^3
Coating	☐ No ☐ Yes
Doping	☐ No ☐ Yes
Remarks on the product	
Ingredient	
Is it a nanomaterial?	☐ Yes

	☐ No
Purity of material	☐ Pure material, concentration = 100 % of this material, ☐ Ingredients
Product name	
Version code	
CAS number	
Concentration of analyzed chemical in the product	_____ ☐ % Vol ☐ % mass
Molecular mass	_____ g/mol
BET surface area	_____ m^2 / g
Initial particle size in nm	
Volume specific surface area	_____m^2/m^3
Coating	☐ No ☐ Yes
Doping	☐ No ☐ Yes
Remarks on the ingredient	

Product used rate		
Product used	as raw material or output product	☐ Input material ☐ Output material ☐ Handled material
	total volume	_____ (unit) (e.g. 40 kg)
	per timescale	_____ (unit)

Appendix 1b. Template 'MARINA exposure scenario library form'

Exposure Scenario for Uses Of Substances By Workers	
Description of the exposure scenario	**Description (free text)**
Name of the exposure scenario	
Description of the exposure scenario	
Potential exposure route(s)	
Product origin	**Description (free text)**
Manufacturing country	
Country of purchase	

Contributing Exposure Scenario for Uses Of Substances By Workers (CES-1)

PLEASE READ THE GUIDELINES BEFORE COMPLETING THIS FORM

Quatliy of the exposure scenario data	Description (free text)	Select from the drop down list
Contextual information	TO BE FILLED BY THE MARINA ASSESOR	
Measurement data	TO BE FILLED BY THE MARINA ASSESOR	
Description of the contributing scenario	**Description (free text)**	**Select from the drop down list**
Name of the contributing scenario		
Mode of use description		
Product characteristics	**Description (free text)**	**Select from the drop down list**
Type of product		
Product (brand) name		
Fraction or concentration of the NOAA in the product		
NOAA characteristics		**Select from the drop down list**
NOAA contained in the product		
Primary particle size (nm) (crystallite size)		
Surface area		
Activity emission potential	**Description (free text)**	
Describe the activity in terms of the type of energy applied during the use/application (e.g. rubbing skin, massage skin, touching, no direct contact…)		
Amount of product used per event/application?		
Human factors not influenced by risk management	**Description (free text)**	
Particular conditions of use (e.g. area and body parts potentially exposed)		
Population potentially exposed (female adults, male adults, children, toddlers)		
Conditions of use: outdoor, indoor, personal use?	**Description (free text)**	
Conditions of use: outdoor, indoor, personal use?		
Room volume (m^3) in the case of inhalation exposure indoors		
Other information relevant for exposure		
Conditions and measures related to information and behavioural advice to consumers		
Usually personal protection measures are not expected for consumer products; however if the use of personal protection equipment (glassess, gloves, etc) is recommneded, this given this can be specified here.		
Exposure		
Duration of the application/use (mins)		
Frequency of the application (number of times the application/use is done a day/week/month/year.		
Measurements	**Go to CES-1 to enter measurement data**	

Appendix 2. Templates 'Consumer exposure database libraries Nanodatabase'

Parameter	***Options***
Product name	
Manufacturer	
Address Manufacturer	
Website Manufacturer	
Category	1. *Appliances* 2. *Automotive* 3. *Electronics and computers* 4. *Food and Beverages* 5. *Good For Children* 6. *Health and Fitness* 7. *Home and Garden* 8. *Impossible to categorize*
Country of origin	
Country of production	
Material	
Location (of the nanomaterial)	1. *Airborne* 2. *Multiphase bulk* 3. *Powder* 4. *Film* 5. *Structured film* 6. *Surface bound nanoparticles* 7. *Nanoparticles suspended in solid* 8. *Nanoparticles suspended in liquid* 9. *Unknown*
Potential exposure pathways	1. *Dermal* 2. *Oral* 3. *Inhalation*
Waste treatment types	1. *Incineration* 2. *Landfill* 3. *Recycling* 4. *Special treatmen*
Waste material	
Biocidal product types	***PT 1-22***
Added on or after date	
Modified on or after date	

Appendix 3. Template "DeRmal Exposure Assessment Method (DREAM)'

Below the complete Dream-questionnaire is presented.

DERMAL EXPOSURE ASSESSMENT METHOD (DREAM) – QUESTIONNAIRE PART 1: COMPANY

Observer (fill in your name):	
Date (dd-mm-yyyy):	
Company code[2]:	
Company name:	
Company address:	
Contact person's name	
Sector:	
Main activity of company:	
Total number of workers:	

[2] Fill in a specific code for this company [e.g. date (yy-mm-dd) followed by your initials and company code]

DERMAL EXPOSURE ASSESSMENT METHOD (DREAM) – QUESTIONNAIRE PART 2: DEPARTMENT

Observer (fill in your name):		
Company code:		
Department:		
	QUESTION	**ANSWERS**
1	Main activity	
2	Do chemical / biological agents occur at the department or is work environment[3] contaminated?	O no → STOP, fill in next department O yes
3	Who is responsible for cleaning the department / work tables / machines?	O not applicable → 6 O department workers themselves O a special cleaning unit O both
3.1	How often is the floor cleaned?	O daily O weekly O monthly O yearly / never

[3] Includes contaminated surfaces (e.g. contaminated machinery, packing material) and tools

3.2	How is the floor cleaned?	O dry O wet O both
3.3	How often are worktables cleaned?	O department does not have worktables O daily O weekly O monthly O yearly / never
3.4	How are worktables cleaned?	O dry O wet O both

3.5	How often are machines cleaned?	O department does not have machines O daily O weekly O monthly O yearly / never
3.6	How are machines cleaned?	O dry O wet O both
4	How often are non-disposable working tools cleaned?	O tools are not used at the department → 7 O daily O weekly O monthly O yearly / never
4.1	How are non-disposable working tools cleaned?	O dry O wet O both

DERMAL EXPOSURE ASSESSMENT METHOD (DREAM) – QUESTIONNAIRE PART 3: AGENT

Observer (fill in your name):		
Company:		
Department:		
Agent (fill in the agent of interest[4]):		
Date:		
	QUESTION	**ANSWERS**
1	Trade name of agent?[5]	
2	Name of active ingredient of interest?	
3	Estimate absolute concentration of the active ingredient in agent	_____ O mg/L O mg/kg O %w/w O % v/v

[4] Agent to which dermal exposure is assessed. Agent may be a mixture of substances (e.g. paint, wood-dust, asphalt fumes).

[5] If applicable.

4	The agent is pure, mixture of a residue?	O pure (≥ 90% active ingredient of interest) O mixture (1-90% active ingredient of interest) O residue (< 1% active ingredient of interest)
5	Specify physical state of agent	O Solid → 5.1 O Liquid → 6.1 O Vapour → next module O Gaseous → next module
5.1	The agent's form	O Powder O Granules O Flocks / shreds / chips / flakes O Pellets O Other specify: _____
5.2	Agent is dusty	O no O yes
5.3	Agent is sticky / wax-like / moist?	O no O yes
6.1	The boiling temperature of concerning active ingredient is?	O < 50°C O 50 – 150 °C O > 150 °C

		O not known
6.2	Viscosity of agent	O Low (like water) O Medium (like oil) O High (like resin/paste)
6.3	Agent sticks (like glue / resin / varnish)?	O no O yes

Observer:						
Company:						
Department:						
Job title:						
	QUESTION			**ANSWERS**		
1	Total number of workers with this job title:					
2	Number of workers per duty/shift:					
3	Mark covered[6,7] body parts			Description of outer layer of clothing		
		No	Yes	Woven[8]	Non-woven[9]	Non-permeable[10]
	Head / neck	O	O	O	O	O
	Upper arms	O	O	O	O	O

[6] A body part is defined as covered when more than 90% of a body part is covered. Do not include TASK SPECIFIC personal protective equipment (PPE). Task specific protective devices are filled in at task level

[7] If workers differ regarding clothing, indicate less covered worker.

[8] Such as cotton / linen / polyester, agent may penetrate.

[9] Such as tyvek / leather, agent may permeate.

[10] Non-woven and non-permeable, agents do not permeate

	Forearms	O	O	O	O	O
	Wrists / hands	O	O	O	O	O
	Torso (front)	O	O	O	O	O
	Torso (back)	O	O	O	O	O
	Lower abdomen and upper legs	O	O	O	O	O
	Lower legs	O	O	O	O	O
	Feet	O	O	Open shoes O	Closed shoes O	Rubber boots O

4	Are work clothes immediately changed after work?	O no O some workers O yes
5	How often are work clothes replaced by clean?	O more times a day O daily O more times a week O weekly
6	Are workers responsible for washing their own work clothes?	O no O yes
7	Workers wash their hands during work	O no O yes

7.1	Specify how hands are normally washed:					
		1 / shift end of day	1 / shift during day	2-4 / shift	5-10 / shift	11-20 / shift
	O only water O general soap O scrub soap O solvents O other (specify) _____	O O O O O	O O O O O	O O O O O	O O O O O	O O O O O
8	Do workers shower at work?	O no O some workers O yes				

DERMAL EXPOSURE ASSESSMENT METHOD (DREAM) – QUESTIONNAIRE PART 5: TASK

Observer (fill in your name):		
Company code:		
Department:		
Job title:		
Task:		
Agent:		
	QUESTION	**ANSWERS**
1	Number of months per year task is performed?	
2	How many workers perform this task?[11]	
3	How many workers perform this task at the same moment?[10]	

[11] Workers with this job title, within this department

4	Task performance [Estimated for **one** general worker with this job title and task]	O daily → 4.1 O weekly O monthly O yearly
4.1	Task frequency per day (Estimated for **one** worker)	O 1 time O 2 – 10 times O > 10 times

		Per day	Per week (Hours)	Per month (Hours)	Per year (Hours)
5	Total time of task performance **(frequency * duration)** *Estimated for one worker*	**O ≤ 10 min** **O 11-60 min** **O >1 – 4 h** **O > 4 – 8 h**	**O 0 – 1** **O >1 – 4** **O >4 – 20** **O >20**	**O 0 – 4** **O > 4 – 16** **O > 16 – 80** **O > 80**	**O 0 – 40** **O > 40 – 160** **O > 160 – 800** **O > 800**
6	Total time of task performance (absolute) *Estimated for one worker*	____ Minutes per day ____ Hours per week / month / year[12]			
7	You observed the task?	O no O yes → 7.1			
7.1	How often did you observe?	O one person once O one person several times O several persons once O several persons, several times			

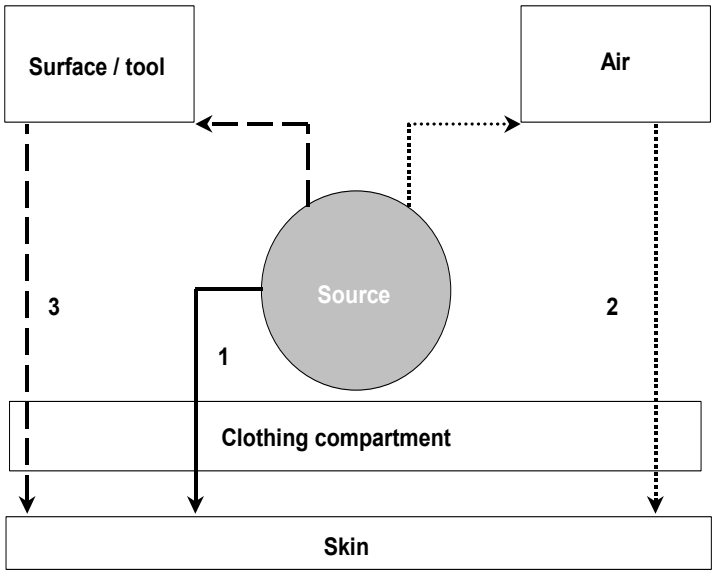
[12] Strike out whichever not applicable

INSTRUCTIONS

- Choose always the answer closest to your opinion.
- Read footnotes carefully.
- Assess exposure to ONE agent (which can be a complex mixture of substances) at the time.
- The questions consider POTENTIAL dermal exposure, which is defined as dermal exposure on clothing and uncovered skin; if body parts are covered exposure to the covered body parts is assessed. The evaluation part of DREAM takes into account the protective effects of clothing and personal protections devices like gloves etc.
- The questions of DREAM are based on the conceptual model for dermal exposure according to Schneider et al., 1999. This model considers, amongst others, the following exposure routes for dermal exposure (see also figure 1):

1. **Emission:** direct release from a source onto skin or clothing, such as exposure by splashes, or immersion of hands into a liquid or powder; droplets and powder particles have an aerodynamic diameter of ≥ 100 micrometer.
2. **Deposition:** agent is released to air and subsequently deposited on skin or clothing: e.g. small particles such as vapours, fine dust. Particles have an aerodynamic diameter of less than 100 micrometer; vapour, very small droplets, or fine dust
3. **Transfer:** contact with surfaces or working tools that have been previously contaminated with agent.

Figure 1: exposure routes for dermal exposure (1= emission; 2=transfer; 3=deposition).



- After filling in, check whether you marked the body parts you consider to be exposed.

Observer (fill in your name):	
Company Code:	
Department:	
Job title:	
Task:	
Exposure to (fill in agent):	
Date:	
ID of observed worker(s):	

1	**Emission.**[13] (Covered) hands are exposed by direct release of agent from a source or by immersion?	O no, unlikely → 2 O yes, occasionally[14] O yes, repeatedly[15] O yes, almost constantly[16]
1.1	Specify amount	O small amount (<10% hands) O medium amount (10 – 50% hands) O large amount (> 50% hands)
2	**Emission.** Other (covered) body parts are exposed by direct release of agent from a source, or by	O no → 3 O yes, occasionally[13]

[13] **Emission:** direct release from a source onto skin or clothing, such as immersion of hands into a liquid or powder, or exposure by splashes; droplets and powder particles have an aerodynamic diameter of ≥ 100 micrometer.

[14] <10% of task duration

[15] 10-50% of task duration

[16] >50% of task duration

	immersion?	O yes, repeatedly[14] O yes, almost constantly[15]	
2.1	Specify amount	O small amount (<10% of body part) O medium amount (10 – 50% of body part) O large amount (> 50% of body part)	
2.2	Please tick body parts exposed due to emission	Body part	Contact
		Head / neck	O
		Upper arms	O
		Forearms	O
		Torso (front)	O
		Torso (back)	O
		Lower abdomen and upper legs	O
		Lower legs	O
		Feet	O

3	**Deposition.**[17] When performing task airborne particles[18] of the agent are formed or present in working environment and deposited on (covered) body parts?	O no, unlikely→ 4 O yes, occasionally/possibly[19] O yes, repeatedly[20] O yes, almost constantly[21]	
3.1	Specify amount	O small amount (<10% body part) O medium amount (10 – 50% body part) O large amount (> 50% body part)	
3.2	Please tick body parts exposed due to deposition	Body parts	Agent deposited.
		Head / neck	O
		Upper arms	O
		Forearms	O
		Hands - wrists	O
		Torso (front)	O
		Torso (back)	O
		Lower abdomen and upper legs	O
		Lower legs	O
		Feet	O

[17] Agent is released to air and subsequently deposited on skin or clothing: e.g. small particles such as vapours, fine dust.

[18] Particles with an aerodynamic diameter of less than 100 micrometer; vapour, very small droplets, or fine dust

[19] <10% of task duration

[20] 10-50% of task duration

[21] >50% of task duration

4	**Transfer of agent to (covered) hands.**[22] When performing this task…								
4.1		**Hands have contact with surfaces or tools?**				**Estimated contamination level of <u>contact surface</u>?**			
	Surfaces[23,24]**:**	**Unlikely**	**Occasionally**[25]	**Repeatedly**[26]	**Almost constantly**[27]	**Not Contaminated**	**Possibly contaminated**	**< 50% of contact surface**	**> 50% of contact surface**
	Floor	O	O	O	O	O	O	O	O
	Worktables	O	O	O	O	O	O	O	O
	Machines	O	O	O	O	O	O	O	O
	Working tools	O	O	O	O	O	O	O	O
	Other surfaces,	O	O	O	O	O	O	O	O
	4.1.a Other surfaces specification:								

[22] **Transfer:** contact with surfaces or working tools that have been <u>previously</u> contaminated with agent

[23] In case surfaces are not present (e.g. work tables), tick 'unlikely'.

[24] In case 'surfaces' of one category have different contact frequencies or contamination levels, indicate then the surface with the highest product of contact frequency and contamination level in that category.

[25] <10% of task duration

[26] 10-50% of task duration

[27] >50% of task duration

5	**Transfer of agent to other (covered) body parts.** [28] When performing this task[29]**…**								
5.1		Other body parts have contact with surfaces, tools or hands?				**Estimated contamination level of <u>contact surface</u>?**			
	Surfaces:[30,31]	**Unlikely**	**Occasionally**[32]	**Repeatedly**[33]	**Almost constantly**[34]	**Not Contaminated**	**Possibly contaminated**	**< 50% of contact surface**	**> 50% of contact surface**
	Floor	O	O	O	O	O	O	O	O
	Worktables	O	O	O	O	O	O	O	O
	Machines	O	O	O	O	O	O	O	O
	Working tools	O	O	O	O	O	O	O	O
	Hands	O	O	O	O	O	O	O	O
	Other surfaces	O	O	O	O	O	O	O	O
	5.1a Other surfaces specification:								

[28] **Transfer:** contact with surfaces or working tools that may have been <u>previously</u> contaminated with agent

[29] Do not consider contact of feet with contaminated floor if footwear is supposed to provide proper protection

[30] In case surfaces are not present (e.g. work tables), tick 'unlikely'.

[31] In case 'surfaces' of one category have different contact frequencies or contamination levels, indicate then the surface with the highest product of contact frequency and contamination level in that category.

[32] <10% of task duration

[33] 10-50% of task duration

[34] >50% of task duration

5.2	Please tick body parts that have contact with contaminated surfaces:	Body part:	Contact
		Head / neck	O
		Upper arms	O
		Forearms	O
		Torso (front)	O
		Torso (back)	O
		Lower abdomen and upper legs	O
		Lower legs	O
		Feet	O

6	**Contamination.** Indicate how surfaces get contaminated with agent during task.						
6.1		**Contaminated during task?**			**Indicate main route only**		
	Surfaces:	**No**	**Possibly**	**Yes**	**Emission[35]**	**Deposition[36]**	**Transfer[37]**
	Floor	O	O	O	O	O	O
	Worktables	O	O	O	O	O	O
	Machines	O	O	O	O	O	O
	Working tools	O	O	O	O	O	O
	Hands	O	O	O	O	O	O
	Other surfaces	O	O	O	O	O	O
	6.1a Other surfaces specification:						

[35] **Emission:** direct release from source onto surfaces, such as immersion of surfaces into a liquid or powder, exposure by splashes. Droplets and powder particles have an aerodynamic diameter of ≥100 micrometer.

[36] **Deposition:** agent is released to air and subsequently deposited on surface: e.g. small particles such as vapours, fine dust. Droplets and powder particles have an aerodynamic diameter of <100 micrometer.

[37] **Transfer:** contact of surfaces with surfaces or working tools that have been previously contaminated with agent

7	Does worker use gloves when performing task?	O no → 13 O yes
7.1 ASK	Specify glove type	O Latex, disposable O Latex, none disposable O Vinyl disposable O Polyvinyl chloride (PVC) O Nitrile rubber O Neoprene rubber O Butyl rubber O Fluorocarbon rubber (e.g. Viton tm) O Laminated, impregnated, coated (e.g. cloth with rubber or leather) gloves O Cotton gloves O Plastic disposable O Leather gloves O Other: _____
8	Gloves connect well to clothing of arms?	O no O yes
9	When performing task gloves are worn during:	O 0 – 10 % of task duration O 10 – 50% of task duration O 50 – 100% of task duration
10	Are gloves taken off correctly (skin does not have contact with outer surface gloves)?	O No O Not observed O Yes
11 ASK	How often are gloves replaced	O after having used them 1 time O daily O weekly O monthly
12	Does worker wear a second pair of gloves under outer gloves?	O no O yes
12.1 ASK	How often are these inner gloves replaced?	O after having used them 1 time O daily O weekly O monthly
13	Is barrier crème used?	O no O yes
14	Does worker use personal protective clothing in addition to clothing indicated at job title level?	O no O yes
15	Mark covered body parts38	

	Covered?	Material outer layer clothing			How often replaced? (Ask)			
		Woven 39	Non-woven 40	Imper-meable 41	After 1 time	Daily	Week-ly	Mont hly

[38] A body part is defined as covered when >90% is covered.

[39] Such as cotton, linen, polyester

[40] Such as tyvek, plastic, rubber, leather

Head / neck	O No	O Yes	O	O	O	O	O	O	O
Upper arms	O No	O Yes	O	O	O	O	O	O	O
Forearms	O No	O Yes	O	O	O	O	O	O	O
Torso (front)	O No	O Yes	O	O	O	O	O	O	O
Torso (back)	O No	O Yes	O	O	O	O	O	O	O
Lower abdomen and upper legs	O No	O Yes	O	O	O	O	O	O	O
Lower legs	O No	O Yes	O	O	O	O	O	O	O
Feet	O No	O Yes	Open shoes O	Closed shoes O	Rubber boots O	Daily O	Weekly O	Monthly O	Yearly O

16 ASK	Amount of agent handled during total time of task performance42	O _____ O mg O mL O g O L O kg O m3 O not applicable

[41] Both non-woven and non-permeable, which is agent specific, search information if you are not sure!

[42] In case of performing measurements task performance is equal to measurement time.

Appendix 4. Templates 'Database of dermal and oral transfer efficiencies'

Search factor	Categories
Substance	Liquid Powder Biological solid in solution
Particle size (powders only)	<50 µm 50–150 µm >150 µm
Transfer type	Hand-to-mouth Hand-to-perioral Perioral-to-oral Skin-to-skin Surface-to-clothing Surface-to-hand Surface-to-glove
Donor surface type	Smooth Rough Carpet Food Skin Textile
Surface loading level	Liquids, powders, and solids in solution: <0.0002 mg cm^{-2} 0.0002–0.002 mg cm^{-2} 0.002–1 mg cm^{-2} ≥1 mg cm^{-2} Biological substances <29 CFU cm 29–440 CFU cm^{-2} 441–1000 CFU cm^{-2} >1000 CFU cm^{-2}
Time since application (liquids and biological substances only)	Liquids or solid in solution 0–3 h 3–12 h >12 h Biological substances 0–60 min >60 min
Type of contact	Press Smudge Grasp
Moisteness of hand	Dry Wet
Number of contacts	1, 2–6, >6

Appendix 5. Templates 'Dustiness library'

		Name/code	Method	Unit	Value
Identification	Powder properties	Chemical Composition*			
		Code			
		Coating*			
		primary particle size*		nm	
		average particle (aggregate) size*		nm	
		Specific Surface arfea*	BET	m2/g	
		bulk density*			
		purity		%	
		Loss on drying		%	
		test type:	RD/CD/VS/SD/other		
Dustiness	Powder used	Mass/ test		g	
		Volume/test		ml	
		Powder moisture content		wt.%	
		Test duration		min	
	Off-line analysis	*Dustiness Mass index inhalable (DMIi)*	*Porous foams IOM/inhalable sampler + filter type*	*mg/kg*	
		Dustiness mass index respirable (DMIr)	Cyclone type + filter	mg/kg	
		EM results	TEM grid		
		EM results			

Size-resolved informaition	Summary data	ELPI	GMND	µm	
			GSD	µm	
			Mode(s)	µm	
	Size-distribution		GMMAD	µm	
			GSD		
			n Mode(s)		
			GMMAD	µm	
	Online data	name/code	method	unit	value
		Dustiness number index (DNI)	CPC type	ΣN over time	1/mg
		Respirable dust Size-distribution	ELPI/FMPS/SMPS/ APS/OPC	dNdLog/Dp	n/cm3/kg
		Dustiness kinetics	ΣN over time	1/mg	
			PGR0 (slope at 0 sec.)	n/sec	
			PGR0.25 (PGR0.25 of total test time)	n/sec	
			PGR0.50 (50% of of total test time)	n/sec	
			PGR0.75 (75% of total test time)	n/sec	
			PGR1 (1% of total time)	n/min	

Appendix 6. Templates 'DTU Environment Database Library on Release from Consumer products'

Inhalation				
	Abbrevation	**Unit**	**Value**	**Reference**
Nanomaterial				
Product				
Scenario & assumptions				
Amount of product used	Qprod	g	*Insert value if reported*	*Insert reference*
Weight fraction of substance in product	Fcprod	g/gprod	*Insert value if reported*	*Insert reference*
Room size (default 20m3)	Vroom	m3	*Insert value if reported*	*Insert reference*
Respirable fraction of inhaled substance (default 1)	Fresp		*Insert value if reported*	*Insert reference*
Ventilaton rate of person (adult male, heavy activity (R.15 table 15-14)	IHair	m3/d	*Insert value if reported*	*Insert reference*
Duration of contact per event (default 1 day)	Tcontact	d	*Insert value if reported*	*Insert reference*
Body weight	BW	kg	*Insert value if reported*	*Insert reference*
Mean number of events per day	N	1/d	*Insert value if reported*	*Insert reference*
Concentration in air after using an amount *Qprod* of the product	Cinh	mg/m3	*Insert value if reported*	*Insert reference*
Inhalatory dose	Dinh	mg/kgbw*d	*Insert value if reported*	*Insert*

				reference
Measured release		particles/m3	*Insert value if reported*	*Insert reference*
Fraction of ENM			*Insert value if reported*	*Insert reference*
Concentration of ENM in air	Cinh(ENM)	particles/m3	*Calculated based on reported values*	
Inhalatory dose Dinh	Dinh(ENM)	particles/kgbw*d	*Calculated based on reported values*	
Dermal A				
	Abbrevation	**Unit**		**Reference**
Nanomaterial			*Insert value if reported*	*Insert reference*
Product			*Insert value if reported*	*Insert reference*
Scenario			*Insert value if reported*	*Insert reference*
Amount of prdouct used	Qprod	g	*Insert value if reported*	*Insert reference*
Weight fraction of substance in product	Fcprod	g/gprod	*Insert value if reported*	*Insert reference*
Dilution factor	D		*Insert value if reported*	*Insert reference*
Concentration of substance in product before dilution	Cprod	g/cm3	*Insert value if reported*	*Insert reference*
Density of product before dilution	RHO(prod)	g/cm3	*Insert value if reported*	*Insert reference*

Volume of product used before dilution	V(prod)	cm3	*Insert value if reported*	*Insert reference*
Volume of diluted product actually contacting the skin	V(appl)	cm3	*Insert value if reported*	*Insert reference*
Thickness of product layer on skin (default 0.01 cm)	TH(der)	cm	*Insert value if reported*	*Insert reference*
Surface area of the exposed skin	A(skin)	cm2	*Insert value if reported*	*Insert reference*
Body weight	BW	kg	*Insert value if reported*	*Insert reference*
Mean number of events per day	n	d-1	*Insert value if reported*	*Insert reference*
R.15-3 Lder			*Calculated based on reported values*	
R.15-4 Dder			*Calculated based on reported values*	
R.15-5a Cder			*Calculated based on reported values*	
R.15-5b Cder			*Calculated based on reported values*	
R.15-5c Cder			*Calculated based on reported values*	
R.15-6a Lder			*Calculated based on reported values*	
R.15-6b Lder			*Calculated based on reported values*	
R.15-6c Lder			*Calculated based on reported values*	

R.15-7a Dder			*Calculated based on reported values*	
R.15-7b Dder			*Calculated based on reported values*	
R.15-7c Dder			*Calculated based on reported values*	
Dermal B				
	Abbrevation	**Unit**		**Reference**
Nanomaterial			*Insert value if reported*	*Insert reference*
Product			*Insert value if reported*	*Insert reference*
Scenario			*Insert value if reported*	*Insert reference*
Amount of prdouct used	Q(prod)	g	*Insert value if reported*	*Insert reference*
Weight fraction of substance in product	Fc(prod)	g/g	*Insert value if reported*	*Insert reference*
Rate (fraction) of substance migrating to skin per unit time	Fc(migr)	g/g.t	*Insert value if reported*	*Insert reference*
Surface density (mass per unit area)	SD(prod)	mg/cm2	*Insert value if reported*	*Insert reference*
Fraction of contact area for skin, to account for the fact that the product is only partially in contact with the skin (default = 1)	F(contact)	cm2/cm2	*Insert value if reported*	*Insert reference*
Contact duration between article and skin	T(contact)	days	*Insert value if reported*	*Insert reference*
Area of contact between product and skin	A(skin)	cm2	*Insert value if reported*	*Insert reference*

Body weight	BW	kg	*Insert value if reported*	*Insert reference*
Mean number of events per day	n	d-1	*Insert value if reported*	*Insert reference*
no SD				
	R.15-8 Lder	mg/cm2	*Calculated based on reported values*	
	R.15-8 Dder	mg/kg.d	*Calculated based on reported values*	
with SD				
	R.15-9 Lder	mg/cm2	*Calculated based on reported values*	
	R.15-9 Dder	mg/kg.d	*Calculated based on reported values*	
Oral exposure				
	Abbrevation	**Unit**		**Reference**
Concentration of substance in product before dilution	Cprod	g/cm3	*Insert value if reported*	*Insert reference*
Dilution factor	D		*Insert value if reported*	*Insert reference*
Density of product before dilution	RHPprod	g/cm3	*Insert value if reported*	*Insert reference*
Qprod	Amount of product before dilution	g	*Insert value if reported*	*Insert reference*
Weight fraction of substance in product before dilution	Fcprod	g/gprod	*Insert value if reported*	*Insert reference*

Volume of product before dilution	Vprod	cm3	*Insert value if reported*	*Insert reference*
Volume of diluted product per event in contact with mouth	Vappl	cm3	*Insert value if reported*	*Insert reference*
Fraction of Vappl that is ingested (default =1)	Foral		*Insert value if reported*	*Insert reference*
Body weight	BW	kg	*Insert value if reported*	*Insert reference*
Mean number of events per day	n	1/d	*Insert value if reported*	*Insert reference*
Concentration of ingested product	Coral	mg/m3	*Calculated based on reported values*	
Intake per day and body weight	Doral	mg/kgbw*d	*Calculated based on reported values*	
House dust intake for children				
	Abbrevation	**Unit**		**Reference**
Weight fraction of substance in product before dilution	Fcprod	g/gprod	*Insert value if reported*	*Insert reference*
Mass ingested	Qprod	g	*Insert value if reported*	*Insert reference*
Body weight	BW	kg	*Insert value if reported*	*Insert reference*
Intake per day and body weight	Doral	mg/kg*d	*Calculated based on reported values*	

Appendix 7. Templates for the PROCess RElease/EMission library (PROC-REM) (PROC-REM)

R.14 Requirements	ConsExpo spray	Additional input	nano-specific requirements	Symbol	Unit
Substance emission strength			Dustiness E_i (EN15051 or SD) Resp. dust. index (m) Resp. dust. index (n) Size-distribution Size-distribution	 DI_{resp} NDI_{resp} D_{GMD} $D_{size-distr}$	 g/Kg n/Kg nm dN/dLogDp
			Dustiness kinetics (particle generation rate)	PGR_0 $PGR_{0.25}$ $PGR_{0.50}$ $PGR_{0.75}$ PGR_1	n/sec n/sec n/sec n/sec n/min
Description of Process/Activity					
Concentration in process			Mass-fraction Number-concentration Size-distribution		
Handling category				H_i	arbitrary
Process or handling Energy - Drop height		Vibration level/frequency		F_i	arbitrary
Amount used		Define amount per work cycle and activity in the work cycle and use-rate - kg/minute - n/minute		M	kg
		Known/estimated Process emission rate		E_i	kg/min n/minute
Frequency (of use)		Frequency of use/work cycle/day Freqency of activities in the work/use cycle		F_{cycle} $F_{activity}$	n/day n/minute
		Duration of work cycle		t_{cycle}	min
		Duration of activity		$t_{activity}$	min
Powder / fugitive / process generated					
Spray assessment					
			Type of spray / spray process	Type	scale
	Weight fraction of non-volatile compound			$W_{f,solid}$	wt%
	Weight fraction of compound of interest			$W_{f,Xi}$	wt%

R.14 Requirements	ConsExpo spray	Additional input	nano-specific requirements	Symbol	Unit
	Density of non-volatile compounds			δ	g/cm^3
			Liquid compound (CAS)	NA	
Viscosity of the liquid				η	Pa.s
Boiling point of liquid				T_B	°C or K
Activity coefficient of substance in liquid				γ	fraction
	Mass generation rate		Substance mass-fraction Droplets/minute	E_0	g/min n/min
	Airborne fraction			W_{air}	fraction
	Initial droplet size-distribution from spray			$E_{size,spray}$	GMD or dN/dLogDp
	Spray duration	Times and duration of use/work cycles and activities		t_{cycle}	min
	Exposure duration			$t_{exposure}$	min
	Inhalation cut-off diameter to determine inhalable droplet sizes			EXP	nm
Temp in liquid processes				$t_{process}$	°C or K
Spray direction	Spray direction	inwards outwards parallel up down		-	fraction

Appendix 8. Templates 'Exposure Control Efficacy Library (ECEL)'

Different changes to ECEL are needed to accommodate the inclusion of information regarding the efficiencies of controls for nanomaterial exposure.

Proposed changes to ECEL to accommodate nanomaterials

The aim is to establish and expand data-libraries on the protection efficiency of:

- Engineering controls (e.g. fume hoods, local exhaust ventilation)
- Dispersion controls
- Personal Protective Equipment (PPE) (e.g. masks, gloves)

This will require the collation of the available data on the efficiency of these control measures on exposure. In addition, the quantitative data and contextual information that is required to enter in a library, along with a suitable structure and format of such a library should be evaluated.

Note: in some studies more than one nano-measurement device is used. If so, each will be entered separately and indicated as 'correlated data' (existing parameter in current ECEL)

Most nano-related studies present an 'adjusted concentration' if results are in particles/cm3. This often results in negative values when the background concentration is subtracted from the measured concentration. These values are entered as such in ECEL with an adjusted concentration of 0 particles/cm3 (percent reduction = 100%; efficacy value = 0)

New parameters

The following new parameters will be included in ECEL:

- Nanomaterial (□ no nanomaterial; □ more than 50% <100nm; □ more than 50% >100nm);
  Important: defined here in terms of the presence of nano particles in the NM used – and not per se that the activity/process will result in the release or emission of nano particles (e.g. from composites)
- Indicative aerolized (mean) particle size range (expressed as % per range)
  [For data entry purposes, the focus will be the overall (mean) particle size range during the measurement – focusing on the 'post measurement'. This will be an indicative estimate, which may be derived from graphs. Only known PS ranges can be entered and the rest may be left empty]

HtblParticleSize: Average particle size or particle size range, D_p, nm (before) and D_p, nm (after)

With drop down list: <30 nm; 30-100 nm, 100-300 nm, 300-500 nm, 500-1000 nm, 1000-3000 nm, 3000-5000 nm, 5000-10000 nm; **OR**: <100nm, <300 nm, <500nm, <1000nm, <3000nm, <5000nm, <10000nm, ≥10000 nm; **OR** 10 nm, 20 nm, 30 nm, 100 nm, 300 nm, 400 nm, 500 nm, 1000 nm

- Source domain (1-4; with description) (see Appendix A)
- Exertion level (respirators) (see Appendix B)

HtblExertionLevel: Light exertion (9 breathings, tidal / minute volume 1L)
Modest exertion (26 breathings, tidal / minute volume 1.35L)
Heavy exertion (34 breathings, tidal / minute volume 1.75L).
This section will be further assessed considering more elaborate assessments on appropriate biometric data to be used for risk assessment in the USA and Nordic countries

- Face velocity (cm/s): numerical [relevant for both textile & LEV]
- Flow rate (L/min): numerical [relevant for both for PPE and LEV]
- Test type: dropdown list
  - Sealed (no leakage; filter or textile test only)
  - Low leakage (e.g. respirators: <1mm x 2; fit factor ≤ APF*; clothing: good connection between protective clothing)
  - Medium leakage (e.g. respirators: 1mm-2mm x 2; fit factor>APF; clothing: partial connection between protection clothing)
  - High leakage (e.g. respirators: ≥2mm x2; fit factor>2*APF; clothing: no connection between protection clothing)

*Assigned Protection Factor (APF) is the level of respiratory protection that a respirator or class of respirators is expected to provide when an effective respiratory program is implemented. Fit factor is a quantitative estimate of the fit of a respirator to a specific individual (or mannequin). It typically estimates the ratio of the contaminant concentration in air to the concentration inside the respirator.

- Body parts (PPE): sometimes only a single body part of a clothing type (e.g. coverall) is tested – this should be indicated for the evaluation of protective clothing (see Appendix G)
- Minimum & maximum (for efficacy value: reason is that for PPE the inside/outside is not always presented – and often indicated as a range) (see definition 'efficacy value' in next item)

Effvaluemin and Effvaluemax

- Analytical method: this parameter is not new but a new parameter type is included in ECEL to select from a drop-down list (the free text field is removed) – see item 2.3. However, an analytical method is included for (i) before and (ii) after, because for PPE different methods are generally used (e.g. before: cotton glove outside; after: hand wash)

2.2. Adapted parameters (relevant for data entry purposes and definitions for web tool user)

The following parameters will be adapted in ECEL:

- Task: change to 'task/process' to include washing, etc
- Situation before/after: re-defined to include any 'pre-measurement situation' and 'post-measurement situation'. As a result, these two inputs also refer to the evaluation of PPE, e.g. outside PPE (pre-) versus inside PPE (post-), concentration upstream versus downstream for filter media testing
- Efficacy value: remains 'efficacy value*' but also re-defined; see footnote below

* The efficacy value is re-defined and now also refers to a protection factor (PF), offered by respiratory or clothing protection and defined as the concentration of test particles outside the respirator or upstream of filter media/clothing in the environment, divided by the concentration of test particles inside the respirator or downstream of filter media/clothing. The concentration inside is due to a combination of penetration through the (filter) material or textile and leakage between the respirator and the face (face seal leakage) or between protective clothing (e.g. between gloves and sleeves). Together they form the total inward leakage (TIL). For respirators, the leakage of a properly fitting respirator is often, but not always, much higher than the filter penetration.

2.3 Additions to drop-down lists of existing parameters

The following will be added to drop-down lists:

- Industries: nano-specific industries (in particular during production)
- Tasks/process: nano-specific tasks such as harvesting, washing, shredding, but also processes such as flame pyrolysis, furnace flow reactors, laser induced pyrolysis, laser vaporization, thermal plasma, microwave plasma, hot wall reactors
- Analytical method (change parameter from free text to drop-down):
  - add list of nano measurement devices (see Appendix E), incl. the particle size range (e.g. SMPS, TSI model 3936 (2.5 – 1000nm)
  - add list of clothing, respirator and filter media testing methods (see Appendix F)
  - addition of existing methods already entered in ECEL (for inhalation, gravimetric methods) – to be combined later
- Include metrics:
  - for surface contamination (outside/inside clothing) (e.g. mass: ug/cm^2; ug/cm^2/min)
  - particle number in general (particles/m^3)

- surface area (um^2/cm^3)

➢ Risk Management Measure (RMM):

- Add engineering and dispersion controls – if not in ECEL already (see Appendix C)
- Add PPE list from Guidenano/SUN (see Appendix D)

2.4 Contextual open text

- For PPE tests and other new RMM, any additional contextual information will be entered in the existing 'situation before/after' fields
- Information of the particle size distribution (PSD) relevant for a specific control should be elaborated on in the existing 'situation before/after' fields

Appendix A Source domains

- *Source domain 1*: Synthesis of nanoparticles, i.e. Point source or fugitive emission during the production phase (synthesis) prior to harvesting the bulk material, e.g. emissions from the reactor, leaks through seals and connections and incidental releases.

- *Source domain 2*: Handling and transfer of bulk manufactured nanomaterial powders, e.g. harvesting, dumping and cleaning.

- *Source domain 3a*: Handling of solid intermediate nano-products including solid intermediates.

- *Source domain 3b*: Handling of liquid intermediate nano-products or application of liquid ready-to-use nano-products, e.g. spraying, pouring, diluting or mixing and painting with a roller.

- *Source domain 4*: Handling of nano-articles, e.g. handling of nano-embedded objects (handling of end-products), fracturing and abrasion of nanoparticles-embedded end products.

Reference:

Schneider T, Brouwer DH, Koponen IK, Jensen KA, Fransman W, van Duuren-Stuurman B, van Tongeren M, Tielemans E. Conceptual model for assessment of inhalation exposure to manufactured Nanoparticles. Journal of Exposure Science and Environmental Epidemiology (2011) 21, 450–463

Appendix B Exertion level (RPE)

Light exertion (19 breathings a minute, tidal volume 1L)

Modest exertion (26 breathings a minute, tidal volume 1,35L)

Heavy exertion (34 breathings a minute, tidal volume 1,75L)

Appendix C Engineering and dispersion controls or RMM

Engineering controls (based on RMM classification in ART model)

1. Physical containment - no extraction (low / medium / high)
   1.1. Low
   1.2. Medium
   1.3. High
2. Receiving hoods (LEV Systems)
   2.1. Canopy hoods
   2.2. Other receiving hoods (e.g. plume oriented)
3. Capturing hoods (LEV Systems)
   3.1. Fixed capturing hoods

3.2. Movable capturing hoods
3.3. On-tool extraction

4. Enclosing hoods (LEV Systems)
4.1. Fume cupboard (without glove bags)
4.2. Biological safety cabinets (BSC) (new)
4.3. Horizontal / downward laminar flow (walk-in cabinet or booths)
4.4. Other enclosing hoods

5. Glove bags and glove boxes
5.1. Glove bag (non-ventilated
5.2. Glove bag (ventilated or kept under negative pressure)
5.3. Low specification glove boxes
5.4. Medium specification glove boxes
5.5. High specification glove boxes

6. Suppression techniques
6.1. Knockdown suppression
6.2. Wetting at point of release

7. **Vapour recovery**

Dispersion controls

8. Separation (worker enclosures)

9. Unidirectional room airflow systems
9.1. Downward laminar airflow (w/o screens; w/o glove ports)
9.2. Cross- and down-flow spray booths

10. Recirculating air filtration systems with negative pressure in facilities – considering filter efficiency* (new)

Appendix D Proposed list of Personal Protective Equipment (PPE)

1. Gloves (hand and forearm) protective equipment
1.1. Laminated Film
1.2. Nitrile
1.3. Neoprene
1.4. Polyvinyl alcohol
1.5. Polyvinyl chloride (PVC)
1.6. Natural rubber
1.7. Butyl
1.8. Viton/Butyl
1.9. Latex (new)
1.10. Vinyl (new)

2. Respiratory protection equipment (Particle Filter – P1, P2 or P3 / Gas-vapour filter (A1/B1-A2/B2-A3/B3) / combined filter)

Note: US coded protection systems (e.g. N95) are excluded for now and will be added during data entry

2.1. Disposable filtering half mask
2.2. Unpowered Half mask

2.3. Unpowered Full face mask
2.4. Powered Half mask
2.5. Powered Full face mask
2.6. Powered helmets
2.7. Simple bandit, cloth or fleece mask (nuisance mask)

	Control group	Control
1	Disposable filtering half mask	P1 (FFP1)
2	Disposable filtering half mask	P2 (FFP2)
3	Disposable filtering half mask	P3 (FFP3)
4	Unpowered Half mask	Filter type P1L
5	Unpowered Half mask	Filter type P2L
6	Unpowered Half mask	Filter type P3L
7	Unpowered Half mask	Gas-vapour filter (A1/B1-A2/B2-A3/B3)
8	Unpowered Half mask	Gas-vapour-particulate filter (combined filter)
9	Unpowered Full face mask	Filter type P1L
10	Unpowered Full face mask	Filter type P2L
11	Unpowered Full face mask	Filter type P3L
12	Unpowered Full face mask	Gas-vapour filter (A1/B1-A2/B2-A3/B3)
13	Unpowered Full face mask	Gas-vapour-particulate filter (combined filter)
14	Powered Half mask	TMP1 (particulate cartridge)
15	Powered Half mask	TMP2 (particulate cartridge)
16	Powered Half mask	TMP3 (particulate cartridge)
17	Powered Half mask	Gas-vapour filter (A1/B1-A2/B2-A3/B3)
18	Powered Half mask	Gas-vapour-particulate filter (combined filter)
19	Powered Full face mask	TMP1 (particulate cartridge)
20	Powered Full face mask	TMP2 (particulate cartridge)
21	Powered Full face mask	TMP3 (particulate cartridge)
22	Powered Full face mask	Gas-vapour filter (A1/B1-A2/B2-A3/B3)
23	Powered Full face mask	Gas-vapour-particulate filter (combined filter)
24	Powered helmets	Supplied air system TH1
25	Powered helmets	Supplied air system TH2
26	Powered helmets	Supplied air system TH3
27	Simple bandit, cloth or fleece mask	Not specified 'nuisance' mask

3. Body Protection

3.1. Insulated Coats and Pants
3.2. Sleeves and PVC Aprons
3.3. Cloth Coveralls (Class 1 to 6)*
3.4. Protective overalls and disposable coveralls
3.5. Full Body Suit (Tyvek / Saranex)
3.6. DEM Windbreaker
3.7. Chemical Splash Suit
3.8. Ventilated / Overpressure suits (single, multiple use)

*CL1: Gas –Tight / CL2: Non - Gas tight / CL3: Liquid Tight / CL4: Spray Tight / CL5: Particle protection / CL6: Limited Spray Tight

4. Eye Protection

4.1. Safety goggles
4.2. Face shields

4.3. Eye shields
4.4. Safety glasses

5. Feet Protection

5.1. Safety boots
5.2. Rubber boots
5.3. Anti-static and conductive footwear

Appendix E Analytical methods relevant for measurement of airborne nanoparticles

	Analytical method
1	SMPS, TSI model 3936 (2.5 - 1000 nm), 1 to 10^8 p/cm^3
2	SMPS, TSI model 3034 (10 – 487 nm), 1 to 2.4×10^6 p/cm^3
3	NanoID (Naneum) model NPS500 (5 – 500 nm), p/cm^3
4	FMPS, TSI model 3091 (5.6 – 560 nm), p/cm^3
5	EEPS, TSI model 3090 (5.6 - 560 nm), p/cm^3
6	Aerotrak (handheld OPC), (TSI model 9303/9306 (≈300 – 25 000 nm), 2 * 10^6 p/cm^3
7	Aerotrak (OPC),(TSI different models (100 – 25 000 nm), 40 000 p/cm^3 (depends on model)
8	APS (OPC), TSI model 3321 (500 – 20 000 nm), 0.001–10^4 p/cm^3
9	MiniDiSC (10 – 300 nm), 10^3 – 10^6 p/cm^3
10	ELPI, DEKATI model (7 – 10 000 nm), p/cm^3
11	CPC (handheld), TSI model 3007 (10 - >1 000 nm), 10^5 p/cm^3
12	CPC (portable), (TSI models 3772, 3775, 3776, 3781, 3785, 3786, 3790 (≈2.5 – 3 000 nm), 10^7 p/cm^3 (depends on model)
13	P-trak (CPC), TSI model 8525 (20 – 1000 nm), 0 - 5x10^5 p/cm^3
14	NanoTracer, Aerasense Philips (10 – 300 nm), 1500 – 10^6 p/cm^3
15	Aerotrak, TSI model 9000 (10 – 1000 nm), 1 – 2 500 and 1 – 10 000 µm^2/cc
16	LQ1 1-DC (4 – 10000 nm), 0 – 2 000 µm^2/cm^3
17	EcoChem DC2000CE (~ 2 - 10 000 nm), ~ 10 to 1000 µm^2/cm^3
18	NSAM, TSI model 3550 (10 – 1000 nm), 0 – 2 500 and 0 – 10 000 µm^2/cm^3
19	Epiphaniometer (10 – 1000 nm), µm^2/cm^3
20	DustTrak, TSI models 8530, 8531, 8532 (100 – 10000 nm), 0.001 – 400 mg/m^3 (depends on model)
21	DustTrak, TSI models 8533, 8534 (100 – 15000 nm), 0.001 – 400 mg/m^3 (depends on model)
22	TEOM, model APM 1400ab (no PS), 0 - 50 00 000 µg/m^3
23	Aethalometer, model AE42-7 (0 – 950 nm), µg/m^3
24	

Note: all relevant gravimetric methods will also be included if mass is presented (e.g. NIOSH method 7302)

Appendix F Overview of various sampling methods for testing protective clothing, filter media and respirators

	Method
1	Interception - gloves
2	Interception – coverall (tyvek)
3	Interception – coverall (cotton)
4	Interception – underwear (long pants, long-sleeved shirt)
5	Interception –head band
6	Interception – patches
7	Removal – hand wash
8	Removal – hand rinse
9	Removal – wipe
10	Removal – tape strip
11	In-situ – natural fluorescence (probe)
12	In-situ – FWA Tracer + video imaging
13	In-situ – FWA Tracer + UV probe
14	TSI 8130 automated filter tester (polydisperse)
15	NIOSH 42 CFR 84
16	TSI 3160 Fractional Efficiency tester (monodisperse)
17	SMPS 3080

Appendix G Overview of different body parts (relevant for protective clothing testing and dermal exposure)

Body parts
Whole body
Head
Neck
Upper chest
Abdomen
Chest
Back
Torso
Upper arms
Fore-arms
Arms
Upper legs (thighs)
Lower legs
Legs
Hands

Appendix H Proposed classification of the engineering controls (as used in the Advanced REACH Tool, Fransman et al, 2010)

No localized controls

Localized control subclass	Description	Assigned typical value[#]	Examples
No localized controls	No control measures in close proximity of the source.	1	

[#] A value of 0.1 is equivalent to a 90% reduction in personal exposure level

Suppression techniques

Localized control subclass	Description	Assigned typical value[#]	Examples
Wetting at the point of release	Wetting systems that wet the process at the point of release (focusing on the emission source) to agglomerate and bind the fine particles to prevent dust from being dispersed into the workroom air.	0.1	Wet grinding, rock crushing, wet drilling.  Thorpe et al, 1999: "Wetting at the point of release"
Knockdown suppression	Post generation suppression of airborne contaminants to reduce dust levels. Knockdown of a contaminant after it has been emitted.	0.7	Water wash curtain, electrostatic capture, misting (steaming), damping down spray.

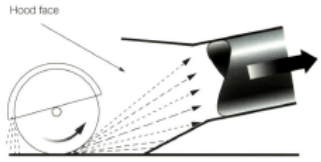
Containment – no extraction

Localized control subclass	Description	Assigned typical value[#]	Examples
Containment - no extraction	Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity. This class reflects "add on" enclosures and does not include inherently closed systems (like pipelines)		

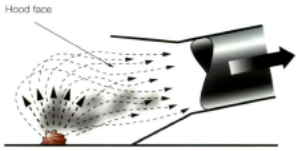
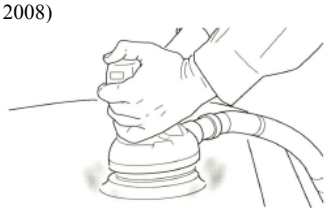
- Low level containment	Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity. The process is contained with a loose lid or cover, which is not air tight. This includes tapping molten metal through covered launders and placing a loose lid on a ladle This class also includes bags or liners fitted around transfer points from source to receiving vessel. These include Muller seals, Stott head and single bag, and associated clamps and closures.	0.1	
- Medium level containment	Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity. The material transfer is enclosed with the receiving vessel being docked or sealed to the source vessel. Examples include sealing heads, transfer containers and multiple o-rings. Inflatable packing head with continuous liner ensures a seal is maintained during the powder transfer and the continuous plastic liner prevents direct contact with the product. The correct type of tie off must be used.	0.01	
- High level containment	Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the activity. The substance is contained within a sealed and enclosed system. This class includes metal smelting furnaces or atomisation units. The material transfer is entirely enclosed with high containment valves (e.g. split butterfly valves and direct couplings, which consist of two sections which connect together to allow the opening of the valve). At the end of the material transfer the two halves are separated, forming a seal on both the process equipment and the material container. The system is designed to minimise the surface area which can contact the material or pairs of valves with wash space between them.	0.001	

Local ventilation systems

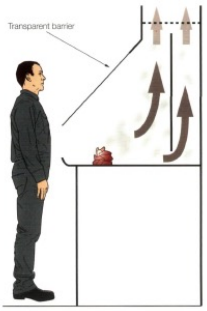
Localized control subclass	Description	Assigned typical value[#]	Examples
Receiving hoods			
Canopy hoods	A canopy hood placed over a hot process to receive the plume of contaminant-laden air given off. For cold processes with no thermal uplift, canopy hoods are ineffective (HSE, 2008).	0.5	 Canopy hood over a hot process (HSE, 2008)

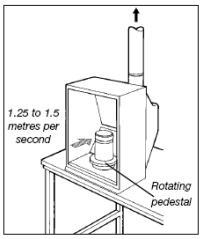
Other receiving hoods	A receiving hood can be applied wherever a process produces a contaminant cloud with a strong and predictable direction (e.g. a grinding wheel). The contaminant cloud is propelled into the hood by process-induced air movement. The face of the hood must be big enough to receive the contaminant cloud and the extraction empties the hood of contaminated air at least as fast as it is filled.	0.2	 Grinding wheel and receiving hood (HSE, 2008)

Capturing hoods

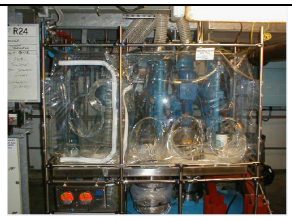
Fixed capturing hoods	Fixed capturing hoods located in close proximity of and directed at the source of emission. The design is such that the work is performed in the capture zone of the ventilation system and the capture is indicated at the workplace.	0.1	 Capturing hood (HSE, 2008)
Movable capturing hoods	Movable LEV systems such as hoods with extendable arms. The design of the system does not prevent work being performed outside the capture zone of the system and worker behaviour can influence the effectiveness of the system.	0.5	 Movable capturing hood (HSE, 2008)
On-tool extraction	LEV systems integrated in a process or equipment that cannot be separated from the primary emission source.	0.1	 On-tool extraction (HSE, 2008)

Enclosing hoods

Fume cupboard	Any form of permanent encapsulation or encasing of the source of which maximally one side is open with a well designed local exhaust ventilation system (e.g. laminar air flow). The design of both the enclosure and the ventilation system is such that the influence of worker behaviour is minimal (e.g. an alarm system prevents the worker from using the fume cupboard in case the system is not working properly).	0.01	 Fume cupboard (HSE, 2008)

Horizontal/downward laminar flow booth	In a horizontal laminar flow booth, contaminated air is extracted through holes situated at the rear of the booth which creates a horizontal laminar air flow. The air is filtered prior to being discharged to the atmosphere. The booth contains the source and has maximally one side open. In a downward laminar flow booth, a curtain of descending laminar air flow is created between the ceiling and the rear of the booth where exhaust grills are located in the lower section. The booth contains the source and has maximally one side open.. Spray rooms and laminar down-flow booths (with the size of a room which contains both the source and the worker) are not considered to be a localised control and will be treated together with the dispersion questions at a later stage.	0.1	
Other enclosing hoods	Any form of permanent encapsulation or encasing of the source of which maximally the front side is open with a proper local exhaust ventilation system.	0.1	 Spraying glazes and colours (http://www.hse.gov.uk/pubns/guidance/cr5.pdf)
Other LEV systems	In case the type of local exhaust ventilation system is unknown or not specified, this default LEV category can be selected. Note that this default category results in a low reduction of the estimated personal exposure level. An attempt should be made to more specifically define the type of local exhaust ventilation.	0.5	

Glove bags and glove boxes

Localized control subclass	**Description**	**Assigned typical value#**	**Examples**
Glove bag	Large plastic bags, available in different design and sizes are fitted with gloves which allow products to be handled in a contained way. An adaption piece is necessary between the glove bag and the process equipment. The glove bag must be designed specifically for the task and the quantity of material to be handled. Various other items such as pass-out boxes, inlet filters, and drains are added to meet specific needs. Note: use of glove bags does not negate the need to implement a long term permanent technological solution.		
> Glove bag (non-ventilated)	Large plastic bags, available in different design and sizes are fitted with gloves which allow products to be	0.01	

	handled in a contained way without exhaust ventilation.	
> Glove bag (ventilated or kept under negative pressure)	Large plastic bags, available in different design and sizes are fitted with gloves which allow products to be handled in a contained way. The glove bag is maintained with filtration and ventilation at specific flow rates	0.001
Glove box	Any form of permanent encapsulation or encasing of the source (which are not opened during the given activity) with a well designed local exhaust ventilation system. The design of both the enclosure and the ventilation system is such that the influence of worker behaviour is minimal (e.g. the enclosure cannot be opened before the substance is properly vented).	
> Low specification glove box	A low specification glove box is specified as: • Single chamber, simple access doors or pass box • Not safe change glove • Single HEPA filtered extract air • Not safe change filters Manual cleaning	0.001
> Medium specification glove box	A medium specification glove box is specified as: • Two or more chambers if large area bin docking or high dust levels expected • Safe change or push through filters are required • Solid (stainless steel) construction for durability • Size is dependent on the task to be carried out • Safe change filters are required • Air should be single or double HEPA filtered and or exhausted directly to the atmosphere after single HEPA filtration. • The equipment should be maintained under negative pressure and the air flow and filter condition continuously monitored. • Emergency air extraction should start up automatically in the event of a leak or a damaged glove. • Interlocked air locks should be used to prevent high dust concentrations in the area of the transfer ports and reduce risk. (escape of the contaminant during transfer of materials into and out of the glove box).	0.0003

	• Glove changes should be able to be carried out without breaking containment • Waste disposal ports are required. Correct sealing of continuous liners. Manual cleaning	
> High specification glove box	A high specification glove box is specified as: • Two or more chambers • Safe change filters are required • Stainless steel construction • Size is dependent on the task to be carried out • Safe change filters are required • Air should be single or double HEPA filtered and or exhausted directly to the atmosphere after single HEPA filtration. • The equipment should be maintained under negative pressure and the air flow and filter condition continuously monitored. • Emergency air extraction should start up automatically in the event of a leak or a damaged glove. • Interlocked air locks should be used to prevent the escape of the contaminant during transfer of materials into and out of the glove box. • Glove changes should be able to be carried out without breaking containment • Waste disposal ports are required. • Integrated sampling and contained drum charging • Sealed and high containment transfer ports (contained transfer couplings, rapid transfer ports (RTPs), alpha/beta valves etc.) • Including waste removal and change parts • Wash in place Alarmed	0.0001

Vapor recovery systems

Localized control subclass	Description	Assigned typical value[#]	Examples

Vapour recovery systems	Reduction of vapour emission during storage, loading and off-loading of gasoline or other liquids, and during re-fuelling of a vehicle, by the combination of a vapour collection system and a vapour control unit. Vapour collection is a passive process where the volume of liquid transferred is equal to the volume of vapour transported back to the tank. The system only works properly when no other escape openings are present.	0.2