Scaffold Public Documents - SPD11

Innovative strategies, methods and tools for occupational risks management of manufactured nanomaterials (MNMs) in the construction industry

EXPOSURE REGISTER MODEL FOR MANUFACTURED NANOMATERIALS (MNMs) IN THE CONSTRUCTION INDUSTRY

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1. EXECUTIVE SUMMARY

Increasing numbers of workers are exposed to manufactured nanomaterials. Nanomaterials are used in research, manufacturing and products. Because of data gaps in exposure and hazard assessment of nanomaterials and also in the information of products containing nanomaterials, it is not yet known to what extent workers are at risk. For that reason, a model of an exposure register is defined for identifying nanomaterial exposed workers at the construction sector.

An exposure register is a system for collecting and maintaining, in a structured record, information on persons with known or suspected occupational or environmental exposure to a hazardous substance. Exposure registers have been used for different substances. For example, the information on exposure to carcinogenic substances is collected in Finland, Italy, Germany and Romania. Workers formerly exposed to asbestos are registered in Germany and similar asbestos related survey data has been collected in the UK. The compulsory registration is expected to stimulate identification, assessment and elimination of carcinogenic exposures at workplaces, resulting in a decreased risk of occupational cancer among notified workers.

For the nanomaterials, there is only one compulsory registration system so far in Europe. France has established a mandatory reporting scheme for manufactured nanomaterials produced, imported or distributed in its territory since 2013, but several other countries are currently considering similar mandatory reporting schemes. The aims of the registers are to serve as a societal response to hazardous exposures, as a step for epidemiological studies, and allow the risk communication. However, there are many open questions before the exposure registers can be built up. Some examples of these open questions are who would manage the exposure register, what data should be collected and how and who may have access to the data.

In the model presented in this report, the basic idea is that the construction company or their occupational health care unit will manage the exposure register and only they have the access to the data. The model is in Excel format. PEROSH Institutes (IFA, TNO, NRCWE, HSL, INRS, FIOH, INSHT, CIOP) have developed a database called NECID (Nanomaterial Exposure and Contextual Information Database) for collecting nanoparticle air exposure data from work places. Exposure data and contextual information can be partly collected using the NECID data structure (as external partners) on company level. The use of NECID ensures the key requirements for good quality data for exposed workers. However, the register can also be used as a separate database (Fig. 1), but then more expert knowledge is needed for the choice of options from the dropdown lists.

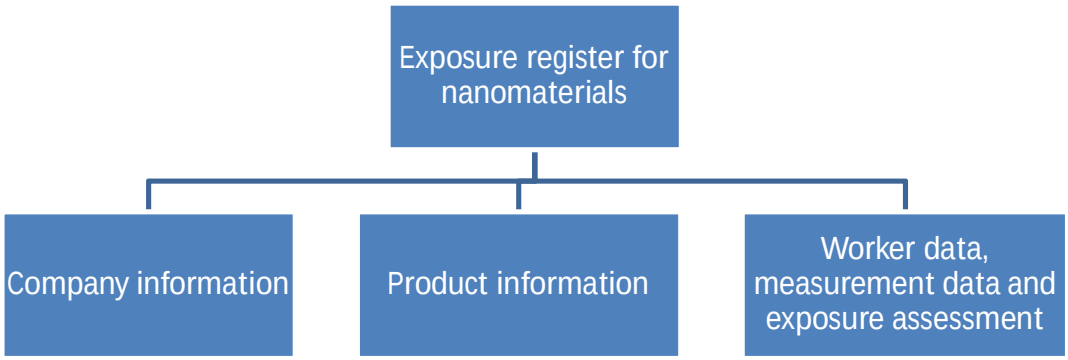

Figure 1. The structure of the exposure register model if used as a separate database.

If the NECID database has been used for storing information in exposure and risk assessment, most of the data that is required in the present register model can be obtained from the NECID database (Fig. 2). Only eight data fields have to be added manually concerning worker identity, job history and measured and assessed exposure level. Fields to be added are: name of the worker, identity or social security number, frequency of the task, date when the use of MNP started and ended (if available), calculated NP concentration per eight hour working day, exposure class assessment and used OELs.

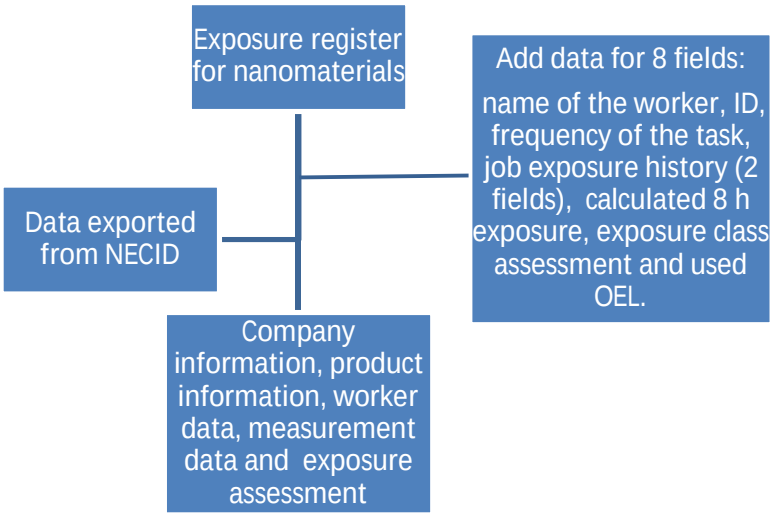

Figure 2. The structure of the exposure register model if data is exported from NECID.

If NECID database is not used the register model consists of three separate sheets (Fig 1), which are linked to each other by repeating some data points. Industrial sector (NACE) codes are used in the Company and Product data sheets. The Product row number from the Product data sheet will be referred to in the Worker data sheet. If NECID database is used the register is a one-sheet register including all the fields and no links are needed.

The identity number or social security number can be used for combining the exposure data of a worker with the health (or disease) information of the same worker in the future. Thus, the data included in this model may be used as a starting point for epidemiological studies.

The data included in the register is coded where possible. Coded data is more useful than free text data, as free text information must be re-coded for use in data analysis (Burstyn, Kromhout et al. 2000). However, with the free text option one may add some important details about the work, products or other issues.

Nanomaterial-exposed workers at the construction sites are most likely exposed to many other (hazardous) substances too. Because of the mixed exposure it is important that the nano exposure register can be connected to other exposure data bases and also to the health data records of the worker. Nanomaterials cannot be separated from all other dusts that exist at the construction site. It is not yet known whether exposure to nanomaterials may cause specific symptoms/health hazards and at which exposure level these symptoms may occur. The use of questionnaires of symptoms are not suitable for workers at the construction sites for the same reason. Also it is not ethically correct to ask symptoms and troubled the workers without any consistent prove of evidence.

At the moment, when there are no uniform national or international regulations for collecting nanomaterial exposure data, the construction company or their occupational health care unit is recommended to collect exposure data and include it in a register, based on the register model presented in this report.

2. OBJECTIVES

The aim of the exposure register is

- to identify possibly exposed workers, by the employer and by the occupational health care unit
- to provide the employer (or occupational health care) with an opportunity to evaluate the exposure level of the workers
- to provide better estimates of exposure to nanomaterials in order to focus the risk management methods effectively

The data collected according to this exposure register model may also be used as a starting point for epidemiological studies in the future.

3. SCOPE

This register is designed to be used by construction industry employers or their occupational health care units. The exposure register is a personal register, but possible further conclusions or studies can be made anonymously using the job codes or activity codes.

In the construction industry it is most likely impossible to distinguish the potential health effects (and exposure) of nanomaterial from other dominant conventional exposures like, e.g., ultra-fine and inhalable dust, and quartz. Because of this fact, the use of the register in epidemiological studies is still a secondary target and the primary target can be seen in focusing the risk management methods efficiently. Exposure register can be useful in enhancing risk communication concerning nanomaterial use within a company. If the registers are planned to be used for epidemiological studies in the future, it is reasonable to use combined company registers which are based on multidimensional job-activity exposure models.

4. INTRODUCTION

Increasing numbers of workers are exposed to manufactured nanomaterials. Nanomaterials are used in research, manufacturing and different kinds of industrial and consumer products. In the construction industry, the products containing nanomaterials are being used for example in cement and concrete products, in paints and coatings, and in insulation materials (van Broekhuizen and van Broekhuizen 2009). Because of knowledge gaps in exposure and hazard assessment of nanomaterials, and also in the information on products containing nanomaterials, it is not known to what extent workers are at risk. For that reason, a model of an exposure register is defined for identifying nanomaterial-exposed workers in the construction sector.

An exposure register is a system for collecting and maintaining, in a structured record, information on persons with known or suspected occupational or environmental exposure to a hazardous substance (Schulte, Schubauer-Berigan et al. 2009). Exposure registers have been used for different substances. For example, the information on exposure to carcinogenic agents is collected in Finland (Kauppinen, Saalo et al. 2007), Italy (Scarselli, Montaruli et al. 2007), Germany (Berufsgenossenschaft Rohstoffe und Chemische Industrie 2014) and Romania (Registrul de Cancer 2014). Workers formerly exposed to asbestos are registered in Germany (Gesundheitsvorsorge 2014) and similar asbestos related survey data has been collected in the UK (Health and Safety Executive 2009). The compulsory registration is expected to stimulate identification, assessment and elimination of carcinogenic exposures at

workplaces, resulting in a decreased risk of occupational cancer among notified workers (Kauppinen, Saalo et al. 2007).

For the nanomaterials, there is only one compulsory registration system so far in Europe. France introduced a nanomaterial register in 2013, which consist also the exposure register part. The aims of the registers are to serve as a societal response to hazardous exposures, as a step for epidemiological studies, and allow the risk communication. However, there are many open questions before the exposure registers can be built up. Some examples of these open questions are who would manage the exposure register, what data should be collected, and how and who may have access to the data (Schulte, Schubauer-Berigan et al. 2009).

Nanomaterial registers and lists

As the conventional Material Safety Data Sheets (MSDS) do not require automatic notification of nanomaterial ingredients, some countries have introduced, or are planning to introduce, a compulsory registration. By now only France and Denmark have introduced a nanomaterial registers in the EU (Boutou-Kempf, Marchand et al. 2011, http://eng.mst.dk/topics/chemicals/nanomaterials/). The nanomaterials should be declared to French (ANSES) if the amount of use is 100 kg or more per year. Belgium has also ratified a mandatory nano reporting scheme and the registration will start in the beginning of the year 2016. The EU Commission has launched a public consultation on transparency measures for nanomaterials on the market (European Commission 2014). Norway is preparing to set a register of nanoscale materials under its National Product Register (NIA Nanotechology Industries Association). Also Sweden and Italy are considering mandatory reporting schemes (Friends of the the Earth 2014). The United Kingdom and Ireland have conducted a voluntary reporting. These reporting systems aim to increase knowledge of the nanomaterials and nanoproducts placed on the market, gather information for risk assessment, and provide information on nanomaterials and nanoproducts to workers and to the public.

Unfortunately no list of all products containing nanomaterial is available. The German Trade association for the Construction Industry (Deutsche Berufsgenossenschaft der Bauwirtschaft; BG Bau) has compiled a list of construction and cleaning products that advertise under the heading ”nano” or that utilize nanotechnology in products http://nano.dguv.de/links-downloads/uv-traeger/bg-bau/

Other sources for nanoproducts are databases like Nanowerk (German), Nanodaten (German), Nanoliste (German) and Nanodatabases (Danish). These databases and reporting schemes can be found at the following site of NIA (Nanotechnology Industries Association):
http://www.nanotechia.org/services/databases-reporting-schemes

Register use in surveillance and epidemiological studies

The exposure register can be used for the promotion of risk communication and management at company level. At an individual level, the exposure register can be used to determine whether somebody is at greater risk than others. Within companies, exposure registers can be used to determine whether control measures are required or whether current measures need to be tightened up. Exposure registers can be a useful aid in risk communication and awareness-raising (Health Council of the Netherlands 2012).

It is possible to build up a multidimensional job-activity exposure matrix with the information in the exposure register. Identification descriptors of job-titles, activities, processes and industry sectors are

needed for the exposure estimation of personal exposure with statistical models (Riediker, Schubauer-Berigan et al. 2012). Formation of cohorts for an epidemiological study may involve combining workers from different companies and possibly different countries, as the number of nanomaterial workers is still quite small, the materials handled are heterogeneous and the exposure is diverse and continually changing (Riediker, Schubauer-Berigan et al. 2012). Associations between exposure and health effects can be made using anonymized data, however these databases can only be linked by data that can be tracked back to individuals (Health Council of the Netherlands 2012).

In France, a two-part epidemiological surveillance system has been proposed. Besides a prospective cohort study several repeated cross-sectional studies are designed. The cohort study will be limited to few high-priority nanomaterials (carbon nanotubes, carbon black, amorphous silica and nanosized titanium oxide) and will necessitate collaboration with enterprises. The cross-sectional studies would involve all nanomaterials and is dependent on the adherence of occupational physicians to the initiative to identify nano-exposed workers (Boutou-Kempf, Marchand et al. 2011) (Canu, Boutou-Kempf et al 2013).

Management and maintaining of the exposure register

The exposure register can be established within a department or section of a company, on a companywide basis, on an industrywide basis or at broad geographic levels, such as region or nation (LaMontagne, Herrick et al. (2002)). In the case of exposure to nanomaterials in the construction sector, the company level is recommended, as this would also enhance the company surveillance of exposure. Either the employer or the occupational health care unit would be responsible for the voluntarily registration.

National registers are not easy to build up as they need legislation and enough resources. One main question would also be which nanomaterials to be registered, because of the currently insufficient toxicological data. A potential benefit of establishing national registers is that and they could collaborate internationally, resulting in increased numbers of workers for epidemiological study cohorts. The structure for a centrally managed register should be even simpler than the one for the company level use presented here.

NECID database for air exposure data

NECID (Nano exposure and contextual information database) is a database for nanoparticle air exposure data developed by a working group of PEROSH Institutes (IFA, TNO, NRCWE, HSL, INRS, FIOH, INSHT, CIOP). It aims at harmonized and uniform storing of nanoparticle exposure and contextual information data and will facilitate the future comparing and sharing of the data (Fransman, Pelzer et al. 2012). IFA is maintaining the database, and other PEROSH countries may use and add information to the database. Also other institutes are able to add and use the information of the database, but they have to make an agreement of the use with the PEROSH Institutes.

The NECID database can be used as a base of nano exposure determinants information for an exposure register in the future. With the use of NECID, a high quality of exposure assessment will be ensured. A high-quality exposure assessment is the critical factor upon which the health surveillance or epidemiological studies are based (Trout and Schulte 2010). The NECID data base is designed mainly for the needs of research in the field of exposure to nanomaterials and also for defining the best ways to control the exposure.

5. METHODOLOGY TO COLLECT THE DATA

Content of the Scaffold exposure register model

The proposed exposure register model for nanomaterials consists of three different Excel data sheets: company information, product information, and worker data and exposure assessment. The sheets can be linked to each other by industrial sector (NACE) code and product row number, which are marked in the Table 1 with an arrow.

If the NECID database is used for collecting information of exposure, it can be used in this exposure register model. The selected data from NECID can be exported by choosing the corresponding fields. When exporting the data, only two options for data presentation type are available (according to activity or worker data) and all the data are presented in a same Excel row. The data that is expressed according to worker is the best choice for the register needs. This is the present (May 2014) situation, but as the NECID register is still under development, this may change in the future. Extra fields that are not available from NECID should be added manually to the register.

Table 1 presents a detailed presentation of the content of the exposure register model. Minimum information needed is marked with a red asterisk*. Options for the inserted data are coded where possible. The pictures of thee excel sheets are presented in Appendix 1. Data which is available from NECID is marked as *N*. Note that if NECID data is used, the register is a one-sheet register including all the fields. In those cases, the links (NACE-code and product row number) need not be repeated. The data is recommended to be chosen according to worker data and all the data points will be printed in a same excel row. The selection options to be used for the NECID data export are presented in Table 2.

USE of NECID as a database for the model

The contextual information and measurement data from the workplace may be added first to the NECID, after which Excel-format sheets for the exposure register can be taken out from the NECID. Those fields, which are not available from NECID, can be inserted manually to the Excel sheet, which can be taken out as a NECID export file. The workplace or the responsible occupational health care provider will manage the register and add worker information and job history (name, social security number, start and end dates of exposure etc.). The designed system for data transfer from NECID is still under development. The current version of the program (May 2014) is NECID 0.06.02. In the future, the NECID database could also possibly provide enough data for the comparison of an individual company, industrial sector or occupational code to sector averages.

It is possible to select more options to be exported from the NECID but with the selections mentioned in Table 2, you will get the main parts of data needed for the register and you have to add manually the worker information, job history and the measured and assessed exposure level.

Table 1. Content of the exposure register model

Sheet 1. Company data	Sheet 2. Product data	Sheet 3. Worker data, measurement data and exposure assessment	
		worker data	measurement data and exposure assessment
*Company name *N*	*Industrial sector *N* (NACE-code)	*Name of the worker	Sampling date *N*
Site address *N*	*Product row number	*Social security number	Location name *N*
Type of construction (free text)	*Product trade name *N*	Occupation (free text)	Unit of measurement *N*
*Industrial sector *N* (NACE code and text)	*Product form *N*	*Job codes (ISCO code and text) *N*	Personal or static sample *N*
Remarks	* Used amount and unit *N*	*Product row number	Background: measured NP concentration *N*
	*Used MNP (OECD list) *N*	*Job tasks, activity codes *N*	Activity or task: measured NP concentration *N*
	*Used MNP (OECD list) *N*	*Duration of the task *N*	Activity-Background: calculated *N*
	*Used MNP (OECD list) *N*	*Frequency of the task	Work day: calculated NP concentration / 8h
	Remarks	*Date when the worker started to use MNP	Assess exposure class (high, moderate, low)
		Date when the worker use of MNP has ended	Used OELs or other limit values
		Control measures (free text)	Remarks

Table 2. Data selection options when exporting data from NECID 0.06.02

Heading in NECID	Options to be selected
Measurement	Measurements ID
	Worker
	Activity ID
	Measuring point ID
	Sample ID
	Value ID
	ENM of interest for this set of measurements
	Second ENM
	Third ENM
	OECD Remarks
Premises	Branch code
	Premises name
	Department name
	City/town
	Country
Location	Location name
	Description of the workplace
	Description of the activity/process
Worker	Worker number
	Job title
	ISCO job code
	ISCO job title
	Remarks
Local control	Local control
Activity	Activity kind
	Activity duration
	Total activity duration in shift
	Use of ENM*
	Exposure pattern*
	Exposure situation*
	Description activity
	Activity code
	Remarks
Materials	Nanomaterial
	Product name
	Product form
	Remarks
Sample information	Date
	Concentration
	Particle size*
	Used as
	Used amount
	Unit

*available from NECID, but not used in the final exposure register model

The information in the worker register should be updated at regular intervals whenever there is a change in the working situation or the worker position and work tasks. No incidental use or accidents are included. The register is not designed to contain biological samples.

6. CONTENT OF THE REGISTER

If the data is separately collected in the Excel format the Exposure register model for construction industry employers consists of three Excel sheets (Appendix 1). If the main data is exported from NECID into the Excel format database, the register is a one-sheet Excel file and extra fields that are not available from NECID can be added manually to the register. The options for each fields are the same, except for the duration of the task. If NECID is used, the information on duration is exported as hours per day, but if the register is used separately, the duration can be classified according to the Stoffenmanager, which options are presented in Table 4.

Company information

Company information can be written on a separate sheet or exported from the NECID (Appendix 1.). The data needed is the company name and address and the industrial sector code, which can be chosen from the NACE Rev 2 codes http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NACE_REV2&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC. (Click the main headings to get access to detailed branch code and copy it to the register.)

Figure 3 is a view of the Eurostat pages presenting current Economic activities data. In the register there is also a box for free text description of the type of construction.

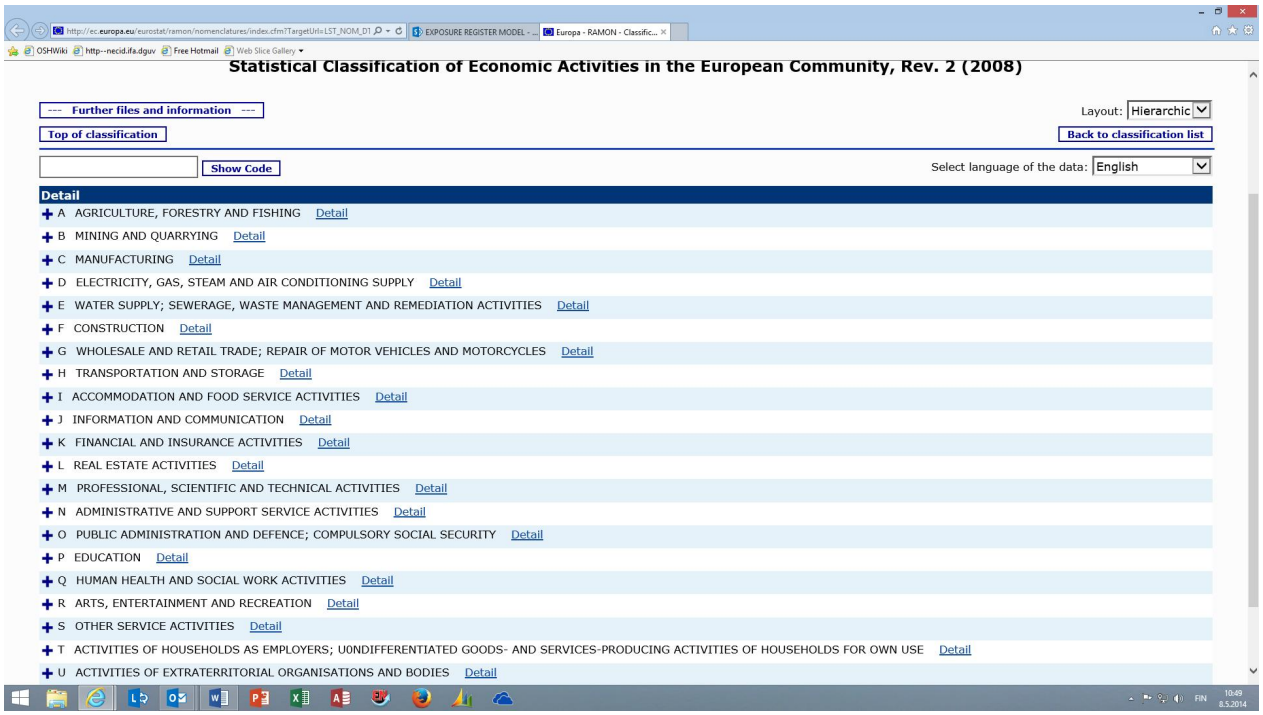

Figure 3. NACE Rev 2 coding (2008) from the Eurostat pages.

Product information

The minimum requirements for the information of the used product are product row number, name, product form and OECD coding for the nanoparticle ingredients (Appendix 1). Coded options for product

form and used manufactured nanomaterials are presented in Table 3. More properties can be available from the NECID database, in which numerous physical and chemical properties of the product and ingredients used can be added while performing the measurements. Properties like purity of the material, viscosity, density, dustiness, moisture content, molecular mass, surface area, particle size, name of the ingredient, identity of material, and concentration of analyzed chemical are available in NECID. In the future, the more information on product and single ingredients that are available, the more accurate the epidemiological studies could be. Other non-nano agents causing possible exposure can be found out by entering the commercial name of the product. With the help of national product registers, the composition of the product should be available, if needed. Information on other known exposures is recommended to be added as free text to the remarks field.

Table 3. Options for product form and OECD coding for used manufactured nanoparticle (MNP). Adopted from NECID database.

Product form	Used MNP (OECD list)
liquid	Fullerenes (C60)
power	Single-walled carbon nanotubes (SWCNTs)
solid object	Multi-walled carbon nanotubes (MWCNTs)
fibers	Silver nanoparticles
paste	Iron nanoparticles
	Titanium dioxide
	Aluminium oxide
	Cerium oxide
	Zinc oxide
	Silicon dioxide
	Dendrimers
	Nanoclays
	Gold nanoparticles
	mixture of nanoparticles
	Other

Worker and measurement data and exposure assessment

This sheet contains worker identification data (name and social security number) measurement data and exposure assessment data and it is linked to the product by the product row number (Appendix 1). If NECID data export is used, these links are not necessary, because all the data is presented on a single row. Occupational coding should be chosen from the ISCO-08 list (Figure 2.) which is available at the following site http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=CL_ISCO08&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC. (Click the main headings to get access to detailed occupational code and copy it to the register. There is also a box for free text description of the occupation.

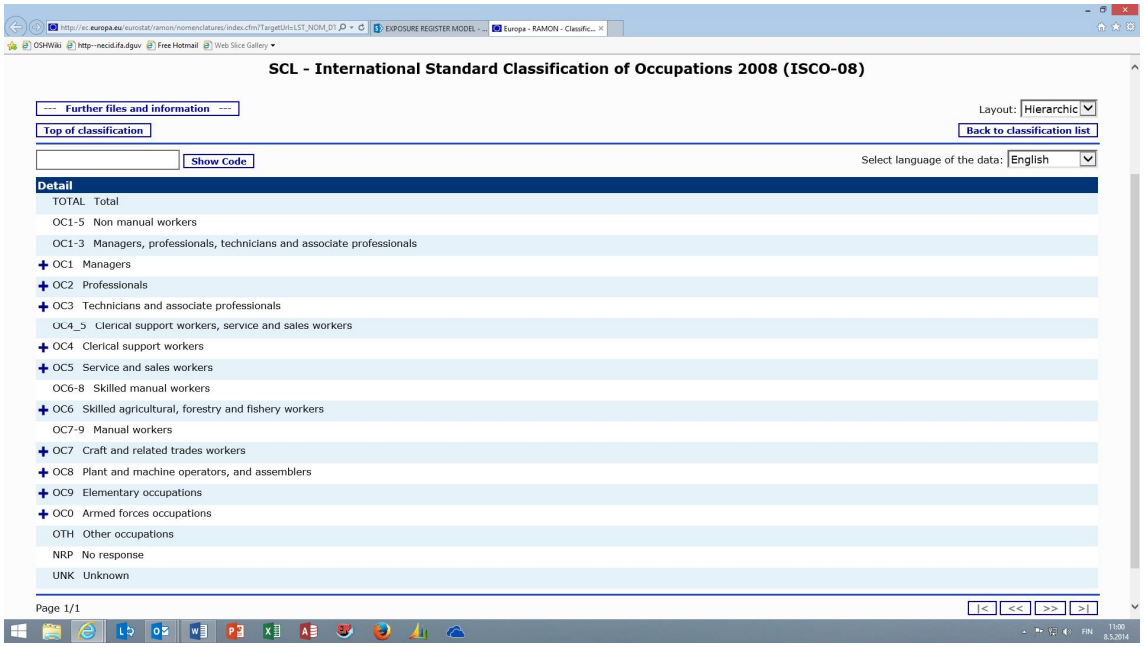

Figure 4. ISCO-08 coding from the Eurostat pages.

All the potentially exposed workers should be added to the register despite of the estimated exposure level. This means all the workers, who are handling nanomaterials or products containing nanomaterials, in situations where it is possible that they are exposed to nanomaterial via the respiratory or dermal route. The worker information should contain all the positions where the worker is involved in a company. The same worker may have several activity codes and may work with several nanoproducts as well. In those cases, the data should be added at different lines. The list of coded options for activity was originally produced in the NECID-project and is presented in Table 5. The duration and frequency of the task/activity are important factors for estimating annual exposure levels. The coded options are presented in Table 4. The same factors for duration and frequency is used also in the Stoffenmanager exposure model. However, in different exposure models the duration and frequency have been presented differently and often frequency of the activity is not included as a separate factor. If the NECID database is used as a starting point for the exposure register, the duration of the activity can be picked there as hours per day

Table 4. Options for duration and frequency of the task.

Duration of the task	Frequency of the task
4 to 8 hours a day	4 to 5 days a week
2 to 4 hours a day	2 to 3 days a week
0,5 to 2 hours a day	approximately 1 day a week
1 to 30 minutes a day	approximately 1 day per two weeks
	approximately 1 day per month
	approximately 1 day a year

Table 5. Options for job tasks (activity codes and texts). Adopted from NECID database.

Job tasks, activity codes
1. Point source or fugitive emission during the production phase (synthesis)
1.01 Flame pyrolysis
1.02 Mechanical reduction
1.03 Chemical vapor condensation
1.04 Laser ablation
1.05 Wet chemistry
1.06 Sintering
1.99 Other
2. Handling and transfer of bulk manufactured nanomaterial powders
2.01 Impaction on contaminated solid objects
2.02 Handling of contaminated solid objects
2.03 Movement and agitation of powders or granules
2.04 Transfer of powders or granules
2.04.01 Falling of powders or granules
2.04.02 Vacuum transfer of powders or granules
2.05 Compressing of powders or granules
2.06 Fracturing of powders or granules
2.99 Other
3. Dispersion of intermediates or application of ready-to-use products
3.01 Impaction on contaminated solid objects
3.02 Handling of contaminated solid objects
3.03 Movement and agitation of powders or granules
3.04 Transfer of powders or granules
3.05 Compressing of powders or granules
3.06 Fracturing of powders or granules
3.07 Spray application of powders
3.07 Spray application of liquids
3.08.01 Surface spraying of liquids
3.08.02 Spraying of liquids in a space
3.09 Activities with open liquid surfaces
3.09.02 Activities with agitated surfaces
3.10 Spreading of liquid products
3.11 Application of liquids in high speed processes
3.12 Transfer of liquids products
3.12.1 Falling of liquids
3.12.2 Bottom loading
3.98 Other solids
3.99 Other liquids
3:04 Falling of powders or granules
3.04.02 Vacuum transfer of powders or granules
4. Activities resulting in fracturing/abrasion of MNO-enabled products
4.01 Fracturing and abrasion of solid objects
4.02 Abrasive blasting
4.03 Weathering/aging
4.99 Other
5. Hot processes
5.01 Burning of liquids
5.02 Burning of solids
5.03 Hardening/melting processes

5.04 Hot solid handling
5.06 Extruder
5.98 Other solids
5.99 Other liquids

The activity code, which is based on NECID coding, is one of the main determinants of this register, as it tells the life cycle stage (like production of nanomaterial, handling of nanomaterial, application, transfer or disposal of nanomaterial) and kind of work tasks performed. A list of the activity code options are presented in Table 5. If NECID is used for the storage of measurement and contextual information data, the options and results could easily be available from that system.

The harmonization of the nanomaterial measurements is under development. It is not yet clear what would be the ideal way to measure the exposure to nanomaterials. It is also unclear which metrics (number, mass or surface area) are most suitable for describing the exposure to nanomaterials or the risk of the exposure. In the air, there are always nanosized particles originating from vehicle exhaust, burning etc., and therefore the background particle concentrations have to be known in assessments. This is one reason why many different factors are asked in the exposure assessment sheet. Compulsory factors to be included are: unit of measurement, personal or static sample (Table 6.), background and activity level concentration. When static samples are taken, and they are representative also for the worker exposure, they should be added to the register. Static samples can be linked to the activity, while personal samples are always linked to personal data.

If the exposure levels have been measured and Occupational Exposure Limits (OEL) or some other limit values are available, the level of exposure can be assessed. For the construction industry, based on the evaluations carried out in the Scaffold project, the following recommendations for limit values related to exposure to specific nanomaterials are given: For titanium dioxide, an OEL of 0.1 mg/m^3 (8 h) is suggested, in order to protect workers from its potential health hazards, which are mainly related to local inflammatory effects in the lungs. The value is in the same size range as the recommended exposure limit for ultrafine TiO_2 of 0.3 mg/m^3, proposed by NIOSH (2011). For amorphous silicon dioxide, an OEL of 0.3 mg/m^3 (8 h) is suggested, based on data showing that exposure to silicon dioxide may induce pulmonary effects, which, however, seem to be reversible upon cessation of exposure. The OEL is not applicable for nanomaterials containing crystalline silica (Scaffold, Deliverable 3.11). When the calculated workday (8 hour) exposure is over the OEL and also the measured level during the activity is higher than the background concentration, the exposure class can be considered high. In cases, when the 8-h exposure is at the level of the OEL and the activity concentration is higher than the background concentration, the exposure class is moderate. The exposure class is low, when the 8-h workday exposure is considerably lower than OEL and also the background concentration is at the same level or higher than the concentration during the activity. In the measurement data excel sheet, a unit for measurement and whether the measurement is from personal or static sample must be chosen. Options to these and options for the exposure classes according measurements are presented in Table 6. The measured exposure concentration during the activity/task and also calculated for the whole working day are added to the data sheet. Also the background level should be added to the register. If the NECID data base is used main parts of the information can be extracted from there.

Table 6. Options for unit of measurement, personal or static sample or assessing exposure classes.

Unit of measurement	Personal or static sample	Exposure class
µg/m3	personal sample	high
number/cm3	static sample	moderate
other		low

Assessment of exposure class according measurements:

high = workday (8-h) conc. > OEL and activity conc. > background conc.

moderate = workday conc. ≤ OEL and activity conc. > background conc.

low = workday conc. << OEL and activity conc. ≤ background conc.

7. DISCUSSION

In this exposure register the construction company or their health care service provider is recommended (voluntarily) to take care of and include the exposure data in the register. The register consist of information of branch (industrial sector), job task, used product and used nanomaterial. One important parameter of the register is the social security number of worker, as it makes it possible to combine the exposure and health data in the future, if that is needed. If the company has used a Control Banding tool (like Stoffenmanager Nano tool) for risk assessment and risk management of nanomaterials, the results of this tool (class of hazard and exposure and risk level) can be added to the register by adding an extra columns to the worker sheet. The Stoffenmanager Nano tool is available at the website: http://nano.stoffenmanager.nl/.

The presented model for an exposure register is based on MS Excel and can be used separately. However, most of the data can be exported from NECID database. The benefit of using NECID as an exposure database is that the quality of contextual data and exposure data is ensured and the data collection for the register will be easier and quicker than when using the exposure register as a separate database, when all the data and data options must be inserted manually. As the NECID database is developed by six institutes belonging to PEROSH group (Germany, Netherland, United Kingdom, France, Finland, Poland, Denmark and Spain) it is easier for the companies in these countries to order the measurements from the consultants using the NECID database. However, it is also possible for the other institutes of other countries to use NECID database by making an agreement of the use with the PEROSH Institutes. Whether the data is collected separately or exported from NECID, only the company and the occupational health care unit have access to the exposure register.

It is supposed that there will be a underreporting in the data when notification to an exposure register is voluntary. Even in compulsory registrations systems, a substantial underreporting is suspected for temporary or low exposures as well as for exposures in small workplaces (Kauppinen, Saalo et al. 2007).

National exposure registers are suggested to stimulate preventive measures at workplaces, but the evaluation of costs and benefits of this kind of registration is challenging. A compulsory national notification may be a recommended procedure for the nanomaterial exposure register in the future, as the combination of the data and checks for completeness would be easier in centrally managed registers. . The toxicological and epidemiological studies of many types of nanoparticles is still sparse, but when the amount of substance specific data of health effects increases it will be easier to target the

exposure data collection at the most harmful nanoparticles. The structure for the centrally managed register should be simpler than the one for the company level use as presented in this report.

8. CONCLUSIONS

The Scaffold register model is designed to be used by construction industry employers or their occupational health care units, which are recommended to take care of and include the worker information asked into the exposure register. The register consists of information of branch (industrial sector), job and worker, used product, used nanomaterial and assessed exposure levels. The exposure register is a personal register for making possible to combine the exposure and health data in the future. However, possible further conclusions or studies can be made anonymously using e.g. job codes or activity codes. The exposure register is beneficial for identifying possibly exposed workers by the employer and by the occupational health care unit and providing the employer (or occupational health care personnel) with an opportunity to evaluate the exposure level of the workers and possibly also symptoms (sentinel events by surveillance) of exposure.

In the construction industry the workers are exposed to many conventional exposures like, e.g., ultra-fine and inhalable dust, and quartz. It will be very hard to distinguish the potential health effects of nanomaterial from other dominant exposures. Because of this fact, the use of the register in epidemiological studies is still a secondary target and the primary target can be seen in focusing the risk management methods efficiently through the knowledge of the use and exposure levels of nanomaterial. Exposure registers can be useful also in enhancing risk communication concerning nanomaterial use within a company.

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10. LIST OF FIGURES, TABLES AND APPENDIXES

APPENDIX 1. Exposure register model for construction industry employers.

SHEET1: COMPANY INFORMATION

NECID*	NECID		NECID*		
Company name	Site address	Type of construction (free text)	Industrial sector (NACE code)		Remarks
			code	text	

copy corresponding NACE code and text from the link (available in EU-languages)

options:
http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=NACE_REV2&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC

* minimum information needed
NECID= data can exported from NECID into the Excel format

SHEET 2: PRODUCT INFORMATION

*	*	NECID*	NECID*	NECID *	NECID *	NECID *	
Industrial sector (NACE-code)[1]	Product row number[1]	Product trade name	Product form	Used amount and unit	Used MNP (OECD list)	Used MNP (OECD list)	Remarks (free text, e.g. name of the other MNP)
	1						
	2						
	3						
use the same codes as in Company information sheet	add more numbered rows if needed		choose from the dropdown list options: liquid power solid object fibers paste		choose from the dropdown list options: 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 Other	add if several MNP used, add more columns if needed and choose options from the dropdown list as in previous column	

* minimum information needed

[1] If NECID database is used the register is a one-sheet register including all the fields and no links (NACE-code and product row number) are needed
NECID= data can be exported from NECID into the Excel format

SHEET 3: WORKER AND MEASUREMENT DATA AND EXPOSURE ASSESSMENT

WORKER DATA

*	*		NECID*		*	NECID*		NECID *	*	*		
Name of the worker	Social security number	Occupation (free text)	Job codes (choose ISCO code and text from the list)		Product row number	Job tasks, activity codes (choose from the dropdown list)		Duration of the task	Frequency of the task	Date when the worker started to use MNP	Date when the worker use of MNP has ended	Control measures (free text)
			code	text		code	text					
			copy corresponding ISCO code and text from the link http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=CL_ISCO08&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC			**	**	**	**			

* minimum information needed
NECID= data can be exported from NECID into the Excel format
[1] If NECID database is used the register is a one-sheet register including all the fields and no link (product row number) is needed
**Choose from the dropdown list (options presented in Table 4 and 5 in page 16). If several job tasks per person needed, insert them in different lines.

SHEET 3 continues:

MEASUREMENT DATA AND EXPOSURE ASSESMENT

NECID	NECID	NECID	NECID	NECID	NECID	NECID				
Sampling date	Location name	Unit of measurement	Personal or static sample	Background	Activity or task	Activity-Background	Work day	Assess exposure class (high, moderate, low)	Used OELs or other limit values	Remarks
				measured NP concentration	measured NP concentration	calculated from the 2 previous columns	calculated NP concentration / 8h			
	work area where the activity takes place	choose from the dropdown list options: µg/m3 number/cm3 other	choose from the dropdown list					**		

**Assessment of exposure class: high=workday conc. > OEL and background;
moderate= workday conc. ≤ OEL and background;
low= workday conc. << OEL and background

NECID= data can be exported from NECID into the Excel format