Institut universitaire romand de Santé au Travail
Institut für Arbeit und Gesundheit
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«Swiss Nano-Inventory»

"An assessment of the usage of nanoparticles in Swiss industry"

Final report

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1. Abstract

Introduction
Addressing the risks of manufactured nanoparticles requires knowledge of their hazards, the exposure of the working population as well as the liberation of particles in the environment. Currently there is no systematically collected information about occupational exposures or liberation of particles in the environment.

Objective
This study aimed to evaluate the prevalence and the level of nanoparticle usage in Swiss industry, the used health, safety and environment measures, and the number of potentially exposed workers.

Design
The Nano-Inventory was created in two successive steps; which both provided insight on different aspects assessing the potential occupational exposure to nanoparticles in Swiss industry.

a) The pilot study consisted of targeted interviews of 198 companies suspected to use or produce nanoparticles. The study was designed as a feasibility study for a questionnaire based industry survey on the handling of nanoparticles and the applications of specific protection means. However, as a targeted study, it provided only qualitative information rather than absolute number of Swiss companies and workers dealing with nanoparticles.
b) The main study was designed as a representative questionnaire-based survey of the Swiss productive sector to provide the number of companies dealing with nanoparticles. A stratified mail survey was conducted among a representative selection of 1'626 companies. The study population, 78'559 clients of the Swiss National Accident Insurance Fund (SUVA), covered about 84% of all Swiss production sector companies.
c) Two smaller, complementary surveys were conducted in parallel to the main survey, to obtain additional information useful for policy makers: a survey among the 99 largest Swiss companies and a survey of the branches, which were underrepresented in the random selection of the main survey.

Results
a) The pilot study provided a rather detailed picture on the types and amounts of nanoparticles used in the investigated companies. Forty-three of the 198 interviewed companies declared the use or production of nanoparticles and 11 imported and traded pre-packaged goods that contained nanoparticles. Considerable quantities (>1'000 kg/year per company) of Ag, Al-Ox, Fe-Ox, SiO_2, TiO_2, and ZnO were found. The median quantity of handled nanoparticles was 100 kg/year. The production of cosmetics, food, paints, powders, and the treatment of surfaces involved the largest quantities of these nanoparticles. More safety measures were found in powder-based applications than in liquid-based ones.

b) The representative survey was answered by 947 of the 1'626 companies (answer rate 58.3%). No significant difference was observed between the response rates of the different language regions of Switzerland German 58.4%, French 56.4% and Italian 62.5%.
On average, two workers per company were directly dealing with a nanoparticle application. The extrapolation to all companies of the Swiss production sector resulted in 1'309 workers (95%-confidence interval 1'073 to 1'545) of the Swiss production sector being potentially directly exposed to nanoparticles. These numbers correspond to 0.08% (0.06% to 0.09%) of all workers in the Swiss production sector. Of the Swiss production sector companies 0.6% (0.2% to 1.1%) were estimated to deal with one or more nanoparticle applications. The extrapolation in terms of number of companies resulted in 586 companies (145 to 1'027). The chemical industry branch showed the highest percentage of companies with a nanoparticle

application (21.2% of the surveyed companies in this branch) and also a higher percentage of potentially exposed workers (0.5% of the workers in these companies). However, as this branch is rather small. In absolute numbers of companies dealing with nanoparticles this branch is similar to other branches, which have a smaller proportion of such companies, but which are larger.

Across all branches, occupational health and safety strategies focused on the use of personal protection equipment (PPE). Few technical or organisational measures were applied.

The results of the Top-99 survey underlined a tendency towards more applications in larger companies and the targeted survey showed the potential for stocks and yearly turnovers in hundreds of tons, especially for the first generation of nanoparticles like carbon black, TiO_2, calcium carbonate, silica gels etc.

Conclusion
The Pilot study showed that nanoparticle use was a reality in 2007 in many industrial sectors in Switzerland and that some companies use already high quantities of a few types of nanoparticles.
The representative survey showed a low prevalence of nanoparticle usage in most branches of the Swiss industry and PPE as predominant protection strategies. The introduction of applications with nanoparticles (outside chemical industry) seems to be at the very beginning.

Before companies can start full-scale productions with nanomaterials, they need to know how to incorporate adequate protection measures into the plans for their new production lines. Technological and organisational protection measures need to be the preferred protection methods.

Policy makers aim to develop strategies to support companies in the responsible development towards a safer usage of nanomaterials. Such strategies need to consider the specific industrial applications, including fields outside nanotechnology, and all sizes of companies. Especially the small and middle-sized companies need help on how to introduce protection means in a proactive and cost effective way.

The results of this study might also be helpful for the implementation of the recently adopted action plan on "Risk Assessment and Risk Management for Synthetic Nanomaterials 2006–2009".

2. Introduction:

Nanoparticles have a diameter of maximal 100 nm in at least two dimensions (1). The properties of materials, such as conductivity or chemical reactivity, often change as the size approaches the nanoscale. Reports on the surface properties show that nanoparticles differ from bulk materials (2). The physical definition for nanoparticles of "less than 100 nm" has its limits: nanoparticles tend to aggregate and agglomerate; structures which are often of an unknown stability and size distribution. In the context of exposure assessment, the restriction to this exact limit of 100 nm must be eased and particles greater than 100 nm must be considered as partially nanoparticles (1). This is important in the context of up-scaled production with nanoparticles, where even a relatively low proportion of particles in the nanoscale can lead to important concentrations of nanoparticles at unwanted places. If particles are sold and bought with only an indication of their mean diameter, which is generally the case, and if no information about an approximate size distribution is given in the safety data sheets, it is difficult to gain information about the effectively present particles.

The changing properties of materials in the nanoscale make nanoparticles interesting for different kind of industrial applications. Research in the field of nanotechnology has developed a great number of different nanoparticles in short time. Today industries already start with the development of mass production and handling facilities, despite the limited knowledge about the risks associated with the exposure to such particles (3,4). A large number of different types of nanoparticles and applications are currently being developed and introduced into industrial processes and consumer products (5). However, there is no specific declaration duty for nanoparticles, neither in Switzerland nor in the rest of Europe. As a consequence, we have limited knowledge about who is using nanoparticles in Swiss industry and what types of particles are used.

The same properties that make these particles interesting for industrial application make them potentially dangerous with regard to negative health effects. In ambient air-pollution-studies particles in the size of particulate matter PM2.5 or PM10 are shown to be harmful to human health. Nano sized particles are even suspected to enter the human body easier than micro sized particles. Nanoparticles and their agglomerates are suspected of having the potential for negative impact on health and environment (6,7). Different types of nanoparticles were shown to have adverse health effects (8).

Information on potential exposure and liberation is still basic and needs to be elaborated in other countries (9) as well as in Switzerland (6). However, some reports showed that there are known nanoparticle applications and potential products (10-12). Several other studies investigated the prevalence of nanoparticles in companies or products. For example the German BAUA survey investigated the handling of nanoparticles focused on the nanotechnology sector (13), a French study assessed the producers of nanoparticles (14) and the UK DEFRA study was designed as a voluntary reporting system (15).

It must be recognized that the influence of particle properties such as size and surface area on toxicology and physiochemical responses are not fully understood (16). There is a scientific discussion going on about which parameters are essential to describe nanoparticle exposure. Mass, number, and surface area are the most often mentioned metrics. But also surface reactivity, charge, etc are frequently proposed with regard to toxicological questions.

For risk assessment studies, toxicological effects need to be combined with information about the level and kind of exposure. Special attention will have to be paid to up-scaled productions and their potential long-term consequences for health and ecology (17).

The occupational risk assessment need to know the number of exposed people, the type and quantity of exposure and the associated health effects. For the environmental risk assessment the amount of permanently or accidentally released nanoparticles is important. However, quantitative studies about industrial use and disposal of nanoparticles are as rare as studies about occupational exposure, and our knowledge in this field is insufficient to do a fact based risk analysis for Switzerland. New measurement strategies and modelling efforts are needed to provide adequate information for risk evaluations.

Already some years ago recommended the UK Royal Society and The Royal Academy of Engineering that occupational exposure levels for manufactured nanoparticles should be kept as low as possible. They also recommended to treat nanomaterial as potentially hazardous, to seek to remove them from waste stream, to not apply free nanomaterial to the environment unless the benefits clearly outweigh the anticipated risks and to assess the potential impact of nanomaterial throughout their lifecycle (18).

Newer guidelines for the safe and responsible production, handling and disposal of nanoparticles are being developed. However, current recommendations are still partially based on analogy reflections or on assumptions, they still lack certain information: for the development of specific guidelines, more information is needed about the exposure resulting from different handling-methods of different nanoparticles with different protection measures. At the moment, the scientific basis for recommendations about the safe handling of nanoparticles is still insufficient.

Missing knowledge
There is an urgent need to evaluate the risks of these particles to ensure their safe production, handling, use and disposal. Studies on toxicological effects need to be combined with information about exposure or potential exposure. In the absence of solid exposure data no solid risk evaluation can be conducted. None of the existing studies about the usage of nanoparticles in industry so far provided systematically acquired data on the prevalence of nanoparticles in the consumer goods or the production sector of an entire country.

2.1. Objectives of the Nano-Inventory

The principal aim of the Nano-Inventory was to estimate the prevalence and extent of nanoparticles in the Swiss industry as well as the potential for exposure to engineered nanoparticles of the Swiss working population. The reason for the interest lies in the assumption that occupational cohorts are likely to have earlier and higher exposures than the general population, which makes them a useful population for risk assessments. The pilot survey was designed to provide a general idea about the different kinds of nanoparticle applications in the industry. It was moreover focused on the used protection means. However, it did not investigate the number of concerned workplaces in Switzerland. The main study was therefore created to estimate the number of concerned companies and potentially exposed workers in Swiss industry.

2.1.1. Objectives of the pilot study

The discussion about nanoparticles and health was already present in the media and it was not sure if companies (specifically their security-managers) were willing and able to answer questions about their production of nanoparticles. Another open question was the identification of different industrial sectors with nanoparticles applications in order to prepare a representative written survey.

The pilot study was designed to evaluate the feasibility of a questionnaire-based approach, to investigate the availability of relevant data and to acquire a first impression about the use of nanoparticles in the Swiss industry. A selected, non-representative

number of companies were interviewed by telephone about following aspects: the type and quantity of nanoparticles used, the potential for an exposure and the current safety-policy in the company.

The aim of this pilot study was to see if companies (specifically their safety staff) were willing and able to answer questions about their production with nanoparticles. Another focus was to identify different industrial sectors with nanoparticles-applications and the quantity of particles used in this selection in order to prepare a representative written survey. Special attention was given to evaluate the information that could be obtained from the companies' safety staff, since they would have to fill the questionnaire during the main study.

2.1.2. Objectives of the main study

To provide an accurate estimation of the number of companies and the number of potentially exposed workers as well as the information about the used protection measures for humans, aquatic and atmospheric environment, a larger representative survey needed to be done.

The representative study was therefore designed to evaluate the number of companies from different industrial branches, the type of particles used and the number of workers, which are potentially exposed to nanoparticles in Swiss industry. Additional information was asked, like data about different protection measures for humans and the aquatic and atmospheric environment.

It should allow an estimation of the Swiss occupational exposure to nanoparticles and could be combined in a later moment with exposure profiles of typical workplaces to estimate the real exposure to nanoparticles. The knowledge about the amounts of nanoparticles being handled by individual companies can be useful for occupational as well as for environmental risk assessments.

3. Methods

3.1. Methods of the qualitative pilot study

Applications and addresses of potential users and producers were looked up using an Internet search. Syndicates of industrial sectors in which applications were suspected were contacted to obtain their membership-lists. A direct application search and the yellow pages complemented the list. About two hundred companies were contacted by telephone.

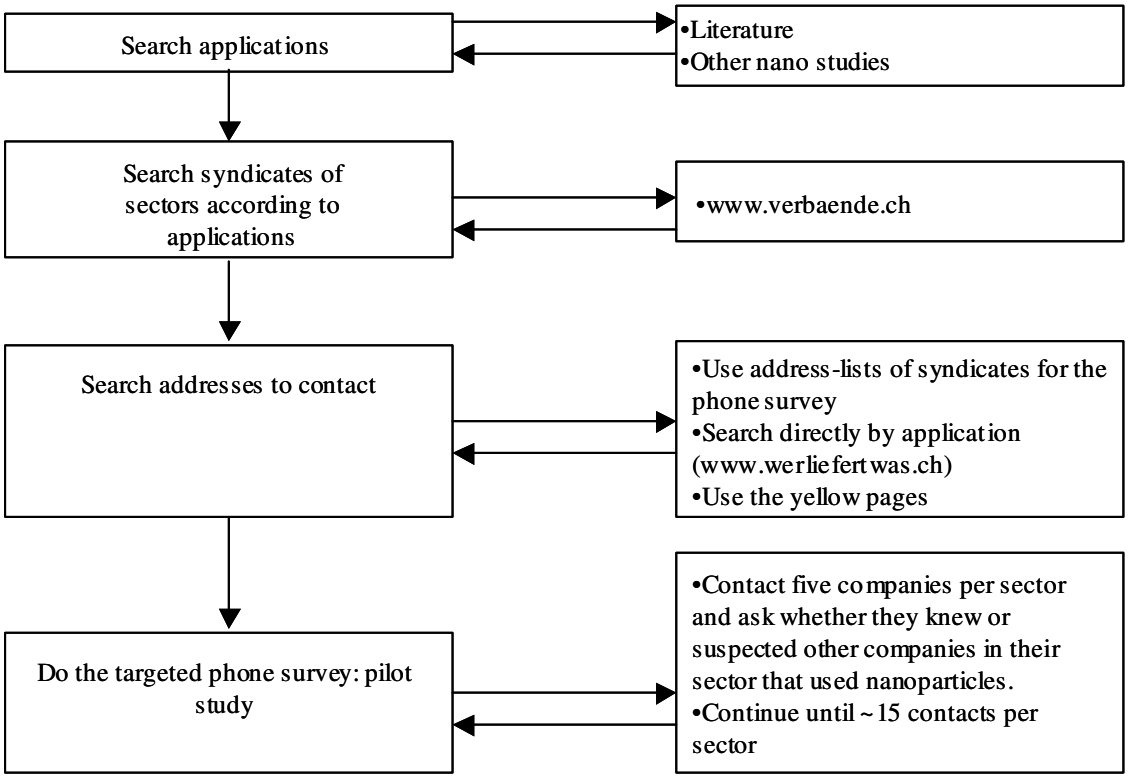

Figure 1: process chart of the pilot study

A short literature review identified presently known applications of nanoparticles. The terms "nanoparticle*" or "nano" were used together with "application*" and "industry*" in the search engines pubmed and sciencedirect. Very fast it was clear that the literature about industrial applications of nanoparticles was rather meagre and that sources directly from research institutes needed to be included.

Self-declared use or production of nanoparticles was searched on Internet and by an address collection from the program TopNano21 (19), a list of companies in the field of nanotechnology. Company addresses in sectors with known applications were found using the list provided on a website on Swiss syndicates: www.verbaende.ch. In other sectors, companies were identified with the help of a product-based search engine: www.werliefertwas.ch. Additional addresses were found in the yellow pages: www.gelbeseiten.ch.

In each sector five of the identified companies were initially contacted by telephone. The security manager or another person in charge (such as the head of the company, the line responsible, the production manager, etc.) was interviewed with the help of an open questionnaire: the type of applications, some key elements for the estimation of a potential exposure and the actual safety policy in the company (see also Table 1). The questions

included the duration and frequency of the application processes as well as the quantities of nanoparticle used (the open questionnaire is shown in the appendix; chapter 7.1.1). At the end, the interviewed person was asked whether he/she knew or suspected other companies in his sector to use nanoparticles. The hereby-identified companies were contacted until a number of about 15 contacts per sector was reached. This approach was chosen to obtain as many "positive hits" as possible. Particles smaller than 1'000 nm in at least two dimensions were considered as nanoparticles.

Table 1: Short description of the fields of questions used in the guiding form to conduct the telephone interviews. The full list of questions is in the annex (in German and French).

Fields of question	*Examples of questions asked in the telephone interview*
Types of nanoparticles	What type of nanoparticles is used?
Key elements for exposure estimation	How many persons are present and therefore potentially exposed? What are the used protection measures to lower the exposure? What kind of manipulation is done with the particles? What is the quantity of nanoparticles used per day?
The actual safety policy	How often are workers informed about the safety risks of nanoparticles? Which is the highest-ranked management-level that takes care of the topic nanoparticles and safety?

3.2. Methods of the representative main study

3.2.1. Nanoparticle definition

During interviews in the pilot study (20) many companies indicated that their particles suppliers do not systematically provide safety data with information about the size distribution. The presence of primary particles could not always be definitely determined or excluded. The following definition of nanoparticles was therefore used for this survey:

a) All nanoparticles according to the ISO nomenclature TS 27687:2007 (1).
b) All particles with mean diameter between 100 to 1000 nm were assumed to contain nanoparticles, unless there was concrete information about the size distribution and the stability of aggregates.
c) Agglomerates of nanoparticles with unclear information about the potential liberation of primary particles.
d) All nano-surface treatments applications as long as there was not a defined chemical bottom up pathway purely based on polymerisation and proven not to result in particle or droplet creation during the application.

3.2.2. Studied entities

In the year 2005 statistics of the Swiss insurance law showed 428'908 Swiss companies, whereof 14'399 in agriculture, 63'353 in the producing sector and 350'537 in the service sector (21). This information is based on the commercial registry for Switzerland for active companies with at least one employee. There might be several geographically separate units for one company.

For this study, the clients of SUVA (Swiss National Accident Insurance Fund) were considered as being representative for the production sector of Switzerland. The reason is that by Article 66 of the Swiss accident insurance law, SUVA is the compulsory insurance for most of the producing companies (84.1% in the year 2005). The 15.9% non-SUVA clients of the production sector were extrapolated assuming that they were equal to the SUVA clients. The selection of companies was based on the SUVA client list of 2007, with 91'804 companies.

3.2.3. Survey design and sampling

The survey was conducted in a stratified (layered) manner expecting an aspects' prevalence related to economic branches. The definition of a single economic branch corresponded to a SUVA insurance risk class. Among the SUVA clients 1'900 companies (1.77% of all SUVA-clients) were randomly selected from 21 layers, each layer consisting of one or several closely related economic branches (see chapter 7.2.4 in the annex). The software R version 2.2.1 was used to sample a representative selection according to the defined sample size in each layer.
The survey was conducted in a stratified (layered) manner expecting an aspects' prevalence related to economic branches. The definition of a single economic branch corresponded to an insurance risk class of SUVA. A total of 1'900 Swiss companies (1.77% of all SUVA-clients) were randomly selected from 21 layers, each consisting of one or several closely related economic branches. The software R version 2.2.1 was used to sample a representative selection according to the defined sample size in each layer.

The random selection of companies (n_h) in each of the layers was proportional to the size of the layers (N_h):

$$\frac{n_h}{N_h} = \frac{n}{N} \quad (1)$$

with n and N corresponding to the total number of questionnaires (n = 1'900) and the total number of companies being clients of the SUVA (N = 91'804).
The number of selections n_h per layer was:

$$n_h = \frac{n \cdot N_h}{N} \ . \quad (2)$$

In layers with only small economic sectors the numbers smaller than 50 were replaced by 50.

$$m_h = \begin{cases} m_h = 0, if\ n_h > 50 \\ m_h = 1, if\ n_h \le 50 \end{cases} . \quad (3)$$

A re-evaluation of the number of selected companies in the layers larger than 50 was necessary. The values n_{new} and N_{new} were created corresponding to the number of letters and the total number of companies for the concerning layers with values n_h bigger than the minimal 50:

$$n_{new} = n - \sum_{h=1}^{H} \left(m_h \times 50 \right) \text{ and} \quad (4)$$

$$N_{new} = N - \sum_{h=1}^{H} \left(n_h \times m_h \right) \quad (5)$$

Finally the size of the selection per layer (n_h^*) was given by

$$n_h^* = \begin{cases} n_h^* = \frac{n_{new} N_h}{N_{new}}, if\ m_h = 0 \\ n_h^* = 50, if\ m_h = 1 \end{cases} \quad (6)$$

To improve the quality of this survey, a panel of four experts reviewed the different economic branches and excluded one layer from the mailing (2x SUVA, 2x Institute for Work and Health). This layer consisted mainly of administrative companies: economic and technical offices, administrations, travel service and shops, governmental administration, post offices, employee placements and programs for temporary occupation of non employed. The exclusion of this layer reduced the number companies to be surveyed from originally 1'900 to 1'625 and the number of corresponding SUVA-clients from 91'804 to 78'559, a reduction of 14.4%. For the remaining 85.6% such a definitive exclusion could not be made, even though about 38% of the surveyed companies were not expected to be in the producing, but in the service sector (22). The randomly selected companies for this survey represented finally 2.06% of the SUVA-clients assumed to be in the production sector.

3.2.4. Extrapolations and calculation of the confidence intervals

The data collected during this survey was extrapolated from the responses to all SUVA clients, estimating the real frequency for each layer of a company dealing with nanoparticles by the frequency of such a response in the survey. Knowing that only 84.1% of the Swiss production companies are clients of SUVA (21), a direct extrapolation was made to obtain estimates for all Swiss companies with an extrapolation factor of 1.19 applied to all layers in equal measure.

The Yes/No-answer to the question if the company had a nanoparticle application was considered to be a variable of Bernoulli. The confidence interval for the response YES was calculated according to Tillé (23) and Grais (24): each layers' variance of frequency was calculated, resulting in the confidence interval for each layers' frequency. For the branches not reporting any nanoparticle application no confidence interval could be calculated. The variance of the overall frequency estimator, resulting in the confidence interval for the overall frequency, was calculated by weighting the different sizes of branches.

The number of workers was extrapolated the same way as the number of companies, using the frequencies of indicated workers per layer. 5.6% of workers among the workers in the production sector were employed by non-SUVA-clients (21). Therefore the used extrapolation factor for the number of potentially exposed workers in the whole Swiss production sector was 1.06.

The confidence interval for the extrapolation of the number of workers was calculated as for a normal stratified selection, according to Tillé (23) et Grais (24). The responses' frequency in different layers was weighted by the size of the layers.

Confidence interval for the number of companies: a proportion

The results of the estimation of an average may be pursued to the estimation of the proportion of a population character considering the variable X as a variable of Bernoulli (taking the value 1 if the character is present or 0 if it is not).

$$p_1, p_2, ..., p_h, ..., p_k; p \tag{7}$$

The proportion of the characters in each layer and in the whole population is:

$$f_1, f_2, ..., f_h, ..., f_k; f\ , \tag{8}$$

where the frequency of the observation of an element X as a variable of Bernoulli is:

$$p_h = \frac{1}{N_h}\sum_{s=1}^{N_h} X_{hs}\ . \tag{9}$$

This frequency is approximated using

$$f_h = \frac{1}{n_h}\sum_{s=1}^{N_h} x_{hi} \tag{10}$$

and the proportion p,

$$p = \sum_{s=1}^{k} \frac{N_h}{N} p_h \tag{11}$$

will be estimated by f':

$$f' = \sum_{s=1}^{k} \frac{N_h}{N} f_h \tag{12}$$

The variance of the estimator f' is:

$$V\{f'\} = \sum_{h=1}^{k}\left(\frac{N_h^2}{N^2}\cdot\frac{N_h - n_h}{N_h}\cdot\frac{p_h(1-p_h)}{n_h}\right) \tag{13}$$

The variance of the variable of Bernoulli within a layer h is:

$$\sigma_h^2 = p_h(1-p_h) \tag{14}$$

and the confidence interval C.I. (using the standard error SEM_h) is:

$$C.I. = f_h \pm 1.96 * SEM_h = f_h \pm 1.96 * \sqrt{\frac{p_h(1-p_h)}{n_h}} \quad (15)$$

The variance of the estimator V* is estimated by:

$$V^*\{f'\} = \sum_{h=1}^{k}\left(\frac{N_h^2}{N^2} \cdot \frac{N_h - n_h}{N_h} \cdot \frac{f_h(1-f_h)}{n_h - 1}\right) \quad (16)$$

Confidence interval for the number of workers

Based on Tillé (23) et Grais (24) the confidence interval of the number of concerned workers in each layer is calculated as follows. The weighting f is calculated on N the total number of companies (SUVA clients) and n the number of selected companies:

$$f = \frac{n}{N} \quad (17)$$

The corrected variances of the population (s_y^2):

$$S_y^2 = \frac{1}{N-1}\sum_{k \in U}\left(y_k - \bar{y}\right)^2, \quad (18)$$

where k is the selected element, U the total population and y the measured aspect. The corrected variances of the layer (s_y^2) can then be estimated without bias by (s_y^2):

$$s_y^2 = \frac{1}{n-1}\sum_{k \in S}\left(y_k - \hat{\bar{y}}_{sr}\right)^2, \quad (19)$$

where ($\hat{\bar{y}}_{sr}$) is the average of the measured elements weighted according to the stratification.

The variance of the estimator of the average ($\hat{v}(\bar{y})$) can be estimated by:

$$\hat{V}(\bar{y}) = \frac{(1-f)}{n} s_y^2 \quad (20)$$

where $v\left(\hat{\bar{y}}_{SR}\right)$ is the estimator of the variances of each layer.

For this layered survey, the confidence interval of the total number of workers was calculated as follows: The weighting f_h based on the N_h the total number of companies per layer and n_h the number of selected companies per layer: $f_h = n_h/N_h$.

The corrected variance of the population (s_y^2) was estimated by (s_y^2):

$$s_y^2 = \frac{1}{n_h - 1}\sum_{k \in S_h}\left(y_k - \hat{\bar{y}}_h\right)^2, \text{ with h} = 1, \ldots, \text{H} \quad (21)$$

where k is the selected element, y the measured aspect and h the layer. The variance of the estimator of the average $v\left(\hat{\bar{y}}_{st}\right)$ was calculated by:

$$V\left(\hat{\bar{y}}_{st}\right) = \sum_{h=1}^{H}\left(N_h \frac{N_h - n_h}{n_h} s_{yh}^2\right), \text{ with h} = 1, \ldots, \text{H} \quad (22)$$

where (s_{yh}^2) is the variance of each layer and ($\bar{y}_{st}$) corresponds to the layers' average weighted in function of the layering.

3.2.5. Data collection (questionnaire)

The usage of nanoparticles in the companies was evaluated by a mailed questionnaire. The questionnaire was inspired by the questionnaire of the German Federal Institute for Occupational Safety and Health (13) and contained the following fields of questions:

- Focused on general aspects: yearly turnover, stock size, transport frequency, composition and size of nanoparticles
- Focused of the handling during the process: manipulations of the particles during the process, means of protection utilised and number of workers present at the process
- Focused on environmental aspects: type of waste treatment and ventilation of the production hall

3.2.6. Data validity check

The data of all questionnaires were checked for coherence and clarified with the respective company before processing.

The data of the negative answers (the majority) were single entered by hand, using the software Epidata (EpiData Association, Denmark: www.epidata.dk) and electronically checked by an electronic questionnaire reading software Teleform (Vista, California: www.cardiff.com). The questionnaires containing information about the presence of nanoparticles were typed twice by hand instead of an electronic reading. This double entry of the questionnaires' data allowed calculating the data entry error rates.

To test for potential misunderstandings by the companies a random sample among the companies returning the questionnaire with "no sub/µm-particle application" was contacted by phone to verify the response. A limit of 5 phone call trials for a company was fixed before replacing the company in the list. The companies were specifically asked about those nanoparticle applications, which were described in literature to be possible in their domain. The minimal necessary sample size for the verification of the answer "no such application" was calculated with the formula "binom.test" in S-Plus 6.2.

3.2.7. Two complementary surveys

In order to enhance the quality of the survey output, two types of company groups were investigated additionally to the representative survey:

a) Top-99 survey: the ninety-nine largest Suisse companies in terms of number of fulltime employees employ about 400'000 employees (or 21.9% of the total employees insured by SUVA). Only a few of these companies would be selected in a random sampling of 1'626 companies. Therefore an additional survey of the ninety-nine largest companies in terms of number of 100% employees was conducted. Branches with a high percentage of administrative and financial institutions were excluded. The excluded sectors are detailed in chapter 7.1 of the annex. This survey represented the group of the largest Swiss companies and filled this potential information gap of the main survey.

b) Targeted survey: the approach of the statistic plan, which grouped several economic branches of different sizes into one layer, bears the potential problem that companies of a smaller economic branch could be statistically underrepresented in the random selection. To fill this potential loss of information the targeted survey selected therefore companies in sub-layers, which were found to be statistically

underrepresented in the layered sample. The panel of four experts indicated in particular the large companies as potentially interesting in terms of potential nanoparticle applications. 195 companies were selected by means of following rule: all companies >100 employees of the branch "metal", >500 of the branch "electronics", "information techniques", "medical- and dental techniques", "watch-making and jewellery", >50 of the branch "surface / galvanic / use of lacquers", >50 of the branch "paper / cardboard", >25 production of "paints / lacquers", >50 of the branch "painter / plasterer"). This additional, targeted survey was not designed to be representative; instead it should fill a potential information gap of the representative survey.

3.2.8. Ethics

The companies were clearly informed in the front page of the questionnaires that all data would be transferred to their accident insurance company (SUVA) but otherwise be treated confidentially. The responding person had to sign the answered questionnaire and state that he/she filled it to the best of his/her knowledge. The job function of the responding person was registered.

3.2.9. Data evaluation

Variable definition: The basic aspect of this survey was the fact of having or not having a nanoparticle application, this variable was therefore chosen as the depending variable.
The representativeness of the selected sample was studied on the basis of the company size as an independent variable, broken down into four size categories. The sizes of the companies were clustered into four different size groups according to the information from the Swiss federal statistical office (SFSO) (25): 1-9 employees, 10-49 employees, 50-249 employees and 250 and more employees. A comparison between the SUVA-clients and all Swiss production companies was made on the same basis.

The reported prevalence of nanoparticles in the companies was compared to the response rate and the size of the companies in terms of number of employees.

The reported nanoparticle usage was explored by the economic branches, types of nanoparticles and used protection measures.

The reported prevalence of nanoparticles in the companies was compared to the response rate and the size of the companies in terms of number of employees.

The reported nanoparticle usage was analysed by economic branch, type of nanoparticles and used protection measures.

4. Results

4.1. Results of the pilot study

The below stated results of the pilot study were published in a scientific journal in January 2008 (20).

4.1.1. Source selection

The sources mentioned in Table 2 were chosen to obtain a comprehensive picture of nanoparticle applications. Several other sources, to include international WebPages, were searched. However, they did not propose other, not yet mentioned application types.

Table 2: Sources to identify potential applications of nanoparticles in the industry for the elaboration of the targeted survey of the pilot study.

University/ Organisation	*Link*	*Last accessed*
University of Ulm	http://wwwex.physik.uni-ulm.de/vortraege/StudiumGenerale/Nanot_0.htm	24.09.2008
Technologiezentrum GmbH, Düsseldorf	http://www.zukuenftigetechnologien.de/11.pdf	24.09.2008
INM: Institute for New Materials, Saarbrücken	www.inm-gmbh.de/htdocs/technologien/schwerpunkte/schwerpunkte_de.htm	27.02.2006*)

*) The cited INM webpage has meantime been removed. However, similar information are presented on following page of the INM: www.inm-gmbh.de/forschung/?PHPSESSID=74b4e577602546b7c8d7b328f576aa88

Table 3 shows syndicates of sectors with an address-list with more than 15 contact addresses. The search was conducted by the Internet database www.verbaende.ch, a database of syndicates. Other databases used were the database to search a company by a product type www.werliefertwas.ch and the yellow pages www.gelbeseiten.ch. Probably not all company sectors were identified. In addition, several applications were identified for which no contacts could be found.

Table 3: Sectors with potential applications for the pilot study, found on the syndicate search page www.verbaende.ch, on the yellow pages www.gelbeseiten.ch and on the product based company search page www.werliefertwas.ch

By the syndicate list www.verbaende.ch	*By the yellow pages www.gelbeseiten.ch*
Printing production	Tyres
Paint production	Milling
Cosmetics production	Powder-Production
Varnish production	Coating
Paper production	Batteries
Chemical production	
Plastic production	
Cleaning agent production	
Feeding stuff production	*By the database www.werliefertwas.ch*
Food science	Filters
Microelectronic production	Gravure printing
Sensors	Deing factor
Clock production	Clock industries (complementar)
Construction materials	

4.1.2. Identified application-fields in Swiss companies

The following application-fields, indicated by the literature sources, were found in the Swiss industry. Table 4 shows the different sources and the corresponding possible application fields. The fields of possible applications are sometimes larger than the applications identified by the survey but they lead to the presumption that other applications in the same field may be used in similar companies.

Table 4: Fields of application found in Switzerland by the pilot study, (source that defined this application: VDI = Technologiezentrum, Düsseldorf - Germany[1], Uni Ulm = University of Ulm - Germany[2], INM = Institut für neue Materialien of Saarbrücken – Germany)

Possible application fields	*Found in the sector*	*Source*
Pharmaceutical research	Research	Uni Ulm
Fine mechanic, optics, analytics	Surface coating	Uni Ulm
Lubricants	Optics	Uni Ulm
Chemical-mechanical polishing	Else	VDI
Chemical or physical particle production (colloids, pigments, dispersions, powder)	Powder production	Uni Ulm
Corrosion-inhibitor	Surface coating	Uni Ulm
Ceramics	Else	Uni Ulm, VDI
Paintings and pigments (hybrid and effect)	Paintings	Uni Ulm
Functional coating, anti-adhesive and defogging agents, Scratch-resistant	Surface coating	Uni Ulm, INM
Varnish-effects and varnish-follies	Paintings	Uni Ulm
Super hard alloys	Metal treatment	Uni Ulm
Food production (milk, juices, brewery)	Food	INM
Sunscreen	Cosmetics	VDI
Cleaning	Cleaning	VDI

4.1.3. Types of nanoparticles

Table 5 shows the types of nanoparticles identified by the pilot study. About 20 types of nanoparticles were identified that are used by the companies interviewed. The application methods were characterised as liquid, powder or else. SiO_2 and TiO_2 were the two predominant nanoparticle types. For eight types of nanoparticles, only one company was found. Up-scaled usages (kilo-tons per year) were found for iron oxides, TiO_2 Ag, AlO_3, and carbon black nanoparticles. Particles smaller than 1000 nm were considered in six companies as potential nanoparticles. There were slightly more liquid than powder applications (30 and 25, respectively). Note that in several companies, more than one type of nanoparticle was identified and that some companies only bought and resold products with nanoparticles. The number of total employees showed that also very small companies could use large amounts of nanoparticles (e.g. silver-particles). Note that in several companies, more than one type of nanoparticle was identified and that some companies just bought and resold a product with nanoparticles.

[1] www.zukuenftigetechnologien.de/11.pdf, last access: 23.09.2008
[2] wwwex.physik.uni-ulm.de/vortraege/StudiumGenerale/Nanot_20.htm, last access: 23.09.2008

Table 5: Types of nanoparticles, quantity of nanomaterials used and total number of employees in the companies identified by the pilot study.

Identified nanoparticles types	*Number of companies*	*Employees total in all companies*	*Quantity used per year [kg]*	*Type of application (number of companies)*
Ag	3	22	3'100	liquid (3)
All types [d]	2	86	1	liquid (1), powder (1)
Al-ox	1	1'700	5	solid (1)
Carbon black	3	325	1'365'001	liquid (1), powder (2)
Carbon nanotubes	1	45	1'000	not known (1)
Fe-ox	2	140	365'000	liquid (1), powder (1)
Organic particles	2	280	380	powder (2)
Polymer	3	460	102'500	liquid (3)
SiO_2	15 [b]	3'906	75'438	liquid (6), powder (7), liquid/powder (2)
SiO_2 & carboxyl	2	835	300	liquid (2)
TiO_2 [c]	6	950	435'466	liquid (1), powder (4), liquid/powder (1)
ZnO	2	530	70'365	powder (2)
Unknown type	6	4'281	504	liquid (3), powder (1), solid (2)
Total sum	48	13'560	2'419'060	liquid (21), powder (19), liquid/powder (3), solid (2), unknown (1)

Some applications were mentioned without further specification: Pigments, cellulose, diamond and (unspecific) metal oxides. [a] Two companies specified micro-fine organic particles smaller than 200nm, used in sunscreen; [b] Three companies declared the use of SiO2 particles with an average size between 100nm and 1mm; [c] One company declared the use of TiO2 with an average size bigger than 100nm, but smaller than 400nm; [d] One company produced mills for particles and had therefore all types of particles that can be milled - but only small test-quantities. Another produced powder types according to customer specification.

4.1.4. Range of nanoparticle quantities

Figure 2 shows the distribution of the quantities of nanoparticles used per year by the companies that use or produce particles (without research institutes and pure re-sellers). The class definitions were less than 100kg/a, which is more a research sector than a production; until 1000kg/a, which resembles a small production; until 5t/a, which still resembles a small production; until 25t/a representative for an up-scaled production of a small company; and until 100t/a respectively more than 100t/a represents a very up-scaled production. The range of quantities reached from "some grams" per year to one thousand tons per year[3]. The majority of the companies using or producing particles had less than a tonne per year. The average quantity was 40 tons, the median 100 kg. Several companies were identified that can be classified as "re-sellers". Of these 17 re-sellers, 6 bought and sold pre-packaged solid products containing nanoparticles e.g. surface treated metal parts (therefore not registered in this report), 11 bought and sold products that had been treated abroad with nanoparticles (therefore registered in this report), some of the companies did not comment the quantity of used nanoparticles. No information was available on the quantities of nanoparticles contained in some products (e.g. textile coatings)

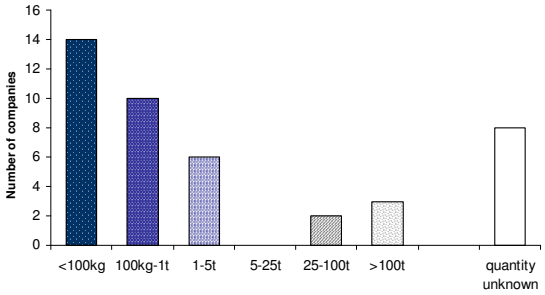

Figure 2: Number of companies identified by the pilot study to use or produce quantities of nanoparticles per year in the shown scale of turnover (n=43).

[3] The top producer declared the production as "pilot plant".

Table 6: Quantity of nanoparticles (NP) identified in the different sectors with different types of nanoparticles [estimated weight/year] identified by the pilot study, and a short description of the applications (n=43).

Sector	*SiO_2*	*Fe-Ox*	*TiO_2*	*Ag*	*ZnO*	*Al-Ox*	*Carbon black*	*Number of companies with NP / interviewed*
Tyres								0/3
Watches/optics								1/12
Cosmetics	(t), coating of UV-protection particles		(100t), UV-protection		(100t), UV-protection			6/15
Food and food- packaging	(kg to t), fluxing agent separating agent, carrier							4/13
Milling machines	(g to kg), tests	(g to kg), tests	(g to kg), tests	(g to kg), tests	(g to kg), tests	(g to kg), tests		1/2
Paints	(g to t), varnish, hydrophoby			(t), varnish				5/16
Surface coating	(g to kg), ceramics, wood-surfaces			(t), anti-micro-biotic coating				7/15
Paper	(100t), binder/ retention agent					(100t), inkjet-paper (>100nm)		2/12
Printing and packaging	(N/A), UV-protection							2/14
Plastics		(kg to 100t), plastic	(kg to 100t), plastic				(1'000t), glue/rubber	2/11
Powder-production	("not much"), powder; (g to kg), research	(g to kg), research	("not much"), powder; (g to kg), research	(g to kg), research	(g to kg), research	("not much"), powder; (g to kg), research	("not much"), powder; (g to kg), research	2/8
Sensors, micro-electronics						(kg), fire-protection		2/13
Textiles	(kg to t), coating							4/17
Metal surface								0/13
Cleaning products			(kg), stabilisator-elutriation					1/14
Pharmaceutical products	(t), dental, rheologic additives, pigments;							3/12
Other	(g), polishing							1/7

4.1.5. Size of the identified companies

Table 7 presents the size of companies using nanoparticles, estimated from the number of the total employees. It shows a peak of "middle"-sized companies. The federal definition of company sizes is as follows (Bundesamt für Statistik, 2001) – micro is smaller than 10 employees, small <50 employees, middle <250 employees and big >250.

Table 7: Distribution of the size of companies, which stated in the telephone interview of the pilot study to use nanoparticles. Re-sellers shown in the graph bought and sold products that had been treated abroad with nanoparticles.

Size of companies in terms of number of employees	*Number of companies using or producing nanoparticles*	*Number of companies reselling the nanoparticles*
0-9 employees	8	3
10-49 employees	10	3
50-249 employees	22	3
>250 employees	7	0
N/A	8	2
Sum of Frequency	55	11

Table 6 shows the quantities and applications of the seven most used nanoparticle types sorted by sector. The row "carbon black" is probably incomplete – this type of powder has been used for years and may therefore not be identified as partially containing nanoparticles. Carbon black can be used as pigment, in paintings, in plastics and even in some application of electronics. Note that several companies are present in two or more sectors and that the proportion of companies with and without nanoparticles is clearly influenced by the targeting structure of the pilot study and does not necessarily reflect the real proportions. Some of the identified companies with nanoparticles do not have a production but only buy and resell products with nanoparticles. Companies buying and reselling products with "free" nanoparticles (powders or liquids) were considered to use nanoparticles. Surface-treated solids or solid-matrix applications such as wire production (no manufacture in Switzerland) were considered as "no nanoparticles".

4.1.6. Identified protection measures

Table 8 shows the protection measures used. Most of the companies working with nano-powder use several types of protection measurers and many of those working with nano-liquids use only personal protective equipment. The protection types were: separation (the application of closed environments like closed machines or separated rooms); airflow (the use of a fume cupboard or a suction device); filter (the use of some air filtering system); personal protective equipment (the use of masks, gloves, eyeglasses etc.). Few other protection types were indicated. All companies that use powders had protection measures, most of them several. Only four companies with liquid-only applications provided respiratory personal protective equipment (not detailed the Table).

Table 8: Protection measures used for the different types of application, identified by the pilot study. Note that one company could show several protection measures.

Application type versus protection type	*Number of companies identified*	*Separation*	*Airflow*	*Filter*	*Personal protective equipment*	*Other protection*	*No protection*
Liquid	22	3	3	3	12	1	2
Liquid & powder	2	1	2	2	2	0	0
Powder	15	9	11	8	11	2	1
Solid	2	1	0	0	1	0	0
Type not declared	1	1	0	0	0	0	0
Type not known	1	0	0	0	0	0	0
Total	43	15	16	13	26	3	3

The number of companies per size-group (Table 9) was sometimes very small, but there was a tendency for most increased number of protection measures in the small to middle sized companies.

Table 9: Protection measures of companies (n=34), which declared in the pilot study interviews to handle nanoparticles, compared to the size of these companies. Note that one company could show several protection measures.

Type of protection	*Separation*			*Airflow / pressure difference*			*Filter*			*Personal protection equipment*			*Other protection types*			*No protection*		
Company size (number of employees)	Number of companies	Company size	% in the size-group	Number of companies	Company size	% in the size-group	Number of companies	Company size	% in the size-group	Number of companies	Company size	% in the size-group	Number of companies	Company size	% in the size-group	Number of companies	Company size	% in the size-group
Micro (n=3, total employees=13)	1	1	8%	1	1	8%	1	1	8%	3	13	100%	1	1	8%	0	0	0%
Small (n=6, total employees=140)	2	50	36%	3	75	54%	3	75	54%	4	100	71%	1	10	7%	1	30	21%
Middle (n=19, total employees=2'255)	9	1'145	51%	10	1'170	52%	8	945	42%	15	1'820	81%	1	230	10%	1	130	6%
Big (n=6, total employees=8'820)	3	4'270	52%	2	1'150	14%	1	400	5%	2	1'900	23%	0	0	0%	1	1'700	21%

4.1.7. Sectors that may use nanoparticles but were NOT contacted in the pilot study

Table 10 shows the application mentioned in literature for which no companies were identified in the pilot study (e.g. no hospital was identified that routinely uses nanoparticles).

Table 10: Possible sectors and applications that were not contacted during the telephone survey

Sector	*Possible Application*
Fire protection materials	Fire extinguishing agent, fire barriers
Pharmacy/medicine	Medical targeting, drug-delivery, magnetic particles, implants, Magnetic Resonance Imaging contrast agent
Electronics	Quantum construction elements, digital memory, background lights, electro conductive coatings*)
Material science	Fullerenes/Carbon NanoTubes, integral parts of cars and engines, materials for light constructions, gasholder, membranes, high speed embossing processes
Laboratory tools	Chromatography, bio detection and labelling, bio magnetic separations, catalytic converters
Surface applications	Photo catalysts, anti graffiti, thermal spray coating

*) One company stated, that particles are not yet used in production. Instead, airborne nanoparticles were considered as a source of quality problems.

4.1.8. Ranking of the interviewees' concern about nanoparticle-exposure

The interview-partners' concern about nanoparticle-exposure in their company was noted during the phone call.
Figure 3 shows this rather subjective impression about the knowledge and the way the interview-partner answered the questions.

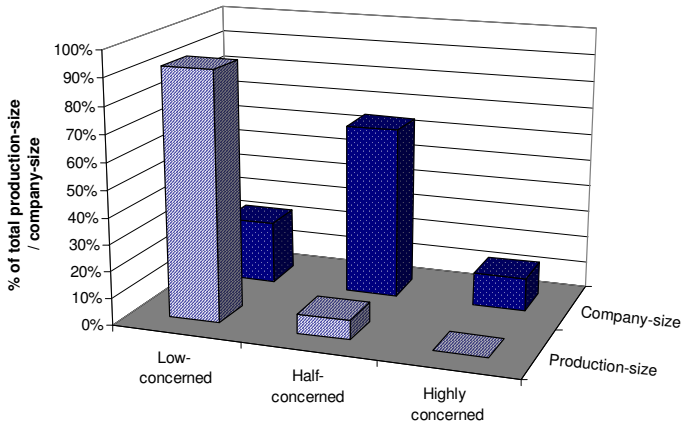

Figure 3: After each telephone call the interview-partners were rated regarding their concerns about nanoparticle exposure in their companies. For the three levels of concerning (low, middle and high) the distribution of the internal sum of company size and production size is shown (n=36 for production size, n=43 for company size). Note that information was gained by the pilot study in the year 2006; the public awareness of nanotechnology and risk might have developed since.

Figure 4 A) shows the highest level of management being involved in the topic of nanoparticles. In many cases the respondents were unsure about this point and one company had no designated person in charge of the topic. The top management of very small and very big companies tended to be more implicated in the topic nanoparticles and environment/health/safety (EHS) than the one of medium sized companies.

Figure 4 B) shows how often the persons in charge inform themselves about risks of nanoparticles. "Rarely" and "often" were the predominant answers.

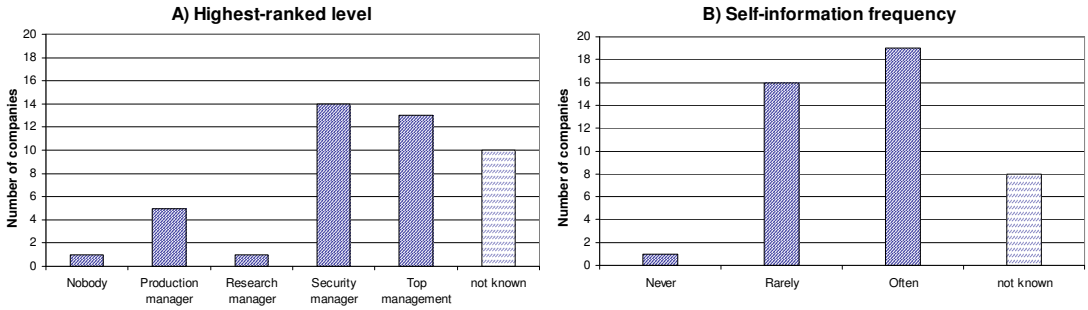

Figure 4: A) Level of the highest-ranked management that takes care of the topic "nanoparticles and safety" (n=43). B) Self-information frequency of the respondents about the topic "nano-particles and EHS" (n=43).

4.2. Results of the main study

The below stated results of the main study have been submitted in August 2008 for publication in a scientific journal.

4.2.1. Response rate and sample representativeness

In the layered survey the average response rate was 58.3% (947 of 1'626 companies) and all twenty layers showed a response rate higher than 45%. The size distribution in the survey sample was compared to the size distribution of the SUVA-clients (22) and all production companies of Swiss industry (25).

Table 11 shows that the proportions between the subsets were similar, however, it also showed a tendency towards an over sampling of larger companies (2.0% versus 1.1%) and an over representation of the large Swiss companies by SUVA clients (1.1% versus 0.6%).

Table 11: Comparison of the company size distribution in percent of each subset: all Swiss production companies, all SUVA-clients, the layered survey sample and the responding subset.

	Micro (1-9 employees)	*Small (10-49 employees)*	*Medium (50-249 employees)*	*Large (250 and more employees)*	*Total*	
Industrial sector of the Swiss industry	79.4%	16.6%	3.4%	0.6%	100%	(72'540 companies)
SUVA	72.5%	21.4%	5.1%	1.0%	100%	(91'804 companies)
SUVA (without removed sector)	71.2%	22.3%	5.4%	1.1%	100%	(78'559 companies)
Main survey - sent questionnaires	67.0%	23.8%	7.2%	2.0%	100%	(1'626 companies)
Main survey - responses	62.4%	26.0%	9.1%	2.5%	100%	(943 companies)

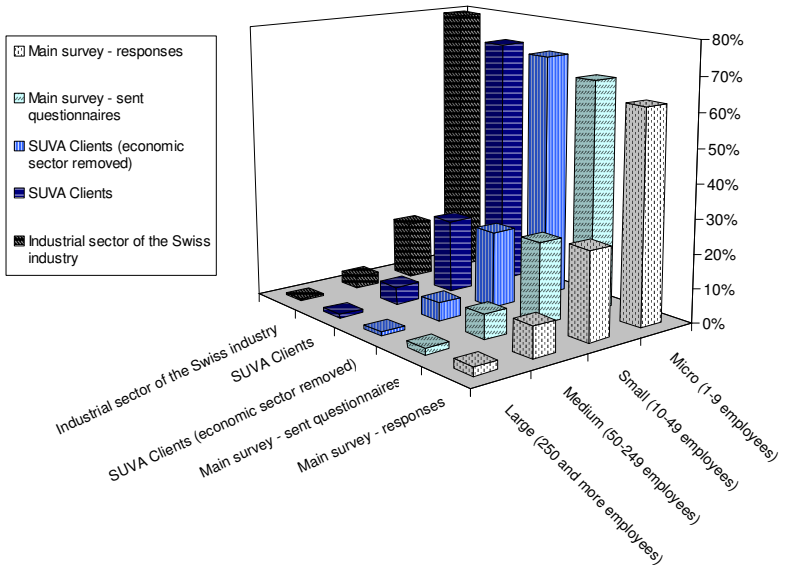

Figure 5*: Visualised form of Table 11. Comparison of all Swiss production companies, all SUVA-clients, the layered survey sample and the responding subset.*

No significant difference was observed between the response rates of the different language regions of Switzerland German 58.4% (702 of 1'202 companies replied), French 56.4% (185 of 328 companies) and Italian 62.5% (60 of 96 companies).

The two complementary surveys showed similar response rates: 65.6% (128 of 195 companies replied) for the targeted survey and 64.6% for the Top-99 (64 of 99 companies).

The questionnaires were signed by members of the management in 54% of the responding companies, by administration personnel (17%), by health and security staff (10%), by human resources (4%), by workers (3%) and by environment/health specialists in less than one percent. Of all returned questionnaires 82% did indicate the function of the responding person.

4.2.2. Nanoparticle prevalence

Of the companies stating that they handle nanoparticles, four were excluded: one chimney sweep reporting soot, one carpenter reporting by error a particle application as detected during a quality control call, one company reporting the smoke of a miller process and one company using metal pieces that had a surface layer based on a nano-polymer without particles (SUVA verified independently this statement).

The following number of companies declared handling nanoparticles and were after a check taken into account: fourteen of the 947 responding companies in the main survey, seven of the 68 responding companies in the Top-99 survey and twenty of the 131 responding companies in the targeted survey. Among the fourteen companies declaring a nanoparticle application twenty-four workers were declared to deal directly with nanoparticles or products containing nanoparticles. The proportion of women among these indicated workers was smaller than ten percent.

The response rate of the companies seemed to depend on the size of the companies. Figure 6 shows that the response rate increased with the company size. The percentage of reported nanoparticle application also increased with the size of the companies.

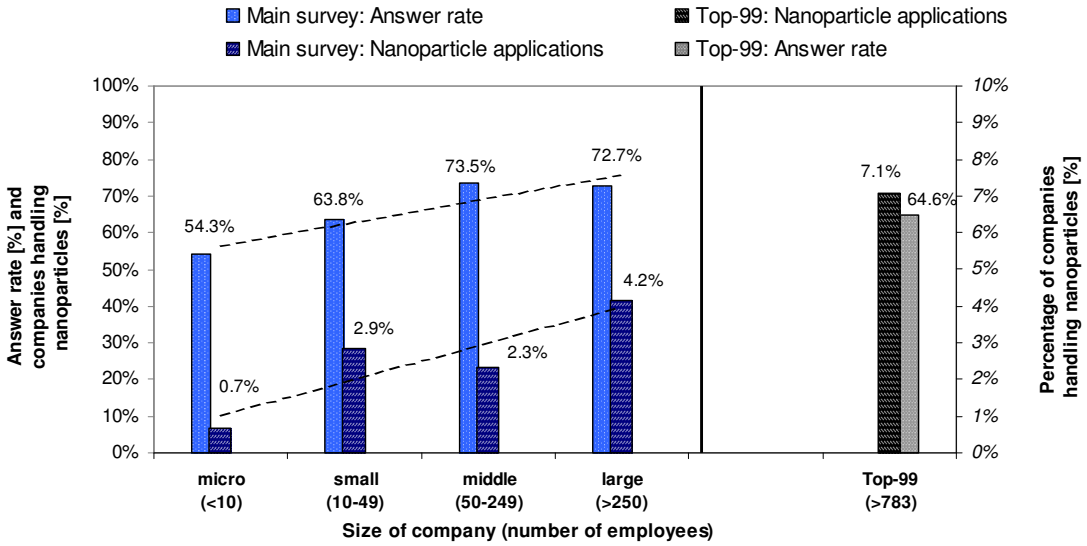

Figure 6: Response rate and percentage of companies reporting the use of nanoparticles compared to the company size (number of employees). Both, the answer rate and the percentage of companies dealing with nanoparticles increased with the company size. The data of the additional survey Top-99 are in support of the tendency for more frequent nanoparticle applications in larger companies.

In order to verify the answer "no nanoparticle application", a random sample of fifty-nine companies was contacted by phone calls: this was the necessary sample size to reject at 95% false negative. The companies were selected among the ones declaring that they did not deal with nanoparticles. The interview partners (normally the ones whose name figured on the questionnaire) were asked about the usage of nanoparticles. Specific questions were asked about applications, that were known in literature for this economic branch (10). The answers "no such application" were shown not to be based on a misunderstanding for all fifty-nine companies.

4.2.3. Extrapolation from survey to SUVA and from SUVA to Switzerland

Table 12 shows in percent per layer the SUVA clients dealing with nanoparticles. These responses of the main survey were extrapolated to all clients of SUVA, and weighted according to the size of each layer: the 95% confidence interval for this extrapolation is shown in parentheses. Among all SUVA-clients, 493 companies (122 to 864) or 0.6% (0.2% to 1.1%) are expected to deal with nanoparticles. Table 12 shows the reported percent of workers among the SUVA client companies the extrapolated percentage of workers dealing with nanoparticles and the resulting number of expected workers in Switzerland. The number of workers in the layer "Trade" was interpolated from the average of the other layers. Table 12 shows only the extrapolation of the workers in direct potential contact to the nanoparticles. An average of 2.5 workers per company working directly with nanoparticles or products containing nanoparticles was reported, while an average of 4.3 people was reported to work in the same room.

The expected total number of companies and workers in Switzerland was extrapolated based on the percentage of companies and workers among the SUVA clients: for the number of companies a factor of 1.19 was used and for the number of workers a factor of 1.06 was applied to all layers in equal measure. A total of 0.6% (0.2% to 1.1%) of Swiss companies is expected to deal with nanoparticles. This corresponds to 586 companies (145 to 1'027). Among the Swiss workers, 0.08% (0.06% to 0.09%) faces a potential exposure to nanoparticles by handling a nanoparticle application. This corresponds to 1'309 workers (1'073 to 1'545). A total of 0.2% (0.17% to 0.22%) is present in the same room as a nanoparticle application, which corresponds to 3'403 workers (2'990 to 3'816) being potentially exposed due to a close workplace to the nanoparticle application.

The survey did not reveal any information about nanoparticle applications in some branches. No confidence interval for the result "0%" could be calculated with the formulas 20-22 (chapter 3.2.4), despite known applications by other surveys (e.g. by the additional surveys or the pilot study).

Table 12: Percentage of companies (SUVA-clients) dealing with nanoparticles and percentage of workers reported to deal with a nanoparticle application. Branch with interpolated number of concerned workers per company from the average of the other layers[a]; overall response rate[b]; average weighted by layer[c].

Layers	Number of companies represented in SUVA	Calculated sample size per layer (1.69% per layer)	Theoretical size of survey numbers <50 -> 50	Number of sent questionnaires	Response rate	Percentage of companies dealing with nanoparticles per layer	Extrapolation: expected companies among the SUVA-Clients (95% confidence interval of the estimation)	Estimated percent of companies dealing with nanoparticles per layer, weighted by the total number of such companies (95% confidence interval of the estimation)	Extrapolation of expected Swiss companies	Number of workers represented by the layers	Number of worker in the companies responding (SUVA)	Workers working with nanoparticles or products containing nanoparticles per layer	Percentage among the estimated workers of the whole survey	Estimated number of workers in contact to nanoparticles (SUVA)	Estimated number of workers in direct contact (Swiss companies)
Chemical Industry	633	11	50	45	73%	21.2%	134 (46 to +223)	27.2% (12.1% to 42.4%)	160	79'856	1'330	0.53%	34%	420	445
Ceramics and Glass	334	6	50	49	63%	6.5%	22 (-7 to +50)	4.4% (0% to 11.6%)	26	7'035	1'326	0.23%	1%	16	17
Surface Modification	366	6	50	43	60%	3.8%	14 (-13 to +41)	2.9% (0% to 9.3%)	17	6'761	675	0.30%	2%	20	21
Stone	248	4	50	50	64%	3.1%	8 (-7 to +23)	1.6% (0% to 5.9%)	9	1'856	109	0.92%	1%	17	18
Trade	3'506	59	59	58	69%	2.5%	88 (-82 to +257)	17.8% (5.9% to 29.6%)	104	153'585	1'119	0.22%	28%	343	364
Electrotechnics	5'524	93	93	92	57%	1.9%	106 (-100 to +312)	21.6% (10.4% to 32.7%)	126	195'689	763	0.13%	21%	256	272
Automobile	11'283	190	190	186	50%	1.1%	121 (-115 to +358)	24.6% (15.9% to 33.4%)	144	100'282	617	0.16%	13%	163	172
Building/Construction, Internal	16'301	275	275	265	48%	0%	0	0%	0	132'186	1'062	0%	0%	0	0
Metals	3'862	65	65	62	66%	0%	0	0%	0	80'555	602	0%	0%	0	0
Engine Construction	4'481	76	75	72	64%	0%	0	0%	0	143'783	1'313	0%	0%	0	0
Carpentry	5'670	96	95	95	56%	0%	0	0%	0	50'335	347	0%	0%	0	0
Paper and Printing	1'441	24	50	49	53%	0%	0	0%	0	55'587	1'313	0%	0%	0	0
Plastics or Polymers	778	13	50	48	69%	0%	0	0%	0	27'080	2'069	0%	0%	0	0
Textiles and Leather	1'172	20	50	49	69%	0%	0	0%	0	25'915	465	0%	0%	0	0
Food and Agriculture	447	8	50	48	69%	0%	0	0%	0	49'271	4'456	0%	0%	0	0
Public Institutions/Administration	2'985	50	50	50	64%	0%	0	0%	0	139'439	932	0%	0%	0	0
Building/ Construction, External	10'364	175	175	167	55%	0%	0	0%	0	141'348	1'564	0%	0%	0	0
Public and Private Transportation	5'666	96	95	93	60%	0%	0	0%	0	129'295	1'814	0%	0%	0	0
Electricity	3'394	57	57	55	49%	0%	0	0%	0	70'202	769	0%	0%	0	0
Workplace integration for disabled	281	5	50	49	84%	0%	0	0%	0	32'702	5'235	0%	0%	0	0
Sum (numbers) /Average (%)	78'736	1'328	1'679	1'625	58%[(b)]	0.63%			586	1'622'762	27'880	0.076%[(c)]	100%	1'235	1'309

4.2.4. Economic branches with nanoparticle applications

The weighted average of companies dealing with nanoparticles was calculated based on the number of represented SUVA-clients per layer and the sum them.

Figure 7 A) shows, how companies dealing with nanoparticles are distributed among the economic branches. Following branches not showing any applications in the survey are presented as "others": building/construction internal, metals, engine construction, carpenter, paper and printing, plastics and polymers, textiles and leather, food and agriculture, public institutes/administration, building/construction external, public and private transportation, electricity, workplace integration for disabled.

Figure 7 B) shows how potentially exposed workers are distributed among economic branches. The frequency of potentially exposed workers was highest in the chemical industry, followed by trade, electrotechnics and automobile related companies. The branches surface modification, stone and ceramic / glass showed a low potential exposure of their workers.

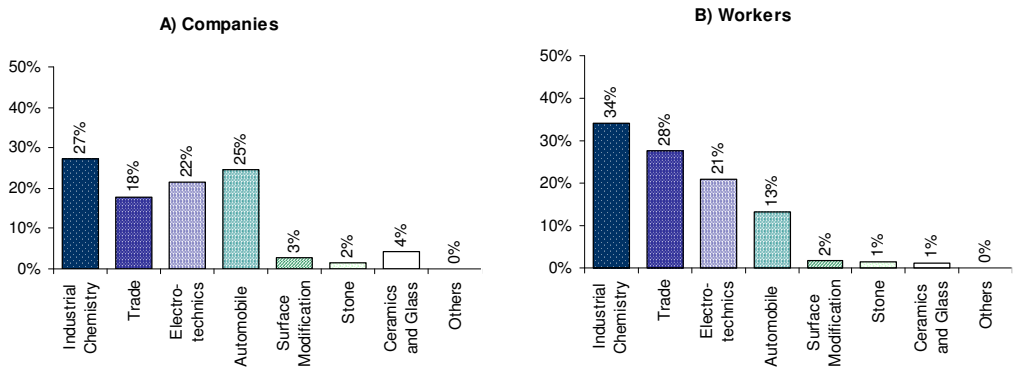

Figure 7: Distribution of companies with nanoparticle applications within the Swiss production sector: A) by company from the different branches, B) by the number of workers in these branches.

Figure 8 A) shows the average material stock size and Figure 8 B) the average yearly turnover of nanoparticles per company. The responses about the stock size ranged from grams to around a ton, no company in the main survey reported a stock or a yearly turnover of nanoparticles larger than 5'000 kg. Stocks and turnovers of more than a ton were only reported in the targeted survey: two companies reported a stock of around a hundred tons (organic pigments and carbon black).

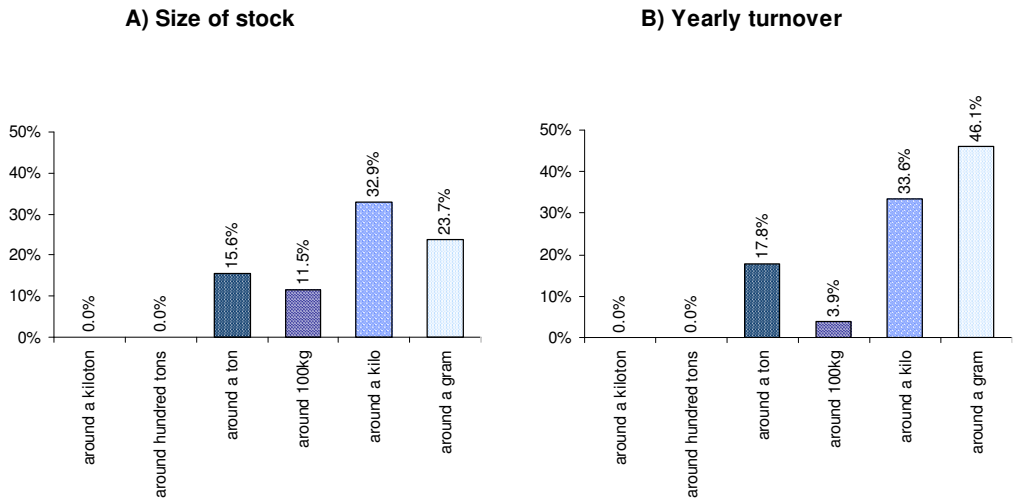

Figure 8: Frequency of the indicated stock sizes and yearly turnover of nanoparticles among the companies declaring a nanoparticle application is shown in A) stock size and B) yearly turnover of nanoparticles.

Two more layers with nanoparticle applications were identified by the targeted survey: outside building construction and paper / print.

4.2.5. Type of nanoparticles

The reported nanoparticles were grouped into inorganic, organic, metallic (pure metal), and undefined nanoparticles. Nanoparticles of inorganic nature were reported to be used most: a range of 0.1 to 5'000 kg with an average of 1'426 kg. Organic nanoparticles were reported to be used with an average 365 kg in the range of 10 to 1'400 kg. Only one company reported the use of silver nanoparticles in a liquid application of 500 liters at 100 ppm.

The Top-99 survey showed results similar to the main survey. The targeted survey, however, showed greater amounts of nanoparticles: a paint-production company reported one hundred tons of powder based organic pigments and showed that in more than the found economic sectors nanoparticle applications can be found: a paper production company using a $CaCO_3$-slurry reported a yearly turnover of several hundred tons of inorganic nanoparticles.

4.2.6. Protection measures

Figure 9 shows the types of measures used to protect workers in the companies reporting a nanoparticle application. The data are shown weighted by the number of companies with nanoparticle applications. None of the reported single protection means showed a clear predominance over the others: personal protective equipment, technical measures as well as organisational measures were used. The use of personal protection equipment was predominant for powder applications and the enclosure of a process for liquid only applications. Workplaces without any specific protection were uniquely reported in combination with liquid-only applications.

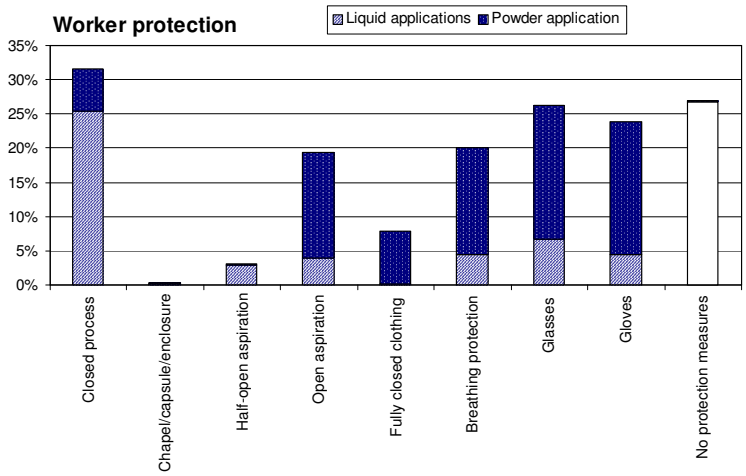

Figure 9: Types of worker protection measures used in companies of the Swiss production sector. Frequence of companies using liquid or powder applications. No company used nano-powder without some kind of protection.

Figure 10 shows the types of environmental protection measure used for nanoparticle applications. Most companies did not apply measures to specifically protect the environment.

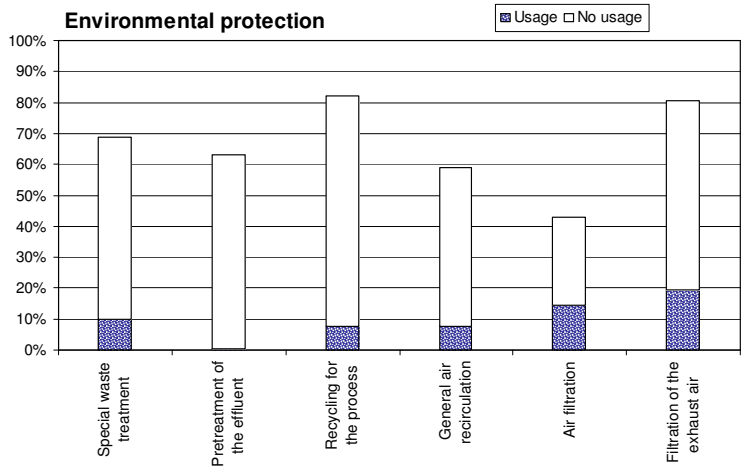

Figure 10: Types of environmental protection measures used in companies of the Swiss production sector. The non-usage of protection measures was predominant over their usage.

5. Discussion

The Nano-Inventory was created in two steps, which both provided insight on different aspects assessing the potential occupational exposure to nanoparticles in Swiss industry.

The pilot survey was designed to prove the feasibility of a written survey and to gain detailed information about the handling of nanoparticles and the application of specific means of protection in industry. However, the pilot study was a targeted study and lacked the important information: the number of companies and workers dealing with nanoparticles. In order to gain this information, the main study was designed as representative survey among Swiss companies of the productive sector.

5.1. Discussion of the pilot survey

In the pilot study 198 companies that were believed to be potentially dealing with nanoparticles were interviewed. Fifty-five of them reported the presence of nanoparticles and 44 companies had some sort of application or production of nanoparticles. Almost all safety managers in all sectors answered our questions about nanoparticle applications and protection measures. Many of them gave detailed information, which allowed the pilot study not only to provide a first impression about types and quantities of nanoparticles used in the Swiss industrial sectors investigated, but also gave a rather detailed picture of the manner in which nanoparticles were handled.

The quantities of nanoparticles used ranged from a few grams to very large-scale production in thousands of tons: namely Ag, AlO_3, Fe-Ox, SiO_2, TiO_2 and ZnO_2. However, the majority of nanoparticle applications were on a small production scale. Applications were identified in the fields coatings, cosmetics, food/animal food/food packing, metal, optics, paints, powder production, research and surface treatment. The means of protection seemed to be adapted to the type of applications used (liquid, powder, solid etc.). Most liquid application protections assumed that nanoparticles would not become airborne (no airways protection).

More Information was obtained about which kind of means of protection was applied with each type of application. The information about who was using the nanoparticles (in terms of company size) was, however, potentially biased due to the targeted design of this pilot study: it is most likely that not all sectors and applications using or producing nanoparticles were identified.

The respondents to the interviews of the pilot study had many open questions about best practices, which pointed to the need for rapid development of guidelines and protection strategies. This was, however, in 2006 and the first versions of such guidelines have since been published. In 2008 ISO published a list of unambiguous terms and definitions related to particles in the field of nanotechnologies. These will help current and future discussions about protection measures (1).

Nevertheless, for the follow up of the pilot study, the information about the occurrence of nanoparticles in the sectors investigated was important and showed that nanoparticles are already a reality in Swiss industry. It supported the need of a representative study. The accuracy of the information gained about the handling of

nanoparticles gave weight to the feasibility of a written survey and helped to design the questionnaires. The results of the pilot study were published in January 2008 (20).

5.2. Discussion of the main study

The main study is the first representative survey about industrial nanoparticle usage in an entire country. The selection of companies included all kinds of industrial branches. The study design allowed for the estimation of a) the number of Swiss companies using nanoparticles, and of b) the number of Swiss workers potentially exposed at their workplaces due to the handling of nanoparticles or being present in the same room as a nanoparticle application.

The prevalence of nanoparticle usage was low, with only 0.63% of the Swiss industrial companies indicating an application. This is surprising considering Switzerland has a long tradition of nanotechnology research and development, and has one of the highest levels of nanotechnology patents and publications per capita (26). Nanoparticle applications were most frequent in the chemical industry (by 21% of the companies in this branch). In absolute terms, however, the number of companies in the automobile, electrotechnics and trade branches were equally important. The low percentages per branch outside the chemical industry suggest that they are only slowly introducing nanotechnological materials. This is supported by responses about the amounts of nanoparticles used, which ranged from only a few grams to several tons, but mostly around a few kilos per year. The representative survey only identified "users", but no "producers" of nanoparticles. Only one company in the targeted survey reported nanoparticle production. This again suggests that the market for nanoparticle applications is still rather young and small.

In terms of potential worker exposure due to a handling of nanoparticles, the chemical industry branch showed the largest numbers, followed by the trade, electrotechnics and automobile related branch. Across all branches, occupational health and safety strategies focused on the use of personal protection equipment. Few technical or organisational measures were applied. This suggests that the need for protection was well accepted, but that inappropriate means were still used instead of the final ones (technical and/or organisational measures). Most companies still seem to have considerable room to improve their protection strategies.

This survey was optimized to estimate the expected number of companies dealing with nanoparticles rather than to represent the characteristics of the material used and their accompanying protection measures in a detailed way. There are other studies already investigating the occupational and environmental usage of nanoparticles. However, their approach was different and so were the type of information gained: the UK's DEFRA study, based on a voluntary reporting system (15), has so far had a rather small response rate. The Woodrow Wilson consumer product inventory (27) focuses on products described on the Internet presence of companies. It excludes companies or products that do not use the term "nano" for commercialisation purposes. The BAuA study among German companies surveyed the use of nanoparticles in a detailed but unrepresentative sample of companies (13) and showed a relatively low response rate. They nevertheless showed similar types and quantities of nanoparticles per company as this study of Swiss companies has.

Three other studies presented an estimation of the potential occupational exposure to nanoparticles in their respective countries:

a) An Italian study investigated the potential use of nanoparticles in industry and estimated this by extrapolating the total number of workers per branch in which an application was known (28). The numbers found are, not surprisingly, very high. However, as the study lacked information about the effective use of particles in industry, the results must be considered as a maximum number of workers who might potentially be exposed to nanoparticles. The results of the study presented here contrast these results, showing that the percentage of companies using nanoparticles is probably much smaller.

b) A UK report (29) presented several estimations of the occupational exposure to particles and nanoparticles in the UK. One of them estimates the number of workers potentially exposed to nanoparticles in the UK to be 2'000. Considering that the UK population is about ten times the Swiss population, this number seems to be lower than the 1'309 workers estimated for Switzerland. However, the UK study focused on specific nanotechnology industries only and did not include other kinds of industry. The two studies' estimations might therefore be situated in about the same range.

c) A descriptive survey among French companies and laboratories estimated a low number of potentially exposed workers in the same range as the UK report: 2'000-4'000 workers (14). However, as the study focuses on producers of nanoparticles, the expected number of workers potentially exposed to nanoparticles is 50%-80% per company, which is much higher than the percentage presented here, of an average of two workers per company.

SUVA is an organisation which has a very good reputation among its clients for its very customer oriented style of working. However, in Switzerland it is also the monopoly insurer for accidents in the workplace. In the year 2004 SUVA won the Swiss quality award for business excellence for being innovative despite having the monopoly (30) in their line of business. The main survey presented here was done in collaboration with SUVA, this might explain the high company response rate to the survey: the questionnaire was coming from their own insurer. The response rate achieved 58% and the high percentage of responses from members of management (54%) show that the approach of doing the survey in collaboration with SUVA probably helped in achieving a maximum number of sincere quality responses describing the Swiss production sector.

The focus of the pilot study and the main survey were complementary. The pilot study focused qualitatively on users or producers of nanoparticles and described their types of used particles in detail. The main survey on the other hand was optimized to evaluate the number or the percentage of Swiss industrial companies concerned.

However, the design chosen for the main survey has its limitations. One is that the number of companies reporting a nanoparticle application per layer was rather low, which leads to relatively large confidence intervals and for several economic sectors the result is "zero". A bigger sample size would be necessary to achieve a better

distinction between "no applications" and "only a few applications". However, as the survey was designed to be representative, a "zero" underlines the result of the very low nanoparticle usage in these branches. The confidence interval for the percentage of companies dealing with nanoparticles in Switzerland might be influenced by the slight over-selection of big companies in the random selection (2.0% in the selection, 1.1% in the study population).

Two other limitations, which could have influenced the results, are that the extrapolation from SUVA clients to all Swiss producing companies could have caused an over-estimation, whereas the fact that not all SUVA clients are manufacturers could have caused an under-estimation.

a) The extrapolation from SUVA clients to all Swiss companies of the production sector was based on the assumption that the 84% surveyed SUVA clients do not differ from the extrapolated 16% of non-SUVA clients. However, companies that present "specific dangers" are forced by law to insure their employees against occupational accidents with SUVA. If the number of production companies among the SUVA clients is over-proportional, then this extrapolation might slightly overestimate the number of companies and workers concerned.

b) Of all SUVA clients, 52.4% are producing companies, 46.1% in the service sector and 1.5% in the primary sector (21). One layer only was excluded from the survey, assuming a high percentage of non-producing companies in this layer. The percentage of non-manufacturing companies in the rest of the population is expected to be around 30-40%. This reduced the probability of a positive response in the random selection and could have led to an under-estimation of the nanoparticle usage.

To estimate the real exposure to nanoparticles in Swiss industry, the results of this study can be combined at a later moment with the exposure profiles of typical workplaces.

6. Conclusion

The combination of all parts of this study provides a good overview on the nanoparticle usage in Swiss industry. The pilot survey demonstrated that in some companies large quantities of selected nanoparticle types are used. In contrast, the main survey showed a small prevalence of nanoparticle applications, small amounts of nanoparticles being used and a limited number of affected workers when taking a view across all companies and branches of the Swiss industry. This knowledge might be useful for risk-assessment and the development of worst-case scenarios.

Personal protection equipment (PPE) was the predominant means of protecting workers. Relying on PPE for routine procedures and large-scale production is usually considered as in adequate occupational health strategy. Thus, the wide use of PPE and the small quantities used support the assumption that this industrial development is still an early stage. This assumption is further supported by a study by the European commission (31), which makes an analysis of the financial development of the nanotechnology field. The authors concluded that the European nanotechnology field is at the beginning of its development. Based on the Lux nanotech report 2004 they concluded that the European nanotechnology field would share less than 1% of manufacturing jobs in the years 2006-2008 but then would increase to 10% in the year 2014. The survey presented here shows a similar proportion of workers potentially in contact to nanoparticles in the general workforce. However, the focus of our study was on the entire industry, while the European report focussed on nanotechnology companies only.

Companies are expected to start full-scale productions of productions with nanomaterials in the near future. These companies need to consider incorporating protection measures into the plans for new production lines. Technological and organisational protection measures need to be the preferred protection methods. This will not only benefit the workers' health, but will also likely increase the competitiveness of the companies as technical and organisational protection means are not only more cost-effective on the long term, but are also easier to control.

The policy makers need to build up strategies to support companies in the responsible development towards a safer usage of nanotechnology. The elaboration of industrial guidelines has to be of top priority, allowing the companies to take responsibility for workers and environment. Such guidelines may have to be designed specifically for different industrial applications, including fields outside nanotechnology, and adapted to all sizes of companies.

The recently adopted action plan on "Risk Assessment and Risk Management for Synthetic Nanomaterials 2006–2009" in Switzerland envisages risk research in the fields of nanotechnology which will allow not only the development of safer nanomaterials but also the creation of knowledge about the safer handling of these newly developed materials.

7. Annex

7.1. Annex pilot study

7.1.1. Guide for the pilot study telephone survey (German and English)

Telefonat:

Datum...

Firma:... **Grösse der Firma: #Angestellte:**...

Person am Telefon:...

1. Kommen im Unternehmen Nanopartikel zum Einsatz?

□ **Ja** weiter zu 2

□ **Nein** Frage nach, ob sie wirklich keine Einsetzen, Frage nach Carbon black, nach Metalloxiden, Pulver, etc. Frage nach Metallverarbeitung, Frage nach regelmässiger Metallverarbeitung (Schmelzen, Schweissen, Laserschneiden etc.), wenn alles nichts, dann vielen Dank ;)

Branchenübliche Stoffe gezielt nachfragen?...

2. Mich interessiert auch welche Arten von Nanopartikeln zum Einsatz kommen? Es geht nur um eine grundsätzliche Evaluation, keine Firmengeheimnisse...

a, Substanz: carbon black, SiO_2, AlO_2, TiO_2, Pharmakologische Dinge, andere? ...

b, Form: □ Pulver, □ Flüssig, □ sonstwie

c, Menge etwa: ...(g, kg, t /d)

d, Dauer pot exp.: ...(nur 1x/d, ständig), (regelmässig, ab und zu)

e, **Anwendungszweck** / Einsatz: ...

Kommentare:

...

3a. In welcher Art kommen die Arbeiter mit Nanopartikel in Kontakt?

a, Art der **Anlieferung** □ Pulverfass, □ Flüssigtank, □ Feststoff, □ Sack etc...

b, Art der Verarbeitung Gibt es **Umschüttung**? □ Ja □ Nein

c, Art Beteiligte: Anlieferung/Verarbeitung/Reinigung(ext/int)/Verpackung ...

d, **Zahl** Beteiligte: Wie viele sind überhaupt während Prozess in der Nähe? ...

3b. Gibt es Schutzvorkehrungen?

Pulver Welches sind die Typen der Luft-Schutzvorkehrungen?

□ Trennung, Organisation etc...

□ Druck, Luftzug, Kapelle etc...

□ Filter, Reinluftfilter etc.. ...

□ PSA (pers. Schutzausrüstung, welcher Art? ...

Filter wohin gehen die Partikel, wenn ein Filter verwendet wird? Wer wechselt oder unterhält die Filter?

□ Firmeninterner Wechsel

□ Externe Firma (ev. Namen?)...

□ Gar kein Filter? Nur Abluft? Wohin geht die?...

4. Jede Firma hat ihre eigene Sicherheitspolitik... sind hier Nanopartikel ein Thema?

□ **Ja**: Wie häufig beschäftigt sich der Sicherheitsverantwortliche mit Nanopartikel?...

□ **Ja**: Arbeiter wird regelmässig informiert: etwa...

□ **jein**: Ab und zu mal wieder Infoblatt oder ähnliches

□ **Nein**: Niemand beschäftigt sich damit

Etage: Welches ist der höchste Chef, der sich je mit Sicherheitsfragen um Nanopartikel kümmert?...

5. Gibt es einen Arbeitsmediziner oder Arbeithygieniker in Ihrer Firma?

□ **Ja** / □ **Nein** Arbeitsmediziner □ **Ja** /□ **Nein** Arbeitshygieniker

6. Dürfen wir sie nochmals kontaktieren, um ev. Probemessungen machen zu können?

□ **Ja**: Kontaktadresse?

□ **Nein**: Vielen Dank für die Auskünfte!

Kommentare:...

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rvey: Application of nanoparticles

te
titute: **Size of the institute (#employees):**
rson responding:

1. Do you use nanoparticles in your institute? For example inorganic: SiO_2, TiO_2 or organic pigments like carbon black etc. or new materials?

yes please continue with question 2
no thank you for sending back this questionnaire

2. What sort of nanoparticles do is used?

a, substance: Carbon black, SiO_2, AlO_2, TiO_2, pharmaceutical, else? ☐
b, form: ☐ powder, ☐ liquid, ☐ else (solgel, solid, etc.)
c, quantity (aprox.): ☐ mg, ☐ g, ☐ kg, ☐ t /per day
d, period: ☐ 1x/day, ☐ continuous, ☐ once in a while
e, purpose of application: ☐

3a. What kind of contact do employees have with nanoparticles?

a, form at delivery ☐ powder tun, ☐ liquid tank, ☐ solid, ☐ sack/bag
b, manner of handling is there any pouring? ☐ yes ☐ no
c, concerned persons: ☐ delivery, ☐ handling, ☐ clearance, ☐ packing
else: ☐
d, number of concerned persons: How many people are present during normal operating process? ☐

3b. Are there any protection measures?

ter Is there some sort of filter used? And how?
☐ Replacement of filters is performed by staff
☐ Replacement of filters is outsourced. Name of company? ☐
☐ No filter is used. If there is an extractor hood (air flow) where does the air go? ☐

wder What kind of air-protection measurements are used?
☐ organisation, separation etc..
☐ pressure, air draught, fume cupboard etc.
☐ filter, etc.
(personal protective equipment)
☐ mask, ☐ gloves, ☐ safety glasses, else: ☐?

quids What kind of protective equipment is used?
(personal protective equipment)
☐ mask, ☐ gloves, ☐ safety glasses, else: ☐?

Institut universitaire romand de Santé au Travail

4. safety policy... is the problem of nanoparticles discussed?

How often does the safety officer (person in charge of safety) treat the problem of nanoparticles? ☐

☐ **routine information**: employees are informed in a regularly manner.
how often? ☐ per year
☐ **rare information**: employees are informed exceptionally
☐ **no information**: only the safety officer is involved in questions about security of nanoparticles

level: Who is the highest superior who is involved in questions about safety of nanoparticles? ☐

5. Is there an occupational doctor or occupational hygienist at the institute or at the university?
☐ **yes** / ☐ **no** occupational doctor
☐ **yes** / ☐ **no** occupational hygienist

commentaries: ☐

thank you for sending back this survey

7.1.2. Types of application identified in literature

Table 13: All types of application that were identified in the literature search. VDI = Technologiezentrum, Düsseldorf - Germany), Uni Ulm = University of Ulm**) - Germany, INM = Institut für neue Materialien of Saarbrücken – Germany***).*

Applications	*Source*	*Expected sector*	*Identified in pilot study*
Batteries / fuel cells / condensers	Uni Ulm	Else	No
Composites and „Gradientenwerkstoffe“	Uni Ulm	Else	No
Supramolecular units	Uni Ulm	Else	No
Automotive manufacturers and their subcontractors, ceramic components of motors	Uni Ulm	Else	No
Materials lightweight construction	Uni Ulm	Else	No
Gasholder	Uni Ulm	Else	No
Absorbability elements	Uni Ulm	Else	No
Catalysers with heightened surface	Uni Ulm	Else	No
High-speed embossing (flexible CD for Bertelsmann/Topac), Holography, light steering	INM	Else	No
New biotechnological and biomedical applications (affinity chromatography, immobilisation of enzymes and cells), waste water treatment, decontamination of harmful substances.	INM	Else	No
Optical fibres	VDI	Else	No
Bio detection and labelling	VDI	Else	No
Bio magnetic separations	VDI	Else	No
Thermals spray coatings	VDI	Else	No
Automotive catalyst	VDI	Else	No
Membranes	VDI	Else	No
Propellants	VDI	Else (Army?)	No
Systems of compact nano materials (membranes, strengthened plastics, light absorber, aero gels, light emitter)	Uni Ulm	Else, plastics	No
Antimicrobials	VDI	Food/ -packing	No
MRI contrast agents	VDI	Medicine	No
Polymer composites or organical-anorganical nano composites as plastics for contrasting implants, catheter etc. Nanoparticles as carrier for gene or drug targeting, super paramagnetic nanoparticles for cancer therapy.	INM	Medicine, Surface coating	No
Orthopaedics/implants	VDI	Medicine/Surface coating	No
Extra hard alloys	Uni Ulm	Metal treatment	No
Photovoltaic solar power plant	Uni Ulm	Microelectronics	No
Quantum components	Uni Ulm	Microelectronics	No
Metal pigments for data drives	Uni Ulm	Microelectronics	No
Background lights	Uni Ulm	Microelectronics	No
Magnetic fluid seals and recording media	VDI	Microelectronics	No
Quantum optical devices	VDI	Microelectronics	No
Photo catalysts	VDI	Microelectronics	No
Solar cells	VDI	Microelectronics	No
Rotary movements	Uni Ulm	N/A	No
Pastes	Uni Ulm	N/A	No
Resistes	Uni Ulm	N/A	No
Inductive components	Uni Ulm	N/A	No
Packaging of integrated circuits	Uni Ulm	N/A	No
Zeolithe reaktors	Uni Ulm	N/A	No
Molecular chemionics	Uni Ulm	N/A	No
Multi layer capacitors	VDI	N/A	No
Phosphors	VDI	N/A	No
Components for non linear optics	Uni Ulm	Optics	No
Hybrid pigments, effects pigments	Uni Ulm	Paintings	No
Drug targeting (homing of pharmaceuticals)	Uni Ulm, VDI	Pharma	No
Key-target – material systems	Uni Ulm	Pharma	No
Nanoemulsions	Uni Ulm	Pharma/Cosmetics	No
Crystallites, emulsions, clusters, fullerenes, nanotubes	Uni Ulm	Powder production	No
Soft magnets, ferrofluids, magnetic particles	Uni Ulm	Powder production	No
Polymers / nano composites, micro system techniques (micro injection die moulding), sensors, membranes	INM	Sensors	No
Nano composites with biocompatible surfaces, microbiocidic surfaces	INM	Surface coating	No
Alternative for enamel, super scratch-resistant polycarbonate eyeglasses with additional functions (UV-, IR-absorption, microbiocidic effects, antistatic effects), self structuring systems for transparent blinds on all plastics and metals.	INM	Surface coating	No
Antigraffiti	INM	Surface coating	No
Electro conductive coatings	VDI	Surface coating	No
Sunscreen	VDI	Cosmetics	Yes
Ceramic process techniques	Uni Ulm	Else	Yes
Chemical-mechanical polishing	VDI	Else	Yes

Applications	*Source*	*Expected sector*	*Identified in pilot study*
Production of food (milk, juices, brewery)	INM	Food	Yes
Lubricants	Uni Ulm	Optics	Yes
Colour effects and colour layers	Uni Ulm	Paintings	Yes
Chemistry / material science, nanoparticle production (colloids, pigments, dispersions, powders)	Uni Ulm	Powder production	Yes
Research in active agent (pharmacology)	Uni Ulm	Research	Yes
Fine mechanics, optics, analytics: low abrasion bearing	Uni Ulm	Surface coating	Yes
Corrosion inhibitors	Uni Ulm	Surface coating	Yes
Functional layers (anti undercoating, climatisation coating, antifilm coating)	Uni Ulm	Surface coating	Yes
Scratch-resistant lacquers as topcoat (automotives etc.)	INM	Surface coating	Yes
Scratch-resistant coatings	VDI	Surface coating	Yes
Fuel cells	VDI	Else	Yes
Structural ceramics	VDI	Else	Yes

*) http://www.zukuenftigetechnologien.de/11.pdf, last access: 24.09.2008
**) http://wwwex.physik.uni-ulm.de/vortraege/StudiumGenerale/Nanot_20.htm, last access: 24.09.2008
***) http://www.inm-gmbh.de/htdocs/technologien/schwerpunkte/schwerpunkte_de.htm, last access: 28.02.06. The cited INM webpage has meantime been removed. However, similar information are presented on following page of the INM: www.inm-gmbh.de/forschung/?PHPSESSID=74b4e577602546b7c8d7b328f576aa88

7.1.3. Syndicate with member addresses on their web page

Industry sector	*Syndicate's homepage*
Printing production	www.druckindustrie.ch
Paint production	www.vslf.ch
Cosmetics production	www.skw-cds.ch
Varnish production	www.flh.ch
Paper production	www.zpk.ch
Chemical production	www.sgci.ch
Plastic production	www.kvs.ch
Cleaning agent production	www.skw-cds.ch
Animal feed production	www.vsf-mills.ch
Food science *)	www.sglwt.ch
Microelectronic production	www.swico.ch
Sensors	www.sensors.ch
Clock production	www.fhs.ch
Construction materials	www.vsbh.ch

*) The head of the syndicate sent during the pilot study a written questionnaire to over 200 members of this syndicate. The return however was very little with less than 4% of responses.

7.2. Annex main study

7.2.1. Sectors excluded from Top-99 survey

Table 14: Some economic sectors have been excluded from the Top-99 survey to focus on the industrial part. The numbers in front of the description is the SUVA-Code of the economic sector.

SUVA	*Description*
25P	Impression and medias
40M	Public administration
42B	Forestry
46H	Train restaurants and night trains
47B	Train companies
47D	Tramways and Trolleybus companies
47E	Ski lift companies
48A	Aviation companies
49A	Transport companies
50A	Plane maintaining companies
52A	Depots and department stores
55A	Power plants and electricity distributing companies
55C	Electricity transport mean montage - air and soil
55D	Electricity installation companies
56B	Gas distribution companies
60F	Office economic and technique, services administrative
61A	Governmental administration, post offices
70C	Employee placement
99B	Program for temporary occupation of non employed

7.2.2. Associations pre-advised before the survey

Table 15: List of association receiving an informative letter before the survey

Definition	*Webpage*	*Acronym*
Chemie	www.sgci.ch	SSIC (SGCI)
Verband der Schweizer Druckindustrie	www.vsd.ch	IGS (VSD)
Verband Schweizerischer Lack und Farbenfabrikanten	www.vslf.ch	USVP (VSLF)
Kosmetik / Waschmittel	www.skw-cds.ch	ASCD (SKW)
Papier	www.zpk.ch	ASPI (ZPK)
Plastik	www.kvs.ch	ASMP (KVS)
Tierfutter	www.vsf-mills.ch	VSF
Lebensmittel	www.sglwt.ch	SOSSTA (SGLWT)
Mikroelektronik	www.swico.ch	SWICO
Sensoren	www.sensors.ch	ASTC (SVS)
Uhren	www.fhs.ch	FHS
Baumaterial	www.vsbh.ch	ASMMC (VSBH)
Textilien	www.swisstextiles.ch	FTS (TVS)
Spitäler	www.hplus.ch	H+
Maschinen-, Elektro- und Metallindustrie	www.swissmem.ch	Swissmem
Arbeitssicherheit	www.sgas.ch	SGAS
Ergonomie	www.swissergo.ch	Swissergo
Studiengruppe für Gesundheitsschutz in Industrie, Dienstleistung und Gewerbe	www.sgig.ch	SGIG
Groupement Romand de Médecine, d'Hygiène et de Sécurité au Travail	www.grmhst.ch	GRMHST
Grenzwert Kommission	-	GWK
Dachverband Sicherheit und Gesundheitsschutz am Arbeitsplatz	www.suissepro.org	SWISSPRO
Schweizerische Organisation der Wirtschaft für Umweltschutz Arbeitssicherheit und Gesundheitsschutz	www.eco-swiss.ch	ECOSWISS
Arbeitnehmerschutz	www.iva-ch.ch	AIPT (IVA)
Société des hygiénistes du travail	www.sgah.ch	SSHT (SGAH)

7.2.3. Pre-advising letter

Fondation universitaire romande de Santé au Travail
Institut universitaire romand de Santé au Travail
Institute for Occupational Health Sciences

Verbandkürzel PräsidentIn
Vorname, Name
Name des Verbandes
Strassenbezeichnung
PLZ Ort

Lausanne, den 20. September 2006

Nanoinventar

Sehr geehrte(r) Herr/Frau .....

in den nächsten Tagen beginnt eine repräsentative Erhebung über die Verbreitung von Nanopartikeln in der Schweizer Industrie. Diese Studie erfolgt im Auftrag von SUVA, BAG, BAFU und SECO und hat zum Ziel, die Grössenordnung und die Art des heutigen Einsatzes von Nanopartikel in der Schweizer Industrie zu dokumentieren. Sie wird vom Institut de Santé au Travail in Lausanne durchgeführt.

Die SUVA wird dazu den Sicherheitsverantwortlichen von rund 2000 Unternehmen aus allen produzierenden Branchen einen Fragebogen zustellen mit der Bitte, ihn auszufüllen und zur Auswertung ans Institut de Santé au Travail zu senden. Die Fragen betreffen Partikeltypen, Mengen, und den Umgang mit den Partikeln. Die Fragen sind bewusst so formuliert, dass keine Produktionsgeheimnisse preisgegeben werden müssen.

Diese Daten werden helfen, geeignete Arbeitsschutzmassnahmen zu evaluieren und Forschungsschwerpunkte zu setzen. Wir können damit das Wissen erarbeiten, wie die Arbeitnehmer vor den eventuellen Gesundheitsrisiken von Nanopartikeln geschützt werden können. Dieses Wissen kann danach der Erarbeitung von Broschüren zur konkreten Empfehlung von Schutzmassnahmen dienen.

Damit wir den Bedarf Ihres Verbandes bei dieser Erhebung korrekt erheben, wären wir ihnen dankbar, wenn Sie Ihre Mitglieder zum vollständigen Ausfüllen des Fragebogens ermutigen würden. Beiliegend finden Sie einen Entwurf des Fragebogens. Für allfällige Fragen stehen wir Ihnen gerne zur Verfügung!

Mit freundlichen Grüssen,

Dr. Michael Riediker Kaspar Schmid

Beilage: erwähnt

Geht an Präsidenten von:
ASM/VSM/Swissmem, ASMMC (VSBH), FHS, GRMST, GWK, H+, KVS, SCASS, SGCI, VSD, SGIG, SGLWT, SKW, SVS/ASTC/SSST, SWICO, Swissergo, TVS, VSBH, VSBH, VSF, VSLF, ZPK

IST, rue du Bugnon 19, CH-1005 Lausanne (Suisse/Switzerland)
Tél. +41-(0)21-314 74 21 / Fax +41-(0)21-314 74 20
http://www.iurst.ch

Figure 11: Informative letter, sent to a selection of industrial associations. The letter was sent together with the description of the study and an intermediate version of the questionnaire.

7.2.4. Description of layers

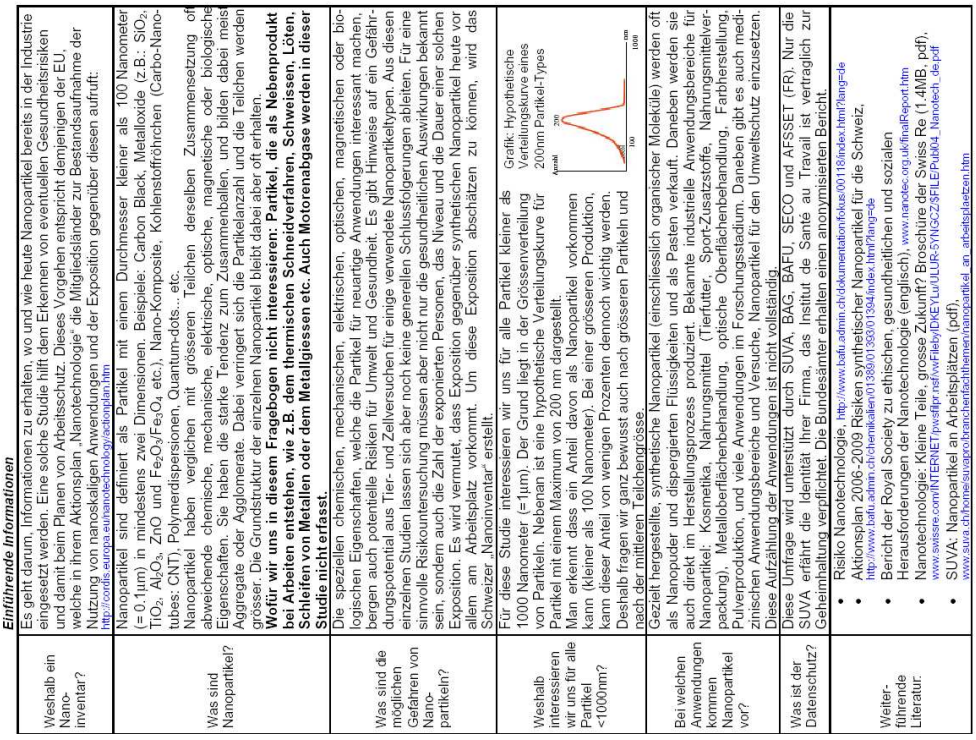
Table 16: Description of the economic sectors in the statistical layers. There is according to the SUVA no official translation of the economic sectors into English.

Short definition	*SUVA-Code*	*Description in German*
Building and Construction, Internal	01A	Zement-, Kalk- u. Gipsfabriken - Abbau
	01B	Sand- und Kieswerke, Transportbetonwerke, Mischgutbetriebe
	02A	Zementwarenfabriken
	44D	Malen und Gipsen
	45B	Bodenlegergeschäfte
	45BA	Bodenlegergeschäfte
	45BB	Bodenlegergeschäfte mit Innendekoration, Näherei
	45D	Gebäudereinigungsgeschäfte, Gebäudeunterhalt
	45G	Installationsgeschäfte für Sanitär-/Heizungs-/Klima-Lüftungsanlagen; Bau-Spenglereien
	45GC	Kaminfegergeschäfte
	45GD	Tankrevisionsbetriebe
	45GE	Installationsgeschäfte
	45GF	Bauspenglereien
	45GG	Installationsbetriebe, Bauspenglereien
	45GH	Bauspengler. m. Dachdecker
	45GK	Installationsbetriebe, Bauspenglerei m. Dachdecker
	45L	Montagebetriebe
	45M	Wand- und Bodenplattenlegergeschäfte, Hafnergeschäfte; Betr., die Kälte-, Wärme-, Schallisolationen ausführen oder Deckenverkleidungen montieren
Ceramic and glass	06A	Keramik und Glas
	06AA	Grobkeramik
	06AB	Feinkeramik
	06AC	Glas und Glasprodukte
	06AD	Glasverarbeitung / Glaserei
Metals	10M	Metallurgie
	10MA	Erzeugen von Metallen
	10MB	Massifumformen von Metallen
	10MC	Giessen von Metallen in Nicht-Sandformen
	10MD	Giessen von Metallen in Sandformen
	11C	Stahl-/Metall-/Apparatebau; allgemein Schlossereien, Schmieden
	11CA	Stahl- u. Metallbau, allg. Schlossereien, Schmieden
	16B	Herst. von Eisen-, Blech und Metallwaren
	16BA	Industriespenglereien
	16BB	Metallwaren-/Blechemballagenfabriken, Stanzereien
	16BC	Herstellung von Drahtprodukten
	16BD	Schliesstechnik, Schneidwaren und Waffengeschäfte
Engine Construction	11CB	Apparatebau, Konstruktionsschlossereien
	11CC	Herstellung, Montage u. Reparatur von Rollläden und Storen
	11CD	Herstellung von Stahlrohrmöbeln u. leichten Metallrohrerzeugnissen
	13B	Maschinen-/Anlagebau
	13BA	Herstellung v. Bestandteilen für die Maschinenbau-Branche
	13BB	Maschinen-/Anlagebau
	13BC	Montage und Reparatur von Produkten der Maschinenbau-Branche
Surface Modification	16C	Oberflächentechnik
	16CA	Betr. der Lackiertechnik
	16CB	Betr. der Galvanotechnik
	16CC	Betr. der thermischen Oberflächentechnik
Carpentry	17S	Sägereien und Holzindustrie (ohne Zimmereien)
	18S	Schreinereien
Paper and Printing	22D	Fabr. von Papier, Karton, Pappe, Halbstoffe
	25C	Papier-, Folien- u. Kartonverarbeitung, Wellkartonfabrikation
	25CA	Papier-/Folienverarbeitung
	25CB	Kartonfabriken
	25P	Grafisches Gewerbe, Fotolabors, Filmstudios, Kinos, Filmverleih
	25PG4F	Filmstudio, Tonstudio
	25PG4K	Kino, Verleih von Bild- und Tonträgern
	25PG4L	Fotolabor
	25PG4P	Herstellung von Planungs-, Ordnungs-, Repräsentationsmitteln
	25PG4S	Schriften- und Reklamegestaltung
	25PG4V	Druckvorstufe, Druckformherstellung
	25PG4W	Druckweiterverarbeitung, Buchbinderei
	25PGO	Druckerei
Plastics or Polymers	23C	Betriebe, die Artikel aus Kunststoff herstellen und verarbeiten

Short definition	*SUVA-Code*	*Description in German*
	23CA	Masch. Verarbeitung v. Kunststoff zu Profilen/Bahnen, Kunststoffaufbereitung
	23CB	Masch. Verarbeitung von Kunststoff zu Formstücken
	23CC	Handwerkliche Verarbeitung v. Kunststoff; spanende und spanlose Weiterverarbeitung von Kunststoff-Halbfabrikaten
Textiles and Leather	26A	Betriebe, die Leder erzeugen und verarbeiten, Innendekorationsgeschäfte
	26AA	Innendekorationen
	26AB	Schuhfabriken, Betriebe der Ledererzeugung, Fellzurichtereien u. Pelzveredlungsbetriebe
	27T	Textil- und Bekleidungsindustrie
	27TA	Spinnstoffaufbereitung, Garne, textile Gewebe herstellen
	27TB	Garne, textile Gewebe herstellen (ohne Spinnstoffaufbereitung)
	27TC	Bekleidungsindustrie
	27TD	Chemiefasern herstellen
	30B	Nasswäschereien, chem. Reinigungsanstalten
Chemical Industry	32A	Herstellung von Grund- und Feinchemikalien, pharmazeutische und kosmetische Produkte
	32F	Herstellung chemischtechnischer Produkte
Food and Agriculture	35H	Schlachthofbetriebe
	35I	Metzgereien, Fleischwarenfabriken; Betriebe, die Schlachthausnebenprodukte verwerten
	35N	Betriebe der Nahrungsmittelindustrie
	37D	Zigaretten- und Zigarrenfabrikation
Stone	38S	Steinbildhauerwerkstätten, Steinsägewerke
Public Institutions and Administration	40M	Öffentliche Verwaltungen
	40MA	Eigenbedarfsarbeiten
	40MC	Spitäler, Heime
	40MD	Administrative Verwaltungen, Schulen
Building and Construction, External	41A	Betriebe die Arbeiten des Bauhauptgewerbes (Erd-, Maurer-, Beton-, Steinhauer- u. Zimmereiarbeiten) ausführen, Felsmaterial gewinnen od. Bauelemente aus Beton herstellen
	42B	Forstbetriebe
	44E	Bedachungen, Fassadenbekleidungen
Public and Private Transportation	46A	Bundesbahnen
	46H	Speise- u. Schlafwagengesellschaften, Restaurationsbetriebe
	47B	Konzessionierte Eisenbahnen
	47D	Strassenbahnen, Trolleybusbetriebe verbunden mit Autobuslinien
	47E	Luftseilbahnen / Skilifte
	48A	Schifffahrtsbetriebe
	49A	Strassentransportbetriebe
	50A	Luftfahrtsbetriebe, Luftfahrzeugunterhaltsbetriebe
Trade	52A	Handels- und Lagerbetriebe
	52AG	Allgemeiner Handel
	52AH	Stahl-, Metallhalbzeughandel
	52AK	Baumaterial-, Holzwerkstoffhandel
	52AL	Brenn-, Treibstoffhandel
	52AM	Landwirtschaftliche Genossenschaften
	52AN	Lagerhäuser
	52AR	Spezielle Grossverteiler (z.B. Migros)
	52D	Altstoffhandel, Recyclingbetriebe
	52T	Getränkeherstellung, Geränkehandel
	52TA	Getränkeherstellung
	52TB	Brauereien
	52TC	Getränkehandel, Getränkedepots
Electricity	55A	Kraftwerke, Stromverteilungsbetriebe
	55C	Frei- u. Kabelleitungsbau
	55D	Elektroinstallationsgeschäfte
	56B	Gasversorgungsbetriebe, verbunden mit Elektrizitätsversorgung
Administration	60F	Kaufm. u. techn. Büros, Verwaltungen, Reisedienste, Verkaufsläden
	60FC	Büros, Verkaufsläden, Reisedienste
	60FD	Technische Büros
	61A	Allgemeine Bundesverwaltungen, Postbetriebe
	70C	Verleih von Personal
	70CA	Ausleihe Betriebspersonal
	70CB	Ausleihe Büropersonal
	99B	Programme für die vorübergehende Beschäftigung von Arbeitslosen
Workplace integration for disabled	71A	Invalidenwerkstätten
Automobile related companies	13D	Reparaturwerkstätten für Strassenfahrzeuge, Landwirtschafts- und Baumaschinen
	13DA	Reparaturwerkstätten für leichte Motorwagen, Service-Stationen
	13DB	Reparaturwerkstätten für schwere Motorwagen
	13DC	Reparaturwerkstätten für Landwirtschafts- und Baumaschinen

Short definition	*SUVA-Code*	*Description in German*
	13DD	Reparaturwerkstätten für Fahr-, Motorfahr- und Motorräder
	13E	Karosseriewerke, Autospenglereien u. Lackierwerke, Waggonfabriken, Bootsbaubetriebe, Flugzeugwerke
	13EA	Karosseriewerke
	13ED	Autospenglereien und Lackierwerke Mitbeteiligung Autospenglereien und Bootsbaubetriebe
Electrotechnics	15D	Elektro-, Informations-, Medizinal- und Zahntechnik, Uhren und Schmuck

7.2.5. Sent questionnaire for the main survey (German/French/Italian)



Institut universitaire romand de Santé au Travail

Einführende Informationen

Weshalb ein Nano-inventar?	Es geht darum, Informationen zu erhalten, wo und wie heute Nanopartikel bereits in der Industrie eingesetzt werden. Eine solche Studie hilft dem Erkennen von eventuellen Gesundheitsrisiken und damit beim Planen von Arbeitsschutz. Dieses Vorgehen entspricht demjenigen der EU, welche in ihrem Aktionsplan „Nanotechnologie" die Mitgliedsländer zur Bestandsaufnahme der Nutzung von nanoskaligen Anwendungen und der Exposition gegenüber diesen aufruft: http://cordis.europa.eu/nanotechnology/actionplan.htm
Was sind Nanopartikel?	Nanopartikel sind definiert als Partikel mit einem Durchmesser kleiner als 100 Nanometer (= 0,1µm) in mindestens zwei Dimensionen. Beispiele: Carbon Black, Metalloxide (z.B.: SiO_2, TiO_2, Al_2O_3, ZnO und Fe_2O_3/Fe_3O_4 etc.), Nano-Komposite, Kohlenstoffröhrchen (Carbo-Nano-tubes: CNT), Polymerdispersionen, Quantum-dots... etc. Nanopartikel haben verglichen mit grösseren Teilchen derselben Zusammensetzung oft abweichende chemische, mechanische, elektrische, optische, magnetische oder biologische Eigenschaften. Sie haben die starke Tendenz zum Zusammenballen, und bilden dabei meist Aggregate oder Agglomerate. Dabei verringert sich die Partikelanzahl und die Teilchen werden grösser. Die Grundstruktur der einzelnen Nanopartikel bleibt dabei aber oft erhalten. **Wofür wir uns in diesem Fragebogen nicht interessieren: Partikel, die als Nebenprodukt bei Arbeiten entstehen, wie z.B. dem thermischen Schneidverfahren, Schweissen, Löten, Schleifen von Metallen oder dem Metallgiessen etc. Auch Motorenabgase werden in dieser Studie nicht erfasst.**
Was sind die möglichen Gefahren von Nano-partikeln?	Die speziellen chemischen, mechanischen, elektrischen, optischen, magnetischen oder biologischen Eigenschaften, welche die Partikel für neuartige Anwendungen interessant machen, bergen auch potentielle Risiken für Umwelt und Gesundheit. Es gibt Hinweise auf ein Gefährdungspotential aus Tier- und Zellversuchen für einige verwendete Nanopartikeltypen. Aus diesen einzelnen Studien lassen sich aber noch keine generellen Schlussfolgerungen ableiten. Für eine sinnvolle Risikountersuchung müssen aber nicht nur die gesundheitlichen Auswirkungen bekannt sein, sondern auch die Zahl der exponierten Personen, das Niveau und die Dauer einer solchen Exposition. Es wird vermutet, dass Exposition gegenüber synthetischen Nanopartikel heute vor allem am Arbeitsplatz vorkommt. Um diese Exposition abschätzen zu können, wird das Schweizer „Nanoinventar" erstellt.
Weshalb interessieren wir uns für alle Partikel <1000nm?	Für diese Studie interessieren wir uns für alle Partikel kleiner als 1000 Nanometer (=1µm). Der Grund liegt in der Grössenverteilung von Partikeln. Nebenan ist eine hypothetische Verteilungskurve für Partikel mit einem Maximum von 200 nm dargestellt. Man erkennt dass ein Anteil davon als Nanopartikel vorkommen kann (kleiner als 100 Nanometer). Bei einer grösseren Produktion, kann dieser Anteil von wenigen Prozenten dennoch wichtig werden. Deshalb fragen wir ganz bewusst auch nach grösseren Partikeln und nach der mittleren Teilchengrösse.	Grafik: Hypothetische Verteilungskurve eines 200nm Partikel-Types
Bei welchen Anwendungen kommen Nanopartikel vor?	Gezielt hergestellte, synthetische Nanopartikel (einschliesslich organischer Moleküle) werden oft als Nanopuder und dispergierten Flüssigkeiten und als Pasten verkauft. Daneben werden sie auch direkt im Herstellungsprozess produziert. Bekannte industrielle Anwendungsbereiche für Nanopartikel: Kosmetika, Nahrungsmittel (Tierfutter, Sport-Zusatzstoffe, Nahrungsmittelverpackung), Metalloberflächenbehandlung, optische Oberflächenbehandlung, Farbherstellung, Pulverproduktion, und viele Anwendungen im Forschungsstadium. Daneben gibt es auch medizinischen Anwendungsbereiche und Versuche, Nanopartikel für den Umweltschutz einzusetzen. Diese Aufzählung der Anwendungen ist nicht vollständig.
Was ist der Datenschutz?	Diese Umfrage wird unterstützt durch SUVA, BAG, BAFU, SECO und AFSSET (FR). Nur die SUVA erfährt die Identität Ihrer Firma, das Institut de Santé au Travail ist vertraglich zur Geheimhaltung verpflichtet. Die Bundesämter erhalten einen anonymisierten Bericht.
Weiter-führende Literatur:	• Risiko Nanotechnologie, http://www.bafu.admin.ch/dokumentation/fokus/00118/index.html?lang=de • Aktionsplan 2006-2009 Risiken synthetischer Nanopartikel für die Schweiz, http://www.bafu.admin.ch/chemikalien/01388/01393/index.html?lang=de • Bericht der Royal Society zu ethischen, gesundheitlichen und sozialen Herausforderungen der Nanotechnologie (englisch), www.nanotec.org.uk/finalReport.htm • Nanotechnologie: Kleine Teile, grosse Zukunft? Broschüre der Swiss Re (1.4MB, pdf), www.swissre.com/INTERNET/pwsfipr.nsf/vwFilebyIDKEYLu/ULUR-5YNGC2$FILE/Publi04_Nanotech_de.pdf • SUVA: Nanopartikel an Arbeitsplätzen (pdf), www.suva.ch/home/suvapro/branchenfachthemen/nanogefahrkel_an_arbeitsplaetzen.htm

Figure 12: German introduction for the main survey and the goal of this survey.

Institut universitaire romand de santé au travail

Erhebung zur Verbreitung von Nanopartikel in der Schweizer Industrie

NANO-INVENTAR
18.12.2007

Diese Erhebung erfolgt mit Unterstützung durch SUVA, BAG, BAFU, SECO und AFSSET (FR)
Sämtliche Angaben unterliegen der Geheimhaltung
Die Identität Ihres Unternehmens wird einzig gegenüber der SUVA offengelegt

Das „Institut universitaire romand de Santé au Travail" (IST):
Das Institut für Arbeit und Gesundheit, ist das einzige universitäre Institut der Schweiz, welches sich ganz dem Thema Gesundheit und Arbeit widmet. Es wird primär durch Stiftungsbeiträge der Kantone Waadt und Genf getragen und hat als Auftrag die Lehre, Forschung, Dienstleistung und Förderung des Gebietes „Arbeit und Gesundheit". Es ist dazu national und international tätig.
Das Institut de Santé au Travail hat keinerlei Kontrollaufgaben und tritt nur beratend und als Experte auf.
Das Institut befindet sich in Lausanne und verfügt über etwa sechzig Mitarbeiter (Mediziner, Ergonomen, Psychologen, Chemiker, Geologen, Biologen, Ingenieure, Techniker, Laboranten, Sekretäre, Lehrlinge), die national und international in ihrer Disziplin anerkannt sind. Das IST ist zudem ein Kollaborationszentrum der Weltgesundheitsorganisation WHO für den Bereich Arbeit und Gesundheit.

Zuständig für Rückfragen am Institut de Santé au Travail:
Kaspar Schmid (DE/FR/E)
Tel. +41 (0)21 314 74 15, FAX: +41 (0)21 314 74 30
Mail: nanoinventory@hospvd.ch

Projektleitung: Michael Riediker, Dr.sc.nat., IST
Auftraggeber und Projektfinanzierungen: SUVA, BAG, BAFU, SECO und AFSSET (FR)

Rücksendeadresse:
Institut de Santé au Travail
Vermerk: Nanoinventar
Rue du Bugnon 19
1005 Lausanne

Figure 13: Cover letter for the main survey, German

XXX-XXXX.X

Institut universitaire romand de santé au travail

NANO-INVENTAR FRAGEBOGEN: Grunddaten des Unternehmens

Diese Erhebung erfolgt mit Unterstützung durch SUVA, BAG, BAFU, SECO und AFSSET (FR). **Sämtliche Angaben unterliegen der Geheimhaltung. Die Identität des Unternehmens wird einzig gegenüber der SUVA offengelegt.**

Ihr Unternehmen (Institution/Organisation) wurde per Zufall aus sämtlichen SUVA-Klienten ausgewählt. Bitte retournieren Sie den Fragebogen auch wenn Sie kein Produktionsbetrieb sind oder keine Produktion in der Schweiz haben: füllen Sie dazu diese erste Seite aus und nutzen Sie die Fragen 7. und 8. um dies klar zu machen.

Diese Spalte leer lassen

Grunddaten des Unternehmens

1. Firmenname:	1.	1.
2. Adresse (Hauptsitz):	2.	2.
3. Kontaktperson:	3.	3.
4. Ungefähre Anzahl Mitarbeiter:	4.	4.
5. SUVA-Nummer:	5. SUVA:	5.
6. Was ist Ihre Branche?	6.	6.
7. Haben Sie eine Produktion?	7. a) ☐ Ja b) ☐ Nein c) wenn ja, wo? Postleitzahl:	7.a 7.b
8. Bemerkungen zu den Grunddaten des Unternehmens?	8.	8.

Definition: Nanopartikel sind definitionsgemäss kleiner als 100 Nanometer (=0.1µm). Für diese Studie interessieren wir uns aber für sämtliche Partikel kleiner als 1000 Nanometer (=1µm), siehe Erklärungs-Blatt. **Im Folgenden werden wir daher nach „Submikrometerpartikel" (Partikel <1µm) oder sub/µm Partikel fragen.**

Werden bei Ihnen synthetische Submikrometerpartikel hergestellt oder verwendet?

9. Werden bei Ihnen sub/µm Partikel		9.1a 9.1b
9.1. hergestellt?	9.1 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht	9.1c
9.2. verwendet?	9.2 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht	9.2a 9.2b
9.3. durch Bearbeitung von Produkten freigesetzt? (nicht gemeint sind Dieselpartikel oder Schweissrauche etc. siehe Informationsblatt)	9.3 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht	9.2c 9.3a 9.3b
9.4. in Zukunft geplant	9.4 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht	9.3c 9.4a 9.4b 9.4c

Falls Sie keine sub/µm Partikel verwenden oder herstellen geben Sie uns bitte an, warum Sie dies NICHT tun:

☐ kein Anwendungsbedarf ☐ gesundheitliche Bedenken ☐ weiss nicht
☐ technische Gründe ☐ zu teuer ☐ anders, nämlich:

Hinweis: Falls Sie die **Fragen 9.1 bis 9.3 mit „nein"** angekreuzt haben und **keine** sub/µm Partikel verwenden oder produzieren, können Sie den Fragebogen hier abschliessen und an das *institut de santé au travail* zurückschicken.

Ich bestätige, dass diese Erhebung nach bestem Wissen und Gewissen ausgefüllt wurde.

Ausgefüllt von (Name): Funktion: Unterschrift:

Bitte bis Ende Februar 2007 zurücksenden

Figure 14: First part of the German questionnaire: General questions to the companies. All pages were personalised with the SUVA number of the company in the form XXX-XXXX.XX.

XXX-XXXX.X

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Grunddaten des Unternehmens MIT sub/µm Partikeln

Diese Spalte leer lassen

10. Welches sind die hierarchischen Stufen, die sich mit Sicherheitsfragen zu sub/µm Partikeln beschäftigen?	10. a)☐ Linien-/Produktionsleiter b)☐ Direktion c)☐ Sicherheitsbeauftragter/Hygieniker d)☐ anders, nämlich:	10.a 10.b 10.c 10.d
11. Ist das Unternehmen einer Branchenlösung angeschlossen? Nummer oder Träger angeben.	11. a) EKAS-Nr: b)☐ nein, keine Branchenlösung oder Träger: (z.B. Nr. 7, Träger: Textilverband Schweiz)	11.a 11.b
12. Gibt es einen Arbeitsmediziner oder Arbeitshygieniker in Ihrer Firma?	12.1 Arbeitsmediziner a)☐ Ja b)☐ Nein c)☐ extern 12.2 Arbeitshygieniker a)☐ Ja b)☐ Nein c)☐ extern 12.3 Sicherheitsingenieur a)☐ Ja b)☐ Nein c)☐ extern 12.4 Sicherheitsbeauftragter a)☐ Ja b)☐ Nein c)☐ extern	12.1a 12.1b 12.1c 12.2a 12.2b 12.2c 12.3a 12.3b 12.3c 12.4a 12.4b 12.4c
13. Wie häufig werden Angestellte über mögliche Gefahren von sub/µm Partikeln informiert?	13. a)☐ bei jedem Auftrag b)☐ ca. 1x pro Woche c)☐ ca. 1x pro Monat d)☐ ca. 1x pro Jahr e)☐ anders, nämlich: f)☐ nie	13.a 13.b 13.c 13.d 13.e 13.f
14. Enthält die technische Beschreibung Ihrer Produkte einen Hinweis auf sub/µm Partikel?	14. a)☐ Ja b)☐ Nein c) wenn ja, welchen?	14.a 14.b 14.c
15. Welche sub/µm Partikel verwenden Sie? Bitte geben Sie alle verfügbaren Informationen an. Beispiele für Prozess: „Lackherstellung" oder „Lackierung" und für Endprodukt: „Lackfarbe" oder „Möbeloberfläche". Bitte verwenden Sie die Rückseite oder ein Zusatzblatt, wenn Ihre Firma mehr als drei Partikeltypen verwendet.	15. a)Produktname 1: b)Partikel-Substanz: c)Prozessbezeichnung: d)Endprodukt: e)mittlere Partikelgrösse: f) Partikelname 2: g)Partikel-Substanz: h)Prozessbezeichnung: i) Endprodukt: j) mittlere Partikelgrösse: k)Partikelname 3: l) Partikel-Substanz: m)Prozessbezeichnung: n)Endprodukt: o)mittlere Partikelgrösse:	15.a 15.b 15.c 15.d 15.e 15.f 15.g 15.h 15.i 15.j 15.k 15.l 15.m 15.n 15.o
16. Frage zur Lagerung: 16.1. Welche ungefähren Mengen sub/µm-Partikel sind bei Ihnen Durchschnittlich an Lager? 16.2. In welcher ungefähren Menge erfolgt eine Zulieferung zu Ihnen? (Ihr Einkauf) 16.3. Wie oft werden sie zugeliefert? 16.4. In welcher ungefähren Menge erfolgt eine Ablieferung an den Kunden? (Ihr Verkauf) 16.5. Wie oft werden sie abgeliefert?	Falls Sie mehrere sub/µm Partikeltypen haben, beantworten Sie diese Fragen bitte für jeden Partikeltyp einzeln (Rückseite oder Zusatzblatt)... 16.1 a)☐g b)☐kg c)☐100kg d)☐t e)☐100t f)☐kt g)☐ anders nämlich: 16.2 a)☐g b)☐kg c)☐100kg d)☐t e)☐100t f)☐kt g)☐ anders nämlich: 16.3 a)☐ pro Woche b)☐ pro Monat c)☐ pro Jahr d)☐ anders nämlich: 16.4 a)☐g b)☐kg c)☐100kg d)☐t e)☐100t f)☐kt g)☐ anders nämlich: 16.4 a)☐ pro Woche b)☐ pro Monat c)☐ pro Jahr d)☐ anders nämlich:	16.1a 16.1b 16.1c 16.1d 16.1e 16.1f 16.1g 16.2a 16.2b 16.2c 16.2d 16.2e 16.2f 16.2g 16.3a 16.3b 16.3c 16.3d 16.4a 16.4b 16.4c 16.4d 16.4e 16.4f 16.4g 16.5a 16.5b 16.5c 16.5d

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Figure 15: Second part of the German questionnaire: questions about the types and amounts of used nanoparticles. All pages were personalised with the SUVA number of the company in the form XXX-XXXX.XX.

XXX-XXXX.X

3/3

Bei mehreren Prozessen bitte mit einer Nummer versehen | Nr:

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Produktions-Prozess Blatt (Prozess-Beschreibung)

Wenn Sie in mehreren Prozessen sub/µm Partikel verwenden, dann fotokopieren Sie bitte dieses Blatt und nummerieren Sie die Kopien. Wenn mehrere sub/µm Partikel in einem identischen Prozess vorkommen, können Sie die Seite einmal ausfüllen und auf der Rückseite die Partikel beschreiben.

		Diese Spalte leer lassen
17. Beschreiben Sie den Prozess kurz: *Z.B. Herstellung Photopapier XYZ*	17.	17.
18. Verwendete Partikel in diesem Prozess (bitte geben Sie auch Eigenproduktion an)?	18. a) Produktname: b) Grundsubstanz: c) mittlere Teilchengrösse: [nm]	18a 18b 18c
19. In welcher Form kommen die sub/µm Partikel im Prozess vor?	19. a) ☐ Pulver b) ☐ Dispersion/Flüssigkeit c) ☐ andere, nämlich:	19a 19b 19c
20. Jährlich ungefähr umgesetzte Partikelmenge in diesem Prozess	20. [kg/Jahr] oder [Liter/Jahr] mit Konzentration [g/Liter]	20.
21. Art der Anlieferung:	21. a) ☐ Fass b) ☐ Tank c) ☐ Feststoff d) ☐ Sack e) ☐ Big Bag f) ☐ anderes, nämlich:	21a 21b 21c 21d 21e 21f
22. Gibt es ein Zwischenlager für diesen Prozess?	22. a) ☐ Ja b) ☐ Nein	22a 22b
23. Gibt es Umschüttungen?	23. a) ☐ Ja b) ☐ Nein	23a 23b
24. Dauer/Häufigkeit des Prozesses: 24.1. Wie häufig findet der Prozess statt? 24.2. Wie lange dauert er?	24.1 a) ☐ pro Tag b) ☐ pro Woche c) ☐ pro Monat d) ☐ anders nämlich: 24.2 a) ☐ Minuten b) ☐ Stunden c) ☐ Tage d) ☐ anders nämlich:	24.1a 24.1b 24.1c 24.1d 24.2a 24.2b 24.2c 24.2d
25. Welche Schutzvorkehrung haben Sie getroffen?	25. a) ☐ geschlossener Prozess b) ☐ Kapelle/Kapselung/Einhausung c) ☐ halboffene Erfassung: z.B. Kabine d) ☐ offene Erfassung: Quellenabsaugung, Saugrohr e) ☐ geschlossener Schutzanzug f) ☐ Atemschutz g) ☐ Brille h) ☐ Handschuhe i) ☐ keine j) ☐ andere:	25a 25b 25c 25d 25e 25f 25g 25h 25i 25j
26. Raumlüftung: 26.1. Gibt es eine Luftrückführung? 26.2. Welcher Rückführungsgrad? 26.3. Wird diese Luft gefiltert? 26.4. Was ist der Abscheidgrad dieser Filter, (oder die Filterklasse)?	26.1 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht 26.2 a) % b) ☐ weiss nicht 26.3 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht 26.4 der Abscheidegrad ist: % (oder die Filterklasse ist:)	26.1a 26.1b 26.1c 26.2a 26.2b 26.3a 26.3b 26.3c 26.4
27. Wie viele Personen sind unmittelbar am Prozess beteiligt oder befinden sich im Raum?	27. a) Anzahl der unmittelbar beteiligten Personen: b) Anzahl der Personen im gleichen Raum: c) davon etwa % männlich und % weiblich	27.a 27.b 27.c
28. Ist Ihnen der Mittelwert der Partikel-Exposition am Arbeitsplatz bekannt (geben Sie Werte an, die ihnen bekannt sind)?	28. a) ☐ Nein b) ☐ alveolengängiger a-Staub: [µg/m³] c) ☐ einatembarer e-Staub: [µg/m³] d) ☐ Teilchenzahl: [Anzahl/cm³] e) ☐ andere, nämlich:	28a 28b 28c 28d 28e
29. Eintrag in die Umwelt: 29.1. Gibt es eine Abfallbehandlung für diesen Prozess? 29.2. Gibt es eine Vorreinigung der Abwässer für diesen Prozess? 29.3. Gibt es ein firmeninternes Recycling der Materialien? 29.4. Erfolgt eine Filterung der Abluft? 29.5. Was ist der Abscheidegrad der Abluft-Filter?	29.1 a) ☐ Ja, b) ☐ Nein c) ☐ weiss nicht d) ☐ keine Abfälle in diesem Prozess 29.2 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht d) ☐ keine Abwässer in diesem Prozess 29.3 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht 29.4 a) ☐ Ja b) ☐ Nein c) ☐ weiss nicht 29.5 a) Abscheidegrad ist: % b) ☐ kein Filter c) ☐ weiss nicht	29.1a 29.1b 29.1c 29.1d 29.2a 29.2b 29.2c 29.2d 29.3a 29.3b 29.3c 29.4a 29.4b 29.4c 29.5a 29.5b 29.5c

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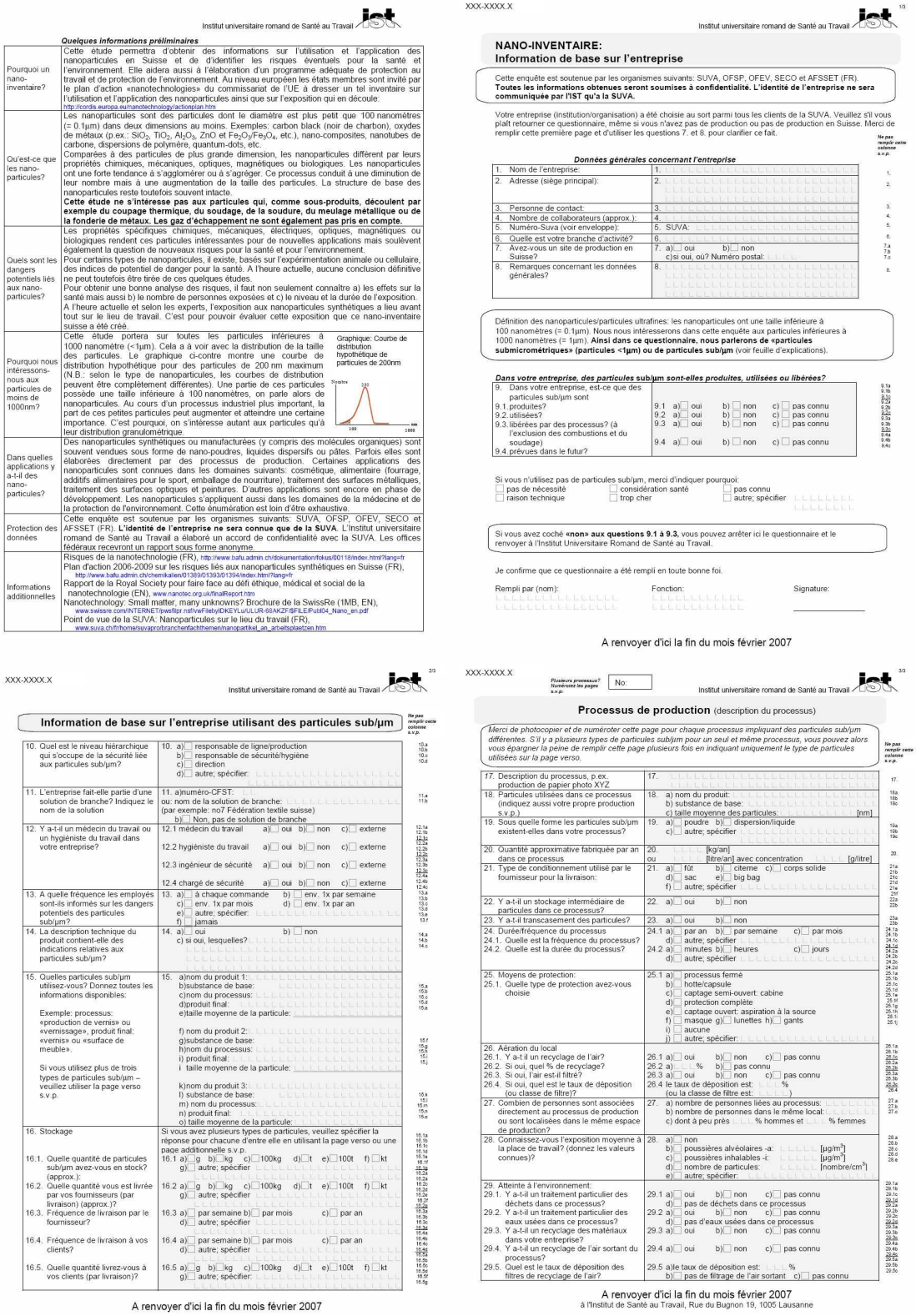
Figure 16: Third part of the German questionnaire: specific questions about the application and the used protection means. All pages were personalised with the SUVA number of the company in the form XXX-XXXX.XX.



Institut universitaire romand de Santé au Travail

Quelques informations préliminaires

Pourquoi un nano-inventaire?	Cette étude permettra d'obtenir des informations sur l'utilisation et l'application des nanoparticules en Suisse et de d'identifier les risques éventuels pour la santé et l'environnement. Elle aidera aussi à l'élaboration d'un programme adéquate de protection au travail et de protection de l'environnement. Au niveau européen les états membres sont invité par le plan d'action «nanotechnologies» du commissariat de l'UE à dresser un tel inventaire sur l'utilisation et l'application des nanoparticules ainsi que sur l'exposition qui en découle: http://cordis.europa.eu/nanotechnology/actionplan.htm
Qu'est-ce que les nano-particules?	Les nanoparticules sont des particules dont le diamètre est plus petit que 100 nanomètres (= 0.1µm) dans deux dimensions au moins. Exemples: carbon black (noir de charbon), oxydes de métaux (p.ex.: SiO_2, TiO_2, Al_2O_3, ZnO et Fe_2O_3/Fe_3O_4, etc.), nano-composites, nanotubes de carbone, dispersions de polymère, quantum-dots, etc. Comparées à des particules de plus grande dimension, les nanoparticules diffèrent par leurs propriétés chimiques, mécaniques, optiques, magnétiques ou biologiques. Les nanoparticules ont une forte tendance à s'agglomérer ou à s'agréger. Ce processus conduit à une diminution de leur nombre mais à une augmentation de la taille des particules. La structure de base des nanoparticules reste toutefois souvent intacte. **Cette étude ne s'intéresse pas aux particules qui, comme sous-produits, découlent par exemple du coupage thermique, du soudage, de la soudure, du meulage métallique ou de la fonderie de métaux. Les gaz d'échappement ne sont également pas pris en compte.**
Quels sont les dangers potentiels liés aux nano-particules?	Les propriétés spécifiques chimiques, mécaniques, électriques, optiques, magnétiques ou biologiques rendent ces particules intéressantes pour de nouvelles applications mais soulèvent également la question de nouveaux risques pour la santé et pour l'environnement. Pour certains types de nanoparticules, il existe, basés sur l'expérimentation animale ou cellulaire, des indices de potentiel de danger pour la santé. A l'heure actuelle, aucune conclusion définitive ne peut toutefois être tirée de ces quelques études. Pour obtenir une bonne analyse des risques, il faut non seulement connaître a) les effets sur la santé mais aussi b) le nombre de personnes exposées et c) le niveau et la durée de l'exposition. A l'heure actuelle et selon les experts, l'exposition aux nanoparticules synthétiques a lieu avant tout sur le lieu de travail. C'est pour pouvoir évaluer cette exposition que ce nano-inventaire suisse a été créé.
Pourquoi nous intéressons-nous aux particules de moins de 1000nm?	Cette étude portera sur toutes les particules inférieures à 1000 nanomètre (<1µm). Cela a à voir avec la distribution de la taille des particules. Le graphique ci-contre montre une courbe de distribution hypothétique pour des particules de 200 nm maximum (N.B.: selon le type de nanoparticules, les courbes de distribution peuvent être complètement différentes). Une partie de ces particules possède une taille inférieure à 100 nanomètres, on parle alors de nanoparticules. Au cours d'un processus industriel plus important, la part de ces petites particules peut augmenter et atteindre une certaine importance. C'est pourquoi, on s'intéresse autant aux particules qu'à leur distribution granulométrique.
Dans quelles applications y a-t-il des nano-particules?	Des nanoparticules synthétiques ou manufacturées (y compris des molécules organiques) sont souvent vendues sous forme de nano-poudres, liquides dispersifs ou pâtes. Parfois elles sont élaborées directement par des processus de production. Certaines applications des nanoparticules sont connues dans les domaines suivants: cosmétique, alimentaire (fourrage, additifs alimentaires pour le sport, emballage de nourriture), traitement des surfaces métalliques, traitement des surfaces optiques et peintures. D'autres applications sont encore en phase de développement. Les nanoparticules s'appliquent aussi dans les domaines de la médecine et de la protection de l'environnement. Cette énumération est loin d'être exhaustive.
Protection des données	Cette enquête est soutenue par les organismes suivants: SUVA, OFSP, OFEV, SECO et AFSSET (FR). **L'identité de l'entreprise ne sera connue que de la SUVA.** L'Institut universitaire romand de Santé au Travail a élaboré un accord de confidentialité avec la SUVA. Les offices fédéraux recevront un rapport sous forme anonyme.
Informations additionnelles	Risques de la nanotechnologie (FR), http://www.batu.admin.ch/dokumentation/fokus/00118/index.html?lang=fr Plan d'action 2006-2009 sur les risques liés aux nanoparticules synthétiques en Suisse (FR), http://www.batu.admin.ch/chemikalien/01389/01393/01394/index.html?lang=fr Rapport de la Royal Society pour faire face au défi éthique, médical et social de la nanotechnologie (EN), www.nanotec.org.uk/finalReport.htm Nanotechnology: Small matter, many unknowns? Brochure de la SwissRe (1MB, EN), www.swissre.com/INTERNET/pwelfpr.nsf/vwFilebyIDKEY/LuXLLR-68AKZF/$FILE/Publ04_Nano_en.pdf Point de vue de la SUVA: Nanoparticules sur le lieu du travail (FR), www.suva.ch/fr/home/suvapro/branchenfachthemen/nanopartikel_an_arbeitsplaetzen.htm

Graphique: Courbe de distribution hypothétique de particules de 200nm

A renvoyer d'ici la fin du mois février 2007

XXX-XXXX.X

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NANO-INVENTAIRE: Information de base sur l'entreprise

Cette enquête est soutenue par les organismes suivants: SUVA, OFSP, OFEV, SECO et AFSSET (FR). **Toutes les informations obtenues seront soumises à confidentialité. L'identité de l'entreprise ne sera communiquée par l'IST qu'a la SUVA.**

Votre entreprise (institution/organisation) a été choisie au sort parmi tous les clients de la SUVA. Veuillez s'il vous plaît retourner ce questionnaire, même si vous n'avez pas de production ou pas de production en Suisse. Merci de remplir cette première page et d'utiliser les questions 7. et 8. pour clarifier ce fait.

Données générales concernant l'entreprise

1. Nom de l'entreprise:	1.
2. Adresse (siège principal):	2.
3. Personne de contact:	3.
4. Nombre de collaborateurs (approx.):	4.
5. Numéro-Suva (voir enveloppe):	5. SUVA:
6. Quelle est votre branche d'activité?	6.
7. Avez-vous un site de production en Suisse?	7. a) ☐ oui b) ☐ non c) si oui, où? Numéro postal:
8. Remarques concernant les données générales?	8.

Définition des nanoparticules/particules ultrafines: les nanoparticules ont une taille inférieure à 100 nanomètres (= 0.1µm). Nous nous intéresserons dans cette enquête aux particules inférieures à 1000 nanomètres (= 1µm). **Ainsi dans ce questionnaire, nous parlerons de «particules submicrométriques» (particules <1µm) ou de particules sub/µm** (voir feuille d'explications).

Dans votre entreprise, des particules sub/µm sont-elles produites, utilisées ou libérées?

9. Dans votre entreprise, est-ce que des particules sub/µm sont	
9.1 produites?	9.1 a) ☐ oui b) ☐ non c) ☐ pas connu
9.2 utilisées?	9.2 a) ☐ oui b) ☐ non c) ☐ pas connu
9.3 libérées par des processus? (à l'exclusion des combustions et du soudage)	9.3 a) ☐ oui b) ☐ non c) ☐ pas connu
9.4 prévues dans le futur?	9.4 a) ☐ oui b) ☐ non c) ☐ pas connu

Si vous n'utilisez pas de particules sub/µm, merci d'indiquer pourquoi:
☐ pas de nécessité ☐ considération santé ☐ pas connu
☐ raison technique ☐ trop cher ☐ autre; spécifier

Si vous avez coché **«non» aux questions 9.1 à 9.3,** vous pouvez arrêter ici le questionnaire et le renvoyer à l'Institut Universitaire Romand de Santé au Travail.

Je confirme que ce questionnaire a été rempli en toute bonne foi.

Rempli par (nom): Fonction: Signature:

A renvoyer d'ici la fin du mois février 2007

XXX-XXXX.X

Institut universitaire romand de Santé au Travail

Information de base sur l'entreprise utilisant des particules sub/µm

10. Quel est le niveau hiérarchique qui s'occupe de la sécurité liée aux particules sub/µm?	10. a) ☐ responsable de ligne/production b) ☐ responsable de sécurité/hygiène c) ☐ direction d) ☐ autre; spécifier:
11. L'entreprise fait-elle partie d'une solution de branche? Indiquez le nom de la solution	11. a) numéro-OFST: ou: nom de la solution de branche: (par exemple: no7 Fédération textile suisse) b) ☐ Non, pas de solution de branche
12. Y a-t-il un médecin du travail ou un hygiéniste du travail dans votre entreprise?	12.1 médecin du travail a) ☐ oui b) ☐ non c) ☐ externe 12.2 hygiéniste du travail a) ☐ oui b) ☐ non c) ☐ externe 12.3 ingénieur de sécurité a) ☐ oui b) ☐ non c) ☐ externe 12.4 chargé de sécurité a) ☐ oui b) ☐ non c) ☐ externe
13. A quelle fréquence les employés sont-ils informés sur les dangers potentiels des particules sub/µm?	13. a) ☐ à chaque commande b) ☐ env. 1x par semaine c) ☐ env. 1x par mois d) ☐ env. 1x par an e) ☐ autre; spécifier: f) ☐ jamais
14. La description technique du produit contient-elle des indications relatives aux particules sub/µm?	14. a) ☐ oui b) ☐ non c) si oui, lesquelles?
15. Quelles particules sub/µm utilisez-vous? Donnez toutes les informations disponibles: Exemple: processus: «production de vernis» ou «vernissage», produit final: «vernis» ou «surface de meuble». Si vous utilisez plus de trois types de particules sub/µm – veuillez utiliser la page verso s.v.p.	15. a) nom du produit 1: b) substance de base: c) nom du processus: d) produit final: e) taille moyenne de la particule: f) nom du produit 2: g) substance de base: h) nom du processus: i) produit final: i taille moyenne de la particule: k) nom du produit 3: l) substance de base: m) nom du processus: n) produit final: o) taille moyenne de la particule:
16. Stockage 16.1. Quelle quantité de particules sub/µm avez-vous en stock? (approx.): 16.2. Quelle quantité vous est livrée par vos fournisseurs (par livraison) (approx.)? 16.3. Fréquence de livraison par le fournisseur? 16.4. Fréquence de livraison à vos clients? 16.5. Quelle quantité livrez-vous à vos clients (par livraison)?	Si vous avez plusieurs types de particules, veuillez spécifier la réponse pour chacune d'entre elle en utilisant la page verso ou une page additionnelle s.v.p. 16.1 a) ☐ g b) ☐ kg c) ☐ 100kg d) ☐ t e) ☐ 100t f) ☐ kt g) ☐ autre; spécifier 16.2 a) ☐ g b) ☐ kg c) ☐ 100kg d) ☐ t e) ☐ 100t f) ☐ kt g) ☐ autre; spécifier 16.3 a) ☐ par semaine b) ☐ par mois c) ☐ par an d) ☐ autre; spécifier 16.4 a) ☐ par semaine b) ☐ par mois c) ☐ par an d) ☐ autre; spécifier 16.5 a) ☐ g b) ☐ kg c) ☐ 100kg d) ☐ t e) ☐ 100t f) ☐ kt g) ☐ autre; spécifier:

A renvoyer d'ici la fin du mois février 2007

XXX-XXXX.X

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Plusieurs processus? Numérotez les pages s.v.p. No:

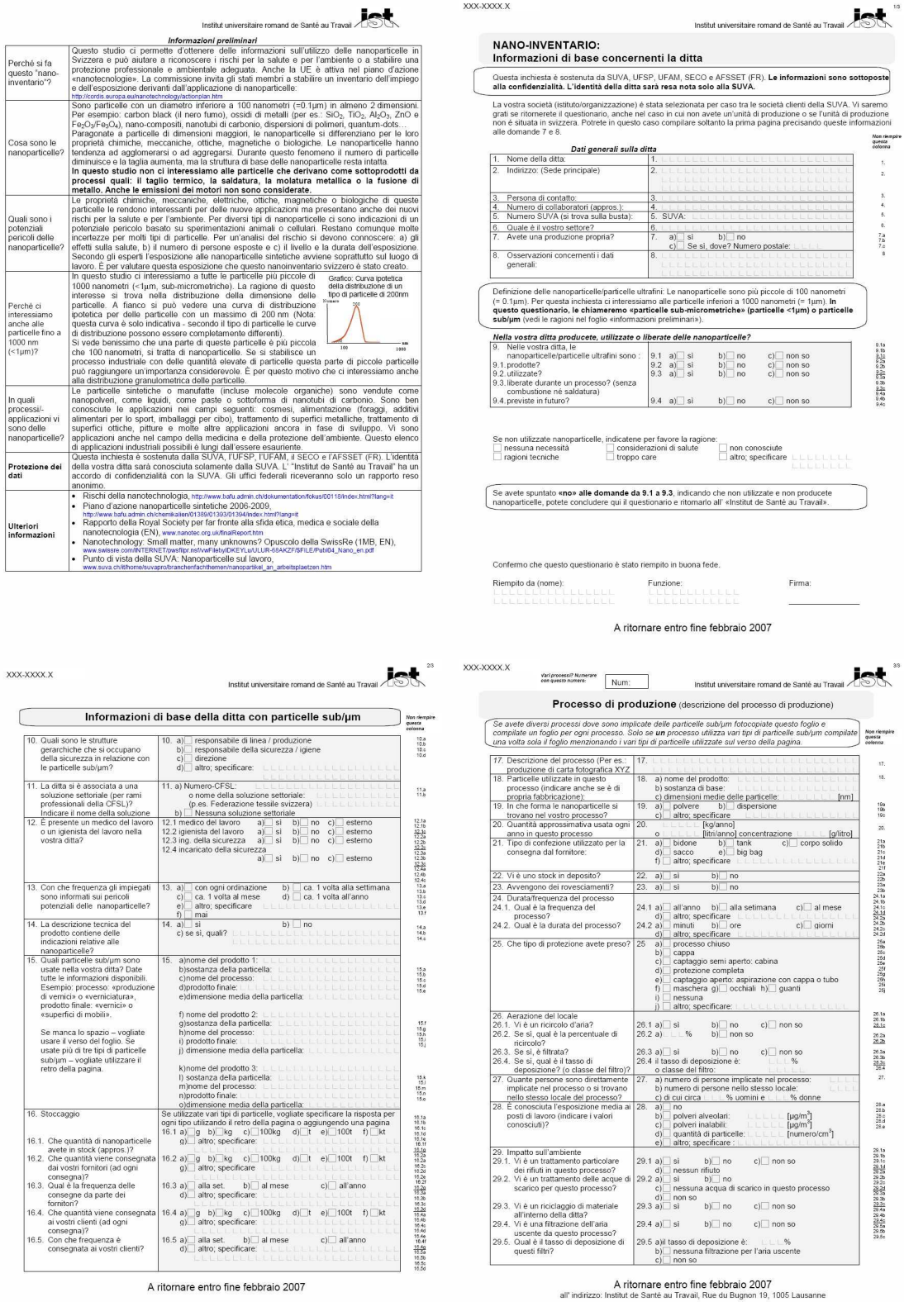
Processus de production (description du processus)

Merci de photocopier et de numéroter cette page pour chaque processus impliquant des particules sub/µm différentes. S'il y a plusieurs types de particules sub/µm pour un seul et même processus, vous pouvez alors vous épargner la peine de remplir cette page plusieurs fois en indiquant uniquement le type de particules utilisées sur la page verso.

17. Description du processus, p.ex. production de papier photo XYZ	17.
18. Particules utilisées dans ce processus (indiquez aussi votre propre production s.v.p.)	18. a) nom du produit: b) substance de base: c) taille moyenne des particules: [nm]
19. Sous quelle forme les particules sub/µm existent-elles dans votre processus?	19. a) ☐ poudre b) ☐ dispersion/liquide c) ☐ autre; spécifier
20. Quantité approximative fabriquée par an dans ce processus	20. [kg/an] ou [litre/an] avec concentration [g/litre]
21. Type de conditionnement utilisé par le fournisseur pour la livraison:	21. a) ☐ fût b) ☐ citerne c) ☐ corps solide d) ☐ sac e) ☐ big bag f) ☐ autre; spécifier
22. Y a-t-il un stockage intermédiaire de particules dans ce processus?	22. a) ☐ oui b) ☐ non
23. Y a-t-il transcasement des particules?	23. a) ☐ oui b) ☐ non
24. Durée/fréquence du processus 24.1. Quelle est la fréquence du processus? 24.2. Quelle est la durée du processus?	24.1 a) ☐ par an b) ☐ par semaine c) ☐ par mois d) ☐ autre; spécifier 24.2 a) ☐ minutes b) ☐ heures c) ☐ jours d) ☐ autre; spécifier
25. Moyens de protection: 25.1. Quelle type de protection avez-vous choisie	25.1 a) ☐ processus fermé b) ☐ hotte/capsule c) ☐ captage semi-ouvert: cabine d) ☐ protection complète e) ☐ captage ouvert: aspiration à la source f) ☐ masque g) ☐ lunettes h) ☐ gants i) ☐ aucune j) ☐ autre; spécifier:
26. Aération du local 26.1. Y a-t-il un recyclage de l'air? 26.2. Si oui, quel % de recyclage? 26.3. Si oui, l'air est-il filtré? 26.4. Si oui, quel est le taux de déposition (ou classe de filtre)?	26.1 a) ☐ oui b) ☐ non c) ☐ pas connu 26.2 a) ☐ % b) ☐ pas connu 26.3 a) ☐ oui b) ☐ non c) ☐ pas connu 26.4 le taux de déposition est: % (ou la classe de filtre est:)
27. Combien de personnes sont associées directement au processus de production ou sont localisées dans le même espace de production?	27. a) nombre de personnes liées au processus: b) nombre de personnes dans le même local: c) dont à peu près % hommes et % femmes
28. Connaissez-vous l'exposition moyenne à la place de travail? (donnez les valeurs connues)?	28. a) ☐ non b) ☐ poussières alvéolaires -a: [µg/m³] c) ☐ poussières inhalables -i: [µg/m³] d) ☐ nombre de particules: [nombre/cm³] e) ☐ autre; spécifier:
29. Atteinte à l'environnement: 29.1. Y a-t-il un traitement particulier des déchets dans ce processus? 29.2. Y a-t-il un traitement particulier des eaux usées dans ce processus? 29.3. Y a-t-il un recyclage des matériaux dans votre entreprise? 29.4. Y a-t-il un recyclage de l'air sortant du processus? 29.5. Quel est le taux de déposition des filtres de recyclage de l'air?	29.1 a) ☐ oui b) ☐ non c) ☐ pas connu d) ☐ pas de déchets dans ce processus 29.2 a) ☐ oui b) ☐ non c) ☐ pas connu d) ☐ pas d'eaux usées dans ce processus 29.3 a) ☐ oui b) ☐ non c) ☐ pas connu 29.4 a) ☐ oui b) ☐ non c) ☐ pas connu 29.5 a) le taux de déposition est: % b) ☐ pas de filtrage de l'air sortant c) ☐ pas connu

A renvoyer d'ici la fin du mois février 2007
à l'Institut de Santé au Travail, Rue du Bugnon 19, 1005 Lausanne

Figure 17: Introduction and the three parts of the French questionnaire.



Institut universitaire romand de Santé au Travail

Informazioni preliminari

Perché si fa questo "nano-inventario"?	Questo studio ci permette d'ottenere delle informazioni sull'utilizzo delle nanoparticelle in Svizzera e può aiutare a riconoscere i rischi per la salute e per l'ambiente o a stabilire una protezione professionale e ambientale adeguata. Anche la UE è attiva nel piano d'azione «nanotecnologie». La commissione invita gli stati membri a stabilire un inventario dell'impiego e dell'esposizione derivanti dall'applicazione di nanoparticelle: http://cordis.europa.eu/nanotechnology/actionplan.htm
Cosa sono le nanoparticelle?	Sono particelle con un diametro inferiore a 100 nanometri (=0.1µm) in almeno 2 dimensioni. Per esempio: carbon black (il nero fumo), ossidi di metalli (per es.: SiO_2, TiO_2, Al_2O_3, ZnO e Fe_2O_3/Fe_3O_4), nano-compositi, nanotubi di carbonio, dispersioni di polimeri, quantum-dots… Paragonate a particelle di dimensioni maggiori, le nanoparticelle si differenziano per le loro proprietà chimiche, meccaniche, ottiche, magnetiche o biologiche. Le nanoparticelle hanno tendenza ad agglomerarsi o ad aggregarsi. Durante questo fenomeno il numero di particelle diminuisce e la taglia aumenta, ma la struttura di base delle nanoparticelle resta intatta. **In questo studio non ci interessiamo alle particelle che derivano come sottoprodotti da processi quali: il taglio termico, la saldatura, la molatura metallica o la fusione di metallo. Anche le emissioni dei motori non sono considerate.**
Quali sono i potenziali pericoli delle nanoparticelle?	Le proprietà chimiche, meccaniche, elettriche, ottiche, magnetiche o biologiche di queste particelle le rendono interessanti per delle nuove applicazioni ma presentano anche dei nuovi rischi per la salute e per l'ambiente. Per diversi tipi di nanoparticelle ci sono indicazioni di un potenziale pericolo basato su sperimentazioni animali o cellulari. Restano comunque molte incertezze per molti tipi di particelle. Per un'analisi del rischio si devono conoscere: a) gli effetti sulla salute, b) il numero di persone esposte e c) il livello e la durata dell'esposizione. Secondo gli esperti l'esposizione alle nanoparticelle sintetiche avviene soprattutto sul luogo di lavoro. È per valutare questa esposizione che questo nanoinventario svizzero è stato creato.
Perché ci interessiamo anche alle particelle fino a 1000 nm (<1µm)?	In questo studio ci interessiamo a tutte le particelle più piccole di 1000 nanometri (<1µm, sub-micrometriche). La ragione di questo interesse si trova nella distribuzione della dimensione delle particelle. A fianco si può vedere una curva di distribuzione ipotetica per delle particelle con un massimo di 200 nm (Nota: questa curva è solo indicativa - secondo il tipo di particelle le curve di distribuzione possono essere completamente differenti). Si vede benissimo che una parte di queste particelle è più piccola che 100 nanometri, si tratta di nanoparticelle. Se si stabilisce un processo industriale con delle quantità elevate di particelle questa parte di piccole particelle può raggiungere un'importanza considerevole. È per questo motivo che ci interessiamo anche alla distribuzione granulometrica delle particelle. Grafico: Curva ipotetica della distribuzione di un tipo di particelle di 200nm
In quali processi/-applicazioni vi sono delle nanoparticelle?	Le particelle sintetiche o manufatte (incluse molecole organiche) sono vendute come nanopolveri, come liquidi, come paste o sottoforma di nanotubi di carbonio. Sono ben conosciute le applicazioni nei campi seguenti: cosmesi, alimentazione (foraggi, additivi alimentari per lo sport, imballaggi per cibo), trattamento di superfici metalliche, trattamento di superfici ottiche, pitture e molte altre applicazioni ancora in fase di sviluppo. Vi sono applicazioni anche nel campo della medicina e della protezione dell'ambiente. Questo elenco di applicazioni industriali possibili è lungi dall'essere esauriente.
Protezione dei dati	Questa inchiesta è sostenuta dalla SUVA, l'UFSP, l'UFAM, il SECO e l'AFSSET (FR). L'identità della vostra ditta sarà conosciuta solamente dalla SUVA. L' "Institut de Santé au Travail" ha un accordo di confidenzialità con la SUVA. Gli uffici federali riceveranno solo un rapporto reso anonimo.
Ulteriori informazioni	• Rischi della nanotechnologia, http://www.bafu.admin.ch/dokumentation/fokus/00118/index.html?lang=it • Piano d'azione nanoparticelle sintetiche 2006-2009, http://www.bafu.admin.ch/chemikalien/01359/01393/01394/index.html?lang=it • Rapporto della Royal Society per far fronte alla sfida etica, medica e sociale della nanotecnologia (EN), www.nanotec.org.uk/finalReport.htm • Nanotechnology: Small matter, many unknowns? Opuscolo della SwissRe (1MB, EN), www.swissre.com/INTERNET/pwsfilpr.nsf/vwFilebyIDKEYLu/ULUR-65AKZF/$FILE/Publi04_Nano_en.pdf • Punto di vista della SUVA: Nanoparticelle sul lavoro, www.suva.ch/it/home/suvapro/branchenfachthemen/nanopartikel_an_arbeitsplaetzen.htm

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Institut universitaire romand de Santé au Travail

NANO-INVENTARIO: Informazioni di base concernenti la ditta

Questa inchiesta è sostenuta da SUVA, UFSP, UFAM, SECO e AFSSET (FR). **Le informazioni sono sottoposte alla confidenzialità. L'identità della ditta sarà resa nota solo alla SUVA.**

La vostra società (istituto/organizzazione) è stata selezionata per caso tra le società clienti della SUVA. Vi saremo grati se ritornerete il questionario, anche nel caso in cui non avete un'unità di produzione o se l'unità di produzione non è situata in svizzera. Potrete in questo caso compilare soltanto la prima pagina precisando queste informazioni alle domande 7 e 8.

Dati generali sulla ditta

Non riempire questa colonna

1.	Nome della ditta:	1.
2.	Indirizzo: (Sede principale)	2.
3.	Persona di contatto:	3.
4.	Numero di collaboratori (appros.):	4.
5.	Numero SUVA (si trova sulla busta):	5. SUVA:
6.	Quale è il vostro settore?	6.
7.	Avete una produzione propria?	7. a) ☐ sì b) ☐ no c) ☐ Se sì, dove? Numero postale:
8.	Osservazioni concernenti i dati generali:	8.

Definizione delle nanoparticelle/particelle ultrafini: Le nanoparticelle sono più piccole di 100 nanometri (= 0.1µm). Per questa inchiesta ci interessiamo alle particelle inferiori a 1000 nanometri (= 1µm). **In questo questionario, le chiameremo «particelle sub-micrometriche» (particelle <1µm) o particelle sub/µm** (vedi le ragioni nel foglio «informazioni preliminari»).

Nella vostra ditta producete, utilizzate o liberate delle nanoparticelle?

9.	Nelle vostra ditta, le nanoparticelle/particelle ultrafini sono :	9.1 a) ☐ sì b) ☐ no c) ☐ non so
9.1.	prodotte?	9.2 a) ☐ sì b) ☐ no c) ☐ non so
9.2.	utilizzate?	9.3 a) ☐ sì b) ☐ no c) ☐ non so
9.3.	liberate durante un processo? (senza combustione né saldatura)	
9.4.	previste in futuro?	9.4 a) ☐ sì b) ☐ no c) ☐ non so

Se non utilizzate nanoparticelle, indicatene per favore la ragione:
☐ nessuna necessità ☐ considerazioni di salute ☐ non conosciute
☐ ragioni tecniche ☐ troppo care ☐ altro; specificare

Se avete spuntato **«no» alle domande da 9.1 a 9.3**, indicando che non utilizzate e non producete nanoparticelle, potete concludere qui il questionario e ritornarlo all' «Institut de Santé au Travail».

Confermo che questo questionario è stato riempito in buona fede.

Riempito da (nome): Funzione: Firma:

A ritornare entro fine febbraio 2007

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Informazioni di base della ditta con particelle sub/µm

Non riempire questa colonna

10.	Quali sono le strutture gerarchiche che si occupano della sicurezza in relazione con le particelle sub/µm?	10. a) ☐ responsabile di linea / produzione b) ☐ responsabile della sicurezza / igiene c) ☐ direzione d) ☐ altro; specificare:
11.	La ditta si è associata a una soluzione settoriale (per rami professionali della CFSL)? Indicare il nome della soluzione	11. a) Numero-CFSL: o nome della soluzione settoriale: (p.es. Federazione tessile svizzera) b) ☐ Nessuna soluzione settoriale
12.	È presente un medico del lavoro o un igienista del lavoro nella vostra ditta?	12.1 medico del lavoro a) ☐ sì b) ☐ no c) ☐ esterno 12.2 igienista del lavoro a) ☐ sì b) ☐ no c) ☐ esterno 12.3 ing. della sicurezza a) ☐ sì b) ☐ no c) ☐ esterno 12.4 incaricato della sicurezza a) ☐ sì b) ☐ no c) ☐ esterno
13.	Con che frequenza gli impiegati sono informati sui pericoli potenziali delle nanoparticelle?	13. a) ☐ con ogni ordinazione b) ☐ ca. 1 volta alla settimana c) ☐ ca. 1 volta al mese d) ☐ ca. 1 volta all'anno e) ☐ altro; specificare f) ☐ mai
14.	La descrizione tecnica del prodotto contiene delle indicazioni relative alle nanoparticelle?	14. a) ☐ sì b) ☐ no c) se sì, quali?
15.	Quali particelle sub/µm sono usate nella vostra ditta? Date tutte le informazioni disponibili. Esempio: processo: «produzione di vernici» o «verniciatura», prodotto finale: «vernici» o «superfici di mobili». Se manca lo spazio – vogliate usare il verso del foglio. Se usate più di tre tipi di particelle sub/µm – vogliate utilizzare il retro della pagina.	15. a)nome del prodotto 1: b)sostanza della particella: c)nome del processo: d)prodotto finale: e)dimensione media della particella: f) nome del prodotto 2: g)sostanza della particella: h)nome del processo: i) prodotto finale: j) dimensione media della particella: k)nome del prodotto 3: l) sostanza della particella: m)nome del processo: n)prodotto finale: o)dimensione media della particella:
16.	Stoccaggio	Se utilizzate vari tipi di particelle, vogliate specificare la risposta per ogni tipo utilizzando il retro della pagina o aggiungendo una pagina
16.1.	Che quantità di nanoparticelle avete in stock (appros.)?	16.1 a) ☐ g b) ☐ kg c) ☐ 100kg d) ☐ t e) ☐ 100t f) ☐ kt g) ☐ altro; specificare:
16.2.	Che quantità viene consegnata dai vostri fornitori (ad ogni consegna)?	16.2 a) ☐ g b) ☐ kg c) ☐ 100kg d) ☐ t e) ☐ 100t f) ☐ kt g) ☐ altro; specificare
16.3.	Qual è la frequenza delle consegne da parte dei forniton?	16.3 a) ☐ alla set. b) ☐ al mese c) ☐ all'anno d) ☐ altro; specificare:
16.4.	Che quantità viene consegnata ai vostri clienti (ad ogni consegna)?	16.4 a) ☐ g b) ☐ kg c) ☐ 100kg d) ☐ t e) ☐ 100t f) ☐ kt g) ☐ altro; specificare:
16.5.	Con che frequenza è consegnata ai vostri clienti?	16.5 a) ☐ alla set. b) ☐ al mese c) ☐ all'anno d) ☐ altro; specificare:

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Vari processi? Numerare con questo numero: Num:

Institut universitaire romand de Santé au Travail

Processo di produzione (descrizione del processo di produzione)

*Se avete diversi processi dove sono implicate delle particelle sub/µm fotocopiate questo foglio e compilate un foglio per ogni processo. Solo se **un** processo utilizza vari tipi di particelle sub/µm compilate una volta sola il foglio menzionando i vari tipi di particelle utilizzate sul verso della pagina.*

Non riempire questa colonna

17.	Descrizione del processo (Per es.: produzione di carta fotografica XYZ	17.
18.	Particelle utilizzate in questo processo (indicare anche se è di propria fabbricazione):	18. a) nome del prodotto: b) sostanza di base: c) dimensioni medie delle particelle: [nm]
19.	In che forma le nanoparticelle si trovano nel vostro processo?	19. a) ☐ polvere b) ☐ dispersione c) ☐ altro; specificare
20.	Quantità approssimativa usata ogni anno in questo processo	20. [kg/anno] o [litri/anno] concentrazione [g/litro]
21.	Tipo di confezione utilizzato per la consegna dal fornitore:	21. a) ☐ bidone b) ☐ tank c) ☐ corpo solido d) ☐ sacco e) ☐ big bag f) ☐ altro; specificare
22.	Vi è uno stock in deposito?	22. a) ☐ sì b) ☐ no
23.	Avvengono dei rovesciamenti?	23. a) ☐ sì b) ☐ no
24.	Durata/frequenza del processo	
24.1.	Qual è la frequenza del processo?	24.1 a) ☐ all'anno b) ☐ alla setimana c) ☐ al mese d) ☐ altro; specificare
24.2.	Qual è la durata del processo?	24.2 a) ☐ minuti b) ☐ ore c) ☐ giorni d) ☐ altro; specificare
25.	Che tipo di protezione avete preso?	25 a) ☐ processo chiuso b) ☐ cappa c) ☐ captaggio semi aperto: cabina d) ☐ protezione completa e) ☐ captaggio aperto: aspirazione con cappa o tubo f) ☐ maschera g) ☐ occhiali h) ☐ guanti i) ☐ nessuna j) ☐ altro; specificare:
26.	Aerazione del locale	
26.1.	Vi è un ricircolo d'aria?	26.1 a) ☐ sì b) ☐ no c) ☐ non so
26.2.	Se sì, qual è la percentuale di ricircolo?	26.2 a) % b) ☐ non so
26.3.	Se sì, è filtrata?	26.3 a) ☐ sì b) ☐ no c) ☐ non so
26.4.	Se sì, qual è il tasso di deposizione? (o classe del filtro)?	26.4 il tasso di deposizione è: % o classe del filtro:
27.	Quante persone sono direttamente implicate nel processo si trovano nello stesso locale del processo?	27. a) numero di persone implicate nel processo: b) numero di persone nello stesso locale: c) di cui circa % uomini e % donne
28.	È conosciuta l'esposizione media ai posti di lavoro (indicare i valori conosciuti)?	28. a) ☐ no b) ☐ polveri alveolari: [µg/m³] c) ☐ polveri inalabili: [µg/m³] d) ☐ quantità di particelle: [numero/cm³] e) ☐ altro; specificare :
29.	Impatto sull'ambiente	
29.1.	Vi è un trattamento particolare dei rifiuti in questo processo?	29.1 a) ☐ sì b) ☐ no c) ☐ non so d) ☐ nessun rifiuto
29.2.	Vi è un trattamento delle acque di scarico per questo processo?	29.2 a) ☐ sì b) ☐ no c) ☐ nessuna acqua di scarico in questo processo d) ☐ non so
29.3.	Vi è un riciclaggio di materiale all'interno della ditta?	29.3 a) ☐ sì b) ☐ no c) ☐ non so
29.4.	Vi è una filtrazione dell'aria uscente da questo processo?	29.4 a) ☐ sì b) ☐ no c) ☐ non so
29.5.	Qual è il tasso di deposizione di questi filtri?	29.5 a)il tasso di deposizione è: % b) ☐ nessuna filtrazione per l'aria uscente c) ☐ non so

A ritornare entro fine febbraio 2007
all' indirizzo: Institut de Santé au Travail, Rue du Bugnon 19, 1005 Lausanne

Figure 18: Introduction and the three parts of the Italian questionnaire.

7.2.6. Details to raw questionnaire results

7.2.6.1. Responses to the questionnaire (without text-responses)

Table 17: Responses to the main survey (without text-responses).

ID	Translated question	Count: "CROSS"	Count: "NO CROSS"	%Cross	%NO Cross
n7a	Yes - we have a production	494	679	42.10%	57.90
n7b	No - we don't have a production	597	576	50.90%	49.10
n91a	Yes - we produce nanoparticles	13	1160	1.11%	98.89
n91b	No - we don't have a production of nanoparticles	1034	139	88.15%	11.85
n91c	I don't know if we have a production of nanoparticles	37	1136	3.15%	96.85
n92a	Yes - we use nanoparticles	50	1123	4.26%	95.74
n92b	No - we don't have a use of nanoparticles	956	217	81.50%	18.50
n92c	I don't know if we have a use of nanoparticles	93	1080	7.93%	92.07
n93a	Yes - we liberate nanoparticles	19	1154	1.62%	98.38
n93b	No - we don't have a liberation of nanoparticles	955	218	81.42%	18.58
n93c	I don't know if we have a liberation of nanoparticles	97	1076	8.27%	91.73
n94a	Yes it is planned	24	1149	2.05%	97.95
n94b	No it is not planned	875	298	74.60%	25.40
n94c	I don't know if it is planned	126	1047	10.74%	89.26
wn1	No use for nanoparticles	780	393	66.50%	33.50
wn2	Concerns about health effects	29	1144	2.47%	97.53
wn3	I don't know why	109	1064	9.29%	90.71
wn4	Technical reasons	42	1131	3.58%	96.42
wn5	To expensive	20	1153	1.71%	98.29
un	Is the questionnaire signed?	1121	52	95.57%	4.43
n10a	Production level	25	1148	2.13%	97.87
n10b	Management level	31	1142	2.64%	97.36
n10c	Security/hygiene level	45	1128	3.84%	96.16
n11b	No business solution	42	1131	3.58%	96.42
n121a	Yes - occupational health practitioner	5	1168	0.43%	99.57
n121b	No occupational health practitioner	56	1117	4.77%	95.23
n121c	Yes occupational health practitioner, but external	17	1156	1.45%	98.55
n122a	Yes - occupational hygienist	5	1168	0.43%	99.57
n122b	No occupational hygienist	64	1109	5.46%	94.54
n122c	Yes occupational hygienist, but external	4	1169	0.34%	99.66
n123a	Yes - security engineer	9	1164	0.77%	99.23
n123b	No security engineer	60	1113	5.12%	94.88
n123c	Yes - security engineer, but external	4	1169	0.34%	99.66
n124a	Yes security agent	59	1114	5.03%	94.97
n124b	No security agent	19	1154	1.62%	98.38
n124c	Yes security agent, but external	0	1173	0.00%	100.00
n13a	Information on each instruction	8	1165	0.68%	99.32
n13b	Information approx. 1x per week	1	1172	0.09%	99.91
n13c	Information approx. 1x per month	6	1167	0.51%	99.49
n13d	Information approx. 1x per year	19	1154	1.62%	98.38
n13f	No information	27	1146	2.30%	97.70
n14a	Yes, there is a indication for the sub/µm particles	21	1152	1.79%	98.21
n14b	No, there is no indication for the sub/µm particles	44	1129	3.75%	96.25
n161a	Stock is around a gram (g)	10	1163	0.85%	99.15
n161b	Stock is around kilogram (kg)	9	1164	0.77%	99.23
n161c	Stock is around hundred kilos (100kg)	13	1160	1.11%	98.89
n161d	Stock is around a tonne (t)	12	1161	1.02%	98.98
n161e	Stock is around hundred tonnes (100t)	4	1169	0.34%	99.66
n161f	Stock is around a kilo-tonne (kt)	1	1172	0.09%	99.91
n162a	Supply is around a gram (g)	6	1167	0.51%	99.49
n162b	Supply is around kilogram (kg)	11	1162	0.94%	99.06
n162c	Supply is around hundred kilos (100kg)	13	1160	1.11%	98.89
n162d	Supply is around a tonne (t)	10	1163	0.85%	99.15
n162e	Supply is around hundred tonnes (100t)	2	1171	0.17%	99.83
n162f	Supply is around a kilo-tonne (kt)	1	1172	0.09%	99.91
n163a	Frequency of supply is around 1x per week	6	1167	0.51%	99.49
n163b	Frequency of supply is around 1x per month	13	1160	1.11%	98.89
n163c	Frequency of supply is around 1x per year	15	1158	1.28%	98.72
n164a	Delivery is around a gram (g)	13	1160	1.11%	98.89
n164b	Delivery is around kilogram (kg)	5	1168	0.43%	99.57
n164c	Delivery is around hundred kilos (100kg)	4	1169	0.34%	99.66
n164d	Delivery is around a tonne (t)	4	1169	0.34%	99.66
n164e	Delivery is around hundred tonnes (100t)	2	1171	0.17%	99.83
n164f	Delivery is around a kilo-tonne (kt)	1	1172	0.09%	99.91
n165a	Frequency of delivery is around 1x per week	5	1168	0.43%	99.57
n165b	Frequency of delivery is around 1x per month	8	1165	0.68%	99.32

ID	Translated question	Count: "CROSS"	Count: "NO CROSS"	%Cross	%NO Cross
n165c	Frequency of delivery is around 1x per year	4	1169	0.34%	99.66
n165d	Frequency of delivery is different, it is…				
nr	Process number				
n17	Description of process				
n18a	Product name of the used nanoparticles				
n18b	Substance of the particles				
n18c	Average size of particles [nm]				
n19a	In form of powder	33	1140	2.81%	97.19
n19b	In form of a dispersion/liquid	31	1142	2.64%	97.36
n20	Volume of turnover [kg/year] / [l/year] (g/L)	43	1126	0.04%	0.96
n21a	Supply in a barrel	10	1163	0.85%	99.15
n21b	Supply in a tank	7	1166	0.60%	99.40
n21c	Supply as solid	1	1172	0.09%	99.91
n21d	Supply in a bag	25	1148	2.13%	97.87
n21e	Supply in a big-bag	4	1169	0.34%	99.66
n22a	Yes, we have a intermediate stock	26	1147	2.22%	97.78
n22b	No, we don't have an intermediate stock	32	1141	2.73%	97.27
n23a	Yes, there is a decanting	35	1138	2.98%	97.02
n23b	No, we don't have a decanting	24	1149	2.05%	97.95
n241a	Process once a day	23	1150	1.96%	98.04
n241b	Process once a week	10	1163	0.85%	99.15
n241c	Process once a month	11	1162	0.94%	99.06
n242a	Process takes minutes	25	1148	2.13%	97.87
n242b	Process takes hours	29	1144	2.47%	97.53
n242c	Process takes weeks	0	1173	0.00%	100.00
n25a	Closed process as a protection	15	1158	1.28%	98.72
n25b	Chapel/capsule/enclosure as a protection	16	1157	1.36%	98.64
n25c	Half-open aspiration	13	1160	1.11%	98.89
n25d	Open aspiration	22	1151	1.88%	98.12
n25e	Fully closed personal protective clothing	8	1165	0.68%	99.32
n25f	Breathing protection	37	1136	3.15%	96.85
n25g	Glasses	44	1129	3.75%	96.25
n25h	Gloves	45	1128	3.84%	96.16
n25i	No protection measures	5	1168	0.43%	99.57
n261a	Yes, there is an air recirculation	15	1158	1.28%	98.72
n261b	No, there is no air recirculation	41	1132	3.50%	96.50
n261c	I don't know if there is an air recirculation	4	1169	0.34%	99.66
n262a	Yes, the recirculation is …in [%]	2	1171	0.17%	99.83
n262b	I don't know what is the recirculation rate	19	1154	1.62%	98.38
n263a	Yes, the air is filtered	16	1157	1.36%	98.64
n263b	No, the air is not filtered	13	1160	1.11%	98.89
n263c	I don't know if the air is filtered	5	1168	0.43%	99.57
n28a	Average is not known	49	1124	4.18%	95.82
n291a	Yes, there is a waste treatment in this process	31	1142	2.64%	97.36
n291b	No, there is no waste treatment in this process	15	1158	1.28%	98.72
n291c	I don't know if there is a waste treatment in this process	3	1170	0.26%	99.74
n291d	No, there is no wastes in this process	13	1160	1.11%	98.89
n292a	Yes, there is a pre-treatment of the effluent	16	1157	1.36%	98.64
n292b	No, there is no pre-treatment of the effluent	21	1152	1.79%	98.21
n292c	I don't know if there is a pre-treatment	2	1171	0.17%	99.83
n292d	There are no effluents in this process	19	1154	1.62%	98.38
n293a	Yes, we have a recycling	21	1152	1.79%	98.21
n293b	No, there is no recycling	34	1139	2.90%	97.10
n293c	I don't know if there is a recycling	1	1172	0.09%	99.91
n294a	Yes, the exhaust air is filtered	26	1147	2.22%	97.78
n294b	No, the exhaust air is not filtered	28	1145	2.39%	97.61
n294c	I don't know if the exhaust air is filtered	4	1169	0.34%	99.66
n295a	The filtration efficiency is…	4	1169	0.34%	99.66
n295b	We don't have filters for the exhaust air	14	1159	1.19%	98.81
n295c	I don't know what is the filtration efficiency	29	1144	2.47%	97.53

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