

## **New and Emerging Issues 2006 Occupational Health Aspects of Nanotechnologies**

Annex 3: HSE's review of progress on Nanotechnologies

### **HSE CONTRIBUTION TO NIDG COORDINATED RESPONSE TO CST Workplace**

#### **Regulatory Review**

HSE completed a regulatory review in February 2006 that is published as follows <http://www.hse.gov.uk/nanotechnology/regulatoryreview.pdf>. In brief the review concludes that:

“... the principles of the existing regulations and the interconnections between them are appropriate and applicable to nanomaterials. We perceive no need to fundamentally change the regulations themselves, nor to introduce new regulations. However, there are important issues which require attention if, in reality, the current and foreseeable future general regulatory framework is to operate effectively in relation to nanomaterials.”

#### **Research**

Technical reports were presented to HSC's relevant advisory committee, WATCH, in January 2005. Further advice on the adequacy of exposure control strategies will be sought from WATCH when the results of our research programme are known.

HSE's research focuses, at present, on exposure and control issues and fire and explosion issues. In addition, we also contribute to the work on human health issues. Our efforts fall under the Task Force programme of the NRCG.

Task Force 2 (exposure) is chaired by HSE and has members from Government and the wider academic community. A draft action plan to address exposure and control issues has been developed. The tables summarising proposed and current projects are attached. A key area is the work to investigate current exposure levels and control measures in University laboratories. HSE's total current committed spend over the next 3 years is approximately £1100k. As results are generated and conclusions drawn, HSE, advised by HSC's Advisory Committees, will work with stakeholders to prepare advice to employers, employees and the public.

Under Task Force 1 (metrology) HSE leads on investigating the fire and explosion risks of nanoparticles. Our project aims to understand the fire and

explosion hazards of selected nanopowders. Areas for investigation include explosion properties; ignition properties; accumulation of electrostatic charge; fire properties; ease with which selected nanopowders can be made to form a cloud; and the suitability of standard test methods. Total cost will be £306k and the first year money is committed.

HSE also plays a role in Task Force 3 (human health) where we have funded HSL to conduct a literature-based review of current *in vitro* assays being used to assess nanoparticle toxicology to aid in the development of a tiered and strategic approach to investigating the potential health hazards of novel nanoparticles. Total cost was approximately £20k.

## **Communications**

Part of the work the HSE/HSL NanoTeam is to disseminate information and interim guidance. We do this through our web page (<http://www.hse.gov.uk/horizons/nanotech/>), Infoline (HSE's public contact centre), a dedicated email address for internal use and through our contacts in Industry and Academia. Our work is outlined in the HSC Annual report (<http://www.hse.gov.uk/aboutus/reports/0506/ar0506.pdf>) and covered by an article in the May 2006 edition of the Royal Society for the Prevention of Accidents' Occupational Safety and Health Journal.

Our current interim advice is contained in HSIN1 and this is scheduled to be updated in January 2007. Our long-term goal is to work with Industry and Academia to develop formal good practice guidance when a clearer understanding of the risks is available from both our and others' research.

HSE/HSL has a wide network of international contacts, including regulators and researchers. We will represent UK government at a French Government event where we will describe the approach taken in the UK.

## **Other**

HSE/HSL's horizon scanning work continues, with the dedicated team in HSL and individual specialists in HSE providing information. An update paper will be presented to HSE's Strategic Intelligence Group this October.

## NRCG – Task Force 2: Exposure - Sources, Exposure, Pathways, Technologies

**Table 1 – Active Research**

Research Objective	Description	Lead	Cost	Progress
5	<p><b>Helpdesk</b></p> <p>The aim of this work is to provide an information bulletin service reviewing studies on exposure and potential health effects of nanomaterials relevant to the occupational setting. The bulletins produced will be available on the web.</p>	HSE/HSL	£52k year 1	The key word lists for the literature searches have been completed. The first bulletin is scheduled for October
6&7	<p><b>Nanoparticle Occupational Safety &amp; Health (NOSH) Consortium</b></p> <p>The research has three specific objectives: generate nanoparticle aerosols and measure their behavior as a function of time; develop a simple, robust, portable device to measure airborne nanoparticles and measure the barrier efficiency of various materials to nanoparticles.</p>	HSE	£35k to HSE Overall budget \$680,000	<p>Project on going at DuPont's Experimental Station Laboratories and is due for completion in 2007. Progress is good with the reproducible production of SiO<sub>2</sub> achieved. The work will focus on SiO<sub>2</sub>, TiO<sub>2</sub> and Ag. Work on respirators proceeds with results showing an unusual pattern of efficiency with an exposure peak when the unit is used after a break in use. The hypothesis is that it might be the loss of static charge that reduces filter efficiency. Papers are in preparation and there will be presentations at the next NIOSH conference.</p>

Research Objective	Description	Lead	Cost	Progress
6&7	<p><b>NANOSH</b></p> <p>This European multi-centre research project will focus on occupational exposure to nanoparticles and their health effects. The overall goal is to delineate exposure and health effects of selected nano-sized particles relevant to the occupational environment. Includes University work.</p>	HSL/HSE	£573k to HSE/HSL overall budget £2.7m	<p>We have the PRF and a project number and although HSL doesn't have the written contract from the NANOSH team preliminary work has started. Sheffield University have pulled out of the pilot phase and negotiations with Leeds and the Safety Officers Association to take their place are ongoing.</p> <p>Some NANOSH funding will be used to work on a piezo-electric means of mass measurement.</p>
	<p><b>Nanosafe2</b></p> <p>A consortium of European companies and research laboratories has developed a research programme for the safe production and use of nanomaterials. The project has 4 main scientific subprojects – Measurement of exposure to and characterisation of airborne nanoparticles, Potential health effects of nanoparticles, Procedures for safe production and handling of nanoparticles, and Standards, regulations and societal implications of nanoparticles.</p>	HSL/HSE	£70k to HSE/HSL overall budget £8.3m	<p>There has been agreement to follow the same sampling strategy as for NANOSH so results can be compared. Results are starting to come in. Dave/HSL will be completing a regulatory review by the end of September. He will make use of existing UK and EU reviews</p>

Research Objective	Description	Lead	Cost	Progress
6&7	<p><b>Investment Research Programme – Nanochallenge</b></p> <p>Objectives of this programme include ‘the development of the HSL aerosol generation and measurement capabilities’. The exposure assessment and control project includes:</p> <p>i) The development of improved methods of collection and characterisation of airborne nanoparticles. The applicability of biological monitoring will also be investigated.</p> <p>ii) The investigation of whether the current method of dustiness testing is suitable for nanomaterials and if not to propose and investigate alternative options for particle dispersal and measurement.</p>	HSL/HSE	Approx £400k	<p>Preliminary work started in February this year, with the main work starting September 2006. The work to date has been on investigating whether the kit currently used to assess dustiness is suitable for nanoparticles. Carbon black, TiO<sub>2</sub> (20 nm but it agglomerated) and gassifier fines have been assessed and the results show the kit doesn’t work. Further work will be done to develop kit for nanoparticles.</p> <p>For the improved collection/characterisation element a start has been made on assessing collection methods and a new camera for the electron microscope is on the way. This work links to the NANOSH project where the Finish partners are doing some characterisation work. Both groups will follow the same methods.</p>

Research Objective	Description	Lead	Cost	Progress
8	<p><b>Investment Research Programme – Nanochallenge</b></p> <p>The exposure assessment and control project includes:  The development of improved methods for the generation of nanoparticle aerosols – This would enhance capabilities for evaluating the performance of instruments used for assessing exposure to nanoparticles and for the performance testing of PPE and RPE, containment systems and other methods of exposure control</p>	HSL/HSE	Approx £400k	Initial set up work ongoing.
	<p><b>Nanoparticle Occupational Safety &amp; Health Consortium</b></p> <p>The research has three specific objectives including the development of a simple, robust, portable device to measure airborne nanoparticles and measuring the barrier efficiency of various materials to nanoparticles.</p>	HSE	£35k to HSE overall budget \$680,000	Meetings with instrument manufacturers show no portable monitoring device available in the short/medium term.

Research Objective	Description	Lead	Cost	Progress
	<p><b>NANOSH</b></p> <p>As part of the proposal, the laboratories involved in WP2 will assess the performance of RPE and protective clothing against nanoparticle penetration in real-life conditions.</p>	HSL/ HSE	£573k	Funding agreed. Work starting.
10	<p><b>The Environmental Nanosciences Initiative</b></p> <p>The Environmental Nanosciences Initiative (ENI) has been set up to provide the mechanism to address basic nanoscience research into fate and behaviour, ecotoxicology and ecological effects. It will provide small exploratory awards (pump priming) to researchers, and the data will be used to build the evidence base to inform the development of government policy. Research needs identified by the NRCG task forces relating to the natural environment will be considered when drafting the announcement of opportunity for funding.</p>	NERC, Defra, EA		Announcement of opportunity for funding hoped to be published this September 2006 (with a closing date for proposals in November 2006)

<b>Research Objective</b>	<b>Description</b>	<b>Lead</b>	<b>Cost</b>	<b>Progress</b>
	<p><b>Environmental effects of nanoparticles and nanomaterials</b></p> <p>The purpose of this meeting is to gather the most up to date information on this topic, to generate a current overview. This will include the fate and transport of nanoparticles.</p>	NERC		Conference 18/19 September

**Table 2 – Research Proposals**

Research Objective	Description	Lead	Cost	Progress
6&7	<p><b>Assessment on nanoparticles in food</b></p> <p>The fundamental approach to exposure estimation for nanoparticles will be the same as for other food chemicals – combining information on food consumption with data on the occurrence of nanomaterials.</p> <p>The key issues are measurement and characterisation (i.e. speciation, physical differentiation) to confirm whether nanoparticles that are present in the final food are comparable with those used to produce the risk assessment.</p> <p><i>In order to gather additional information on the food safety and regulatory implications, the Food Standards Agency intends to commission an assessment of new and potential applications of nanotechnology for food contact materials. A similar research requirement has been issued in relation to food additives and novel food ingredients.</i></p>	FSA		Proposals have been received and are currently under consideration.

Research Objective	Description	Lead	Cost	Progress
8	<p><b><i>Effectiveness of current control measures</i></b></p> <p>It is proposed that the project will include; a review of control measures currently used for the production, handling and end use of nanoparticles. The most common control systems will be identified and have their performance assessed. This will focus on capture or containment of nanoparticles (using systems such as LEV, fume cupboards, laminar flow booths, glove boxes, etc) and include all parts of the system including leakage through seals and filters.</p>	HSL/ HSE		Work will start following a survey, as part of NANOSH, of what control devices are being used
	<p><b><i>Control Banding project</i></b></p> <p>HSE would like to form an international group to develop a Control Banding approach to exposure control. The work would start with discussions between HSE and NIOSH.</p>	HSE		The Disease Reduction Programme (DRP) has confirmed they are continuing to support control banding. Therefore, a case will be made for the nano control banding work to be included in the DRP programme.

Research Objective	Description	Lead	Cost	Progress
10	<p><b>Current and Predicted Environmental Exposure to Engineered Nanomaterials</b></p> <p>The project aims to evaluate the current environmental exposure to existing production, uses and disposal (i.e. life-cycle stages) of nanomaterials and to predict likely future exposures of nanomaterials in development or emerging uses. It will include an attempt to quantify and evaluate the potential distribution of materials between different environmental compartments.</p>	Defra		Proposal being put to the ACHS in May 2006 (June 06)

**Table 3 – Suggested Future Work**

Research Objective	Proposal	Priority	Funding/Cost Estimate	Progress
5	<p><b>Life Cycle Analyses</b></p> <p>Examples of life cycle analyses, from manufacture through uses to waste removal, need to be conducted. It was suggested that iron used in land remediation, titanium dioxide and carbon nanotubes offer good choices. This approach should clarify exposure processes through the analysis of each of the scenarios/components of the life cycle of the target materials.</p>	High	£50K	
	<p><b>Measurement</b></p> <p>There needs to be quantification of the amount of exposure within the life cycle of a nanoparticle. This will identify which pathways will need to be targeted for exposure and risk management. Possible link to life cycle analysis proposal</p>	High	£50K	
	<p><b>Differentiation between natural and man made nanoparticles</b></p> <p>Link to Metrology Task Force.</p>			
	<p><b>Identification of further uses and sources</b></p>			
6&7	<p><b>Modelling</b></p> <p>The first stage will be to generation of real exposure data and compare this to the predictions of existing environmental and human exposure models. There is current work on improving human exposure models and it is recognised that this work should</p>			

Research Objective	Proposal	Priority	Funding/Cost Estimate	Progress
	finish before the longer-term goal of work on modeling nanoparticle exposure.			
8	<b>Assessment of the effectiveness of water filtration techniques against nanoparticles</b>	Medium	£150K	
10	<b>Review of published literature on fate and transport of nanoparticles in soil and water</b>	High	£25K	Await outcome of conference on Environmental effects of nanoparticles ... (table 1)
	<b>Review of published literature on the range of nanoparticles developed and used for waste water remediation</b>	High	£20K	
	<p><b>Laboratory study of nano-iron and bimetallic materials currently available for remediation of soil or water.</b></p> <p>Although a number of products are commercially available, the manufacturers are not UK-based. But these products may be proposed for use in the UK, currently without the benefit of robust fate and transport data. The study will provide a benchmark for government and regulatory decision-making on which nanoparticles are potentially suitable for small-scale releases to provide information on field-scale fate and transport.</p>		This study could be funded through a CASE studentship/fellowship	

Research Objective	Proposal	Priority	Funding/Cost Estimate	Progress
	<p><b>eld-scale remediation of contaminated groundwater and soil.</b></p> <p>Robust science is needed from controlled field trials to assess the perceived benefits and environmental risks of remediation using nanoparticles. Such work should include a comparative assessment of remedial performance using micro- and nano-scale particles, assessment of measurement technologies and investigation of transport of nanoparticles.</p>			
10	<p><b>Consideration of the unintentional release of nanoparticles through disposal to landfill or discharge to sewage systems and wastewater treatment plant.</b></p> <p>The LCA approach can address the scale of exposure through disposal routes.</p>			
	<p><b>Develop an understanding of nanoparticle behaviour and fate in drinking water treatment processes</b></p>			