NANOMATERIALS SAFETY

IMPLEMENTATION PLAN

Comments and questions regarding this plan should be directed to the contact person listed below:

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1.0 REVISION/REVIEW LOG

Environment, Safety, Health & Assurance (ESH&A) will review this document once every two years at a minimum:

Revision Number	Effective Date	Contact Person	Pages Affected	Description of Revision
0	**4/15/08**	**J. Withers**	**All**	**Initial Issue**
1	**10/1/08**	**J. Withers**	**All**	**New requirements**
2	**12/31/08**	**J. Withers**	**All**	**G:/DOCS&RECS/DCP/ revision descriptions/ Plan 10200.035 rev 2 revdesc.doc**
3	**4/15/09**	**J. Withers**	**All**	**G:/DOCS&RECS/DCP/ revision descriptions/ Plan 10200.035 rev 3 revdesc.doc**

2.0 PURPOSE AND SCOPE

Ames Laboratory has limited activities involving nanomaterials. Potential hazards associated with nanomaterials work are addressed through the Laboratory's Integrated Safety Management System (ISMS) and specifically the Readiness Review process. Readiness Review provides the identification and evaluation of potential hazards and establishes effective control mechanisms to ensure protection of the employee and the environment. To date, hazards associated with projects involving nanomaterials have been determined to be amenable to conventional controls such as ventilation and use of personal protective equipment. The Laboratory recognizes that nanotechnology is an emerging field and that many of the associated ES&H concerns related to work with these materials are still being investigated. Ames Laboratory safety professionals monitor professional sources of information to identify new control strategies associated with nanomaterials research.

The DOE Notice 456.1, Statement of Nanoscale Safety, is part of the DOE-ISU contract for operation of Ames Laboratory. Specifically, DOE N 456.1 delineates requirements in the areas of training, exposure assessment, medical surveillance, controls, posting and labeling, transportation, and waste management of nanoscale materials. In addition, Ames Laboratory utilizes the Department of Energy Nanoscale Science Research Centers *Approach to Nanomaterial ES&H(Revision 3a – June 2008)* document as a resource for evaluating health and safety risks associated with use of nanoscale materials.

The following information outlines the Laboratory's implementation of DOE N 456.1, the *Approach* document, and lessons learned from other facilities and through review of audit reports.

3.0 RESPONSIBILITIES

3.1 LABORATORY DIRECTOR – The Laboratory Director is ultimately responsible for ensuring compliance with DOE N 456.1 and the *Approach* document and assuring that the Laboratory's

environment, safety and health programs adequately address the hazards associated with use of nanomaterials. The Director delegates this responsibility through the line management structure of the Laboratory.

3.2 PROGRAM DIRECTORS / DEPARTMENT MANAGERS – Program Directors / Department Managers are responsible for ensuring that all research with nanomaterials conducted within the program is done in accordance with established policies and procedures. Program Directors/Department Managers delegate this responsibility through the line management structure of the Program.

3.3 GROUP / SECTION LEADERS – Group / Section Leaders are responsible for ensuring that all research with nanomaterials within their group is conducted in accordance with established policies and procedures as described later in this document. Responsibilities include participation in the Readiness Review process, day-to-day management of laboratory activities, ensuring that laboratory personnel are trained and feel empowered to report unsafe work conditions or other safety concerns related to work with nanomaterials.

3.4 EMPLOYEES – Ames Laboratory employees are required to work with nanomaterials in accordance with established policies and procedures. Employees shall interact with supervisory personnel, Safety Coordinators / Representatives and ESH&A personnel on concerns and issues that relate to work with nanomaterials.

3.5 ENVIRONMENT, SAFETY, HEALTH and ASSURANCE – The ESH&A office shall assist research staff on the effective implementation of nanomaterials safety programs that ensure protection of the worker and environment. ESH&A staff will stay current on environment, safety and health best practices as they relate to nanomaterials and communicate that information to research staff.

4.0 PROGRAM ELEMENTS

4.1 REFERENCES & STANDARDS

Ames Laboratory recognizes that information on the safe use of nanomaterials is constantly being updated. Literature published by organizations such as the National Institute for Occupational Safety and Health (NIOSH), the American Industrial Hygiene Association (AIHA), the National Research Council, the American Chemical Society and the International Council on Nanotechnology and other organizations will be evaluated by ESH&A personnel and communicated to research staff as deemed appropriate. As of this writing, the Laboratory's program is primarily based on the following publication: *Department of Energy Nanoscale Science Research Centers - Approach to Nanomaterial ES&H - Revision 3a – June 2008*.

4.2 IDENTIFICATION & MANAGEMENT OF NANOMATERIAL HAZARDS

4.2.1 Proposal Review

ESH&A personnel review all funding requests. Proposals with nanomaterials work are closely scrutinized for assurance that the work does not fall outside of the "safety envelope" established during Readiness Review (see below). Any identified concerns are communicated to research staff and followed up if funding is received.

4.2.2 Readiness Review

Nanoscale work is identified via Readiness Review (Procedure 10200.006). Specifically, the physical hazard of nanomaterials is addressed on the ES&H Hazard Identification Checklist by the following statements:

Section A – Chemical & Biological Concerns: *A14 Nanoscale materials.*

For each identified hazard, the Activity Supervisor develops associated Hazard Management Statements that explain what controls are in place to minimize exposure potential. Standard Operating Procedures (SOPs) are also reviewed for adequacy along with a check of training records.

4.2.3 Hazard Inventory

The Hazard Inventory form is completed by all Ames Laboratory employees. "A"-listed hazards are located on the first page of the form and are those agents that have special requirements such as medical surveillance. Hazard "A265" denotes use of nanoscale materials. When an employee checks A265, a Hazard Information Request Form is generated and sent to the employee for completion. Questions for nanoscale materials are as follows:

- What type(s) (e.g., carbon nanotubes) of nanomaterial (≤100 nanometer) do you use?
- What task(s) are you performing when potential nanomaterial exposure may occur?
- What is the greatest quantity you use at any given time?
- How frequently do you use it (e.g., daily, once a week, etc.)?
- How long do you use it during any given day (e.g., minutes, hours, etc.)?
- Is the material ever used outside of a glove box or fume hood? Is yes, how is it used?
- Do you wear a lab coat, protective eyewear and gauntlet or forearm length gloves when handling the free or open nanomaterial? If not, why?
- Do you wear a respirator during your nanomaterial use? If yes, describe what type of respirator and activity involved?

The employee completes the form, gets a signature from a supervisor and sends the form to the ESH&A Industrial Hygienist (IH) for review. The IH reviews the information in conjunction with completion of a Nanomaterials Hazard Assessment (described below). A recommendation for medical surveillance is then made to Occupational Medicine by the IH.

4.2.4 Nanomaterials Hazard Assessment

The IH utilizes Form 10200.187 – Nanomaterials Hazard Assessment to conduct a risk-based hazard assessment. Questions of the form are as follows:

1. Specific Usage
   - What type(s) (e.g., carbon nanotubes) of nanomaterial (≤100 nanometer) do you use?
   - What task(s) are you performing when potential nanomaterial exposure may occur?
   - What is the greatest quantity you use at any given time?
   - How frequently do you use it (e.g., daily, once a week, etc.)?
   - How long do you use it during any given day (e.g., minutes, hours, etc.)?
   - Is the material ever used outside of a glove box or fume hood? Is yes, how is it used?
   - Do you wear a lab coat, protective eyewear and gauntlet or forearm length gloves when handling the free or open nanomaterial? If not, why?
   - Do you wear a respirator during your nanomaterial use? If yes, what type of respirator do you use and during what activity?
2. MSDS Review
3. Standard Operating Procedure (SOP) Review: Are the following items specifically addressed in the SOP
   - Health & safety information
   - Hazard control measures (e.g. PPE) usage
   - Waste disposal practices
   - Decontamination procedures
   - Spill/release containment & clean up
   - Authorized personnel
   - Designated use area
   - Transportation of samples
4. Labeling of Containers
5. Posting of Laboratory
6. Training
7. Hazard Inventory Verification: Is A265 denoted for every nanomaterial user?
8. Medical Surveillance

   Industrial Hygiene Comments

4.2.5 Medical Surveillance

Laboratory employees with an A265 hazard will be offered a baseline medical exam at Occupational Medicine (G11 TASF). The baseline exam will consist of a general physical, general blood work, pulmonary function test and x-ray. Recall frequency will also be determined by the physician.

4.2.6 Training

Laboratory personnel identify work with nanomaterials via completion of a Training Needs Questionnaire (TNQ). The TNQ question on nanomaterials work is as follows:

"Do you work with nanoscale materials (particles with diameters less than 100 nanometers)?"

If answered "yes", the employee's training profile is updated and reflects the need for completion of the Lab's nanomaterials safety module entitled "Nanotechnology Awareness (AL-208)". This course is computer-based, takes 30 minutes to complete and requires an 80% or higher score on a Learning Assessment Tool. Subjects covered in the training module include:

- Introduction to Nanomaterials
- Definitions
- Overview of inhalation, dermal, ingestion routes of exposure
- Safety precautions including engineering controls, respiratory protection
- Work practices including spill clean up
- Waste management
- Transportation
- Training
- Medical surveillance
- Lab postings and labeling
- Points of contact

New health and safety information related to nanoscale materials is emerging on a regular basis. By necessity, training will need to be assessed for adequacy on a regular basis. Any new or refresher information will be provided to all employees who have previously completed the module in a timely manner.

4.2.7 Exposure Monitoring

Quantitative exposure monitoring for nanoscale materials is not feasible because accepted methods (instrumentation, exposure limits, etc.) do not currently exist. IH personnel continue to monitor progress on the development of monitoring methodology through professional sources of information including DOE and ISU EH&S personnel. In the absence of an accepted quantitative method, the qualitative, risk-based exposure assessment described previously is used.

4.2.8 Exposure Controls

Engineering controls such as a ventilated enclosure or chemical hood are recommended for all work with dispersible (able to be inhaled) nanoparticles. If engineering controls are not feasible, respiratory protection is recommended with the employee being placed on the Respiratory Protection Program which includes fit-testing and training. Other personal protective equipment that is recommended as standard issue for work with nanoparticles includes a lab coat and latex gloves with extensions.

4.2.9 Transportation

Transportation of nanoscale materials is assessed during the Readiness Review process. Off-site transportation is conducted in accordance with DOT regulations. Between lab transportation of nanoscale materials will be conducted using methods (e.g. use of shatter proof containers) that reduce the risk of human or environmental impact caused by an accidental spill.

4.2.10 Waste Management

Waste management practices are assessed during the Readiness Review process. Nanoscale material wastes will be handled in a fashion similar to RCRA wastes. Both Ames Laboratory and ISU waste management personnel have a documented procedure for managing nanoscale material waste. Nanoscale material waste will be classified separately and be associated with a specific Satellite Accumulation Area (building, lab). Materials will be packed for disposal by a licensed vendor. Documentation will be available that verifies type of waste, quantity and means and location of final disposition.

4.2.11 Annual Self-Assessment

The IH will conduct an annual review of nanoscale material usage at Ames Laboratory including programmatic documentation. Results of the annual review will be discussed in the Laboratory's year-end self-assessment report.

4.3 INTEGRATION OF NEW RESEARCH FINDINGS PERTAINING TO NANOSCALE MATERIALS

ESH&A personnel stay abreast of the latest developments in the safe use of nanomaterials through a variety of external and internal mechanisms:

External sources of information include participation in professional development conferences/meeting sponsored by the American Academy of Industrial Hygiene (Professional Conference of Industrial Hygiene), the American Conference of Governmental Industrial Hygienists (American Industrial Hygiene Conference & Exposition), DOE (Nanotechnology Centers-sponsored courses) and academia (Iowa State University). Internal sources of information include proposal reviews, Readiness Review, independent walkthroughs and interactions with researchers during training.

Information gleaned from these sources is utilized to bring about improvements in the way the Laboratory anticipates, recognizes, evaluates and controls hazards associated with nanomaterials. These improvements include enhanced training and the development of more effective hazard assessment and control strategies.

4.4. SUPPORTING THE RESOLUTION OF ES&H CONCERNS

Ames Laboratory has an effective Oversight and Assurance Program (Plan 10200.035) that provides immediate feedback on the adequacy of the ES&H program. Feedback on the efficacy on the methods in place for anticipating, recognizing, evaluating and controlling hazards of nanomaterials work is received via a variety of mechanisms including the Independent Walkthrough Program, the employee concern program, Readiness Review (5-year reviews), topical appraisals, internal reviews conducted by the Laboratory's Independent Auditor and external reviews conducted by DOE.