Brookhaven National Laboratory's

Implementation of the Secretarial Policy Statement on Nanoscale Safety

DOE Policy 456.1

The following outlines the implementation of DOE P 456.1 for Brookhaven National Laboratory operated by Brookhaven Science Associates. This implementation plan is an update of a plan submitted in November 2005 and is based on the principles delineated in the BNL Environmental, Safety, Security and Health (ESS&H Policy) which commits every employee, contractor and guest to continual improvement in ESS&H performance for all activities performed at BNL.

As described below, the Director of Brookhaven National Laboratory has;

- Accepted responsibility for ensuring compliance with the DOE Secretarial Policy Statement on Nanoscale Safety (DOE P 456.1, dated September 15, 2005).
- Established a laboratory program that will ensure that all aspects of the Secretary's Policy Statement (and Brookhaven's policies and procedures) are addressed in all operations utilizing nanomaterials at BNL.

With respect to Policy expectations:

1 Adoption of "Best Practices" and Standards

DOE Policy*: "DOE will adopt and implement, as appropriate, both existing and future environment, safety and health best practices, National Consensus Standards and guidance relating to nanotechnology developed by recognized standard-setting organizations. Further, any DOE Directives and Standards which contain provisions that are relevant to nanotechnology work must be appropriately applied"*.

- The BNL ISM program includes evaluation of proposed work to determine which standards (regulatory and consensus) are most appropriate to minimize hazards associated with the work. Policies and procedures are identified, documented and deployed though the BNL Standards Based Management System (SBMS) and are adopted for use at BNL. These standards provide adequate assurance that the public, workers, and the environment are protected from adverse consequences. A BNL nano-science safety Subject Matter Expert has been assigned to monitor the development of ESH practices for working with nano-scale materials.
- BNL manages all work involving nanomaterials in conformance with 10 CFR 851, *Worker Safety and Health Program*[1], 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*, and 29 CFR 1910.1200, *Hazard Communication* through

[1] Although the nanotechnology section (Appendix A, section 12) remains reserved, BNL recognizes that more general requirements for the management of chemical risks remain relevant and will continue to comply with relevant requirements through the policies and procedures of Brookhaven's DOE-certified Integrated Safety Management System.

implementation of the BNL *Interim Procedure "Approach to Nanomaterial ESH"*

- BNL is in receipt of the recently issued (December, 2007) ASTM International's standard ASTM E2535-07, *Standard Guide for Handling Unbound Engineered Nanoscale Particles in Occupational Settings*. Review of that standard and discussions between the participants in the NSRC Directors' ES&H Nanomaterial ES&H working group and BNL nanotechnology SMEs, indicate that BNL has achieved compliance with all the recommendations of this consensus standard except for the training section. Plans for completion of the recommended training are in progress.
- BNL has adopted the Department of Energy Nanoscale Science Research Centers' *Approach to Nanomaterial ES&H* (revision 2, June 2007) and incorporated that into the BNL Standards Based Management System.
- BNL nanotechnology SME's continue to monitor, adopt or adapt the recommendations of the National Institute for Occupational Safety and Health, the American Industrial Hygiene Association, the National Research Council, the American Chemical Society, and the International Council on Nanotechnology and other organizations.
- BNL will continue to manage the uncertainty about the toxicity of nanomaterials (and associated risk) by:
  - Applying a precautionary approach[2] for all nanomaterial related research.
  - Minimizing worker exposure and the release of nanomaterials into the environment.
  - Minimizing the quantities of unbound nanoparticle use.
  - Collaborating with all BNL organizations and the other NSRCs, the DOE community and external organizations involved in nanotechnology research.

  As an example of this approach, Brookhaven National Laboratory has mandated that all work with unbound nanoparticulates be conducted in a HEPA filtered exhaust hood, a glove box, or a sealed enclosure. Recent modification of the BNL Center for Functional Nanomaterial labs has included installation of HEPA filters in chemical exhaust hoods where nanoparticulate work is projected.
- Brookhaven National Laboratory considers all federal, state and local regulatory agencies and the following organizations as recognized standard-setting organizations. The Laboratory also recognized the following organizations: American Conference of Governmental Industrial Hygienists, Association, the American National Standards Institute, ASTM International, and the National Fire Protection Association. In the future, it may recognize other organizations.

2 Identification and Management of EH&S Hazards

DOE Policy: *"DOE and its contractors will identify and manage potential health and safety hazards and potential environmental impacts at sites through the use of the existing Integrated Safety Management System, including Environmental Management Systems"*.

[2] In conformance the general principle in the National Research Council's *Prudent Practices for Handling Hazardous Chemicals in Laboratories*, Laboratory personnel should treat "all new compounds, or those of unknown toxicity, as though they could be acutely toxic in the short run and chronically toxic in the long run"

- BNL uses its DOE validated Integrated Safety Management System (ISM), to address the hazards and risks of nanomaterials.
- ISM at BNL is implemented through the Environmental Management System (ISO 14001 registered), the Occupational Health and Safety Management System (OHSAS 18001 registered), and the Work Planning program which drives the following;
    - Establishing goals that drive continual improvement of ESH programs,
    - Measuring progress towards achieving these goals,
    - Establishing operational controls to reduce risk,
    - Review of all work activities for risk analysis and control,
    - Periodically reviewing performance with management,
    - Communicating with stakeholders and neighbors to address concerns.
- All proposed experimental work performed on nanoscale materials at BNL is reviewed using the BNL Experimental Safety Review (ESR) process (a subset of the Work Planning program), to identify the hazards associated with the proposed work and to establish the necessary set of ESH controls to allow the experimental work to be performed safely.
    - The ESR process is managed by a Departmental Experimental Review Coordinator
    - Information required for a comprehensive ESH review is collected when a proposal is made for work at BNL using a screening process. This includes:
        - Identification of materials and precursors to be brought on site
        - Identification of equipment needed for handling and analysis of the nanoscale materials.
        - A description of the tasks involved.
        - A risk analysis
        - A contingency plan (if appropriate).
        - A waste disposal plan.
    - The SBMS interim procedure “Approach to Nanomaterial ESH” is used to identify specific controls appropriate for the type of nanomaterials used in the experiment.
    - All ESR’s are reviewed by the Department Experiment Review Coordinator with assistance as needed from Subject Matter Experts available from the ESH Directorate and appropriate Scientific Departments.
    - All ESR’s are documented and re-reviewed when changes are made and on an annual schedule.
    - All experimenters are required to review, understand and acknowledge the ESH requirement in the ESR prior to performing any experimental activities.
    - No experimental work is approved until it is demonstrated that it can be done safely and within the envelope of safe operation approved for the facility.
    - The ESR and Job Training Analysis programs assure that all experiment participants have adequate training and qualifications to perform the work.

- The ESR is used to determine if any of the participants are considered "nanoparticulate" workers as defined in the NSRC "Approach to Nanaomaterial ESH" document and those participant names retained in a laboratory database to facilitate any required medical surveillance.

- BNL has instituted an "Institutional Nanoscale Science Advisory Committee" (INSAC) reporting directly to the Laboratory Director. The INSAC consists of scientists, support staff and pertinent subject matter experts and is chaired by the Deputy Director for Science. The Committee is charged by the Laboratory Director to:
  - Assist line organizations in the interpretation and implementation of the "Approach to Nanomaterials" interim SBMS procedure.
  - Provide consistent guidance for all research activities at BNL involving engineered nanomateials.
  - Assure at DOE Secretarial Policy Statement on Nanoscale Safety is adequately implemented.
  - Assure that the nanomaterials are being utilized properly and safely at BNL.
  - Keep the Laboratory Director apprised of any developing nano safety issues and the status of the implementation of the interim document.

- The Laboratory is committed to open, honest, and transparent communication and involvement with its internal and external communities regarding its mission, priority projects, and matters of interest and importance to its stakeholders. As part of this commitment, a Communication and Stakeholder Engagement Plan for Lab-wide nanoscience research has been developed. This plan is updated regularly and includes activities that address potential environmental, safety and health issues that may be related to nanoscience research.

  Implementation of the plan has included routine engagement and communication activities with employees, the Laboratory's Community Advisory Council, and elected, government and regulatory officials. These efforts help to keep stakeholders properly informed about developments in emerging nanoscience, and they continue to allow opportunities for stakeholders to have a voice in Lab decisions of related interest and importance.

  In addition, the Laboratory actively participates in the Department of Energy's NSRC Communications Working Group and informational updates are regularly provided regarding engagement and communications activities and outcomes.

3 Integration of New Research Findings Pertaining to Nanoscale Safety

DOE Policy: *"DOE organizations working with nanomaterial will stay abreast of current research and guidance relating to the potential hazards and impacts of nanomateial, and will ensure that the best current knowledge is reflected in the identification and control of these potential hazards and impacts at their facilities."*

- Brookhaven National Laboratory Director has appointed the INSAC and charged the committee with staying abreast of all relevant research, potential hazards and impacts of nanomaterials. The committee includes Subject Matter Experts (SME's) including expertise in Industrial Hygiene, Hazards Analysis, Environmental, and Waste Management. These

SME's are involved in technical societies, DOE-sponsored activities, and cooperative activities that promote awareness of nanomaterials' ES&H hazards and impacts. Brookhaven National Laboratory supports these SME's efforts to stay abreast of developments, share information and become involved in standards making bodies by:

- Sending staff to conferences/professional development related to nanotechnology:
  - The 2nd International Symposium on Nanotechnology and Occupational Health (Minneapolis, October 2005)
  - The International Conference on Nanotechnology Occupational and Environmental Health and Safety: Research to Practice (Cincinnati, December 2006
  - The 3rd International Symposium on Nanotechnology, Occupational and Environmental Health (Taipei, Taiwan, August – September 2007)
  - The American Industrial Hygiene Conference and Exposition (Dallas, May 2003; Atlanta, May 2004; Anaheim, May 2005; Chicago, May 2006; and Philadelphia, June 2007)
  - Various ESH-coordinated on-site teleweb seminars relating to nanomaterials
  - BNL has sponsored a staff member on the ASTM E56 Committee that is responsible for the development of the ASTM E2535-07 Standard "Standard Guide for Handling Unbound Engineered Nanoscale Particles in Occupational Settings"

- Brookhaven National Laboratory SME's share best practice knowledge concerning nanomaterial hazards and control technologies relevant to the synthesis, handling, and disposal of nanomaterials in nanoscience facilities with external organizations including presentations at;
  - American Society of Chemical Engineers (Ninth Annual Frances S. Sterrett Environmental Chemistry Symposium, May 2005)
  - 5th New England International Nanomanufacturing Workshop - June 2007
  - Safe Development of Nanotechnology Conference – November 2007

- Along with the Directors of the four other Nanoscale Science Research Centers, Brookhaven National Laboratory Director formally chartered an ES&H working group. The group's activities include:
  - Reviewing new environment, safety and health standards and regulations, from national and international organizations, to determine applicability to the Centers
  - Revising the Nanoscale Science Research Centers' *Approach to Nanomaterial ES&H* document to keep it current with emerging knowledge about nanomaterial hazards and control technologies (currently Revision 2 dated June 2007)
  - Sharing successful safety initiatives and approaches to management of hazards and concerns
  - Providing ES&H information and assistance to other NSRCs and other institution engaged in nanoscience and nanotechnology

4 Supporting the Resolution of ES&H Concerns

"DOE will continue to both support research on the environmental and safety and health impact of nonmaterial, and participate in government-wide activities aimed at identifying and resolving potential environmental, safety and health issues."

- Brookhaven National Laboratory actively participates in NSRC-Director-chartered, DOE/SC-coordinated NSRC ES&H Working Group and other SC and BES efforts intended to collect and disseminate information to the BES NSRCs and other interested parties. It will share information and work products through the NSRC ES&H Working Group, the IH/OS Special Interest Group[3], and through professional societies and meetings.
- Brookhaven National Laboratory (Research Proposal Evaluation Board) recognizes the merit of user proposals that involve research relating to nanomaterial ES&H concerns when evaluating proposals.

Through the plans, policies and procedures listed above, Brookhaven National Laboratory continues its on-going efforts to integrate effective management of ES&H concerns into all aspects of the facility's planning and operations.

[3] The IH/OS Special Interest Group (SIG) is a network of personnel from the U.S. Department of Energy (DOE) community involved in occupational safety and health (S&H) issues. The IH/OS SIG provides the DOE community with tools for the development, enhancement, and/or implementation of programs and training designed to improve worker S&H.