BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division INDUSTRIAL HYGIENE GROUP Standard Operating Procedure	NUMBER IH74150
	REVISION FINAL Rev01
SUBJECT: Nanoscale Area Surveys Principles	DATE 06/18/07
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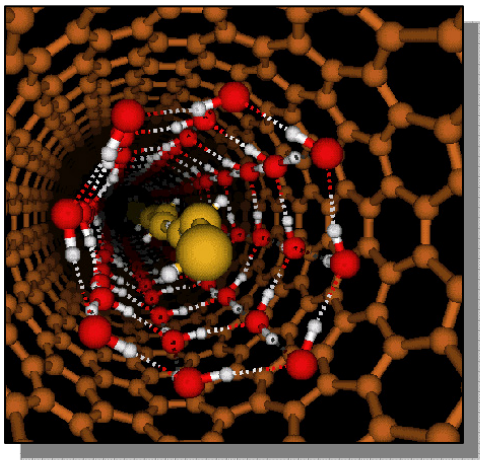

1.0 Purpose/Scope

This procedure provides a standardized method for conducting area surveys for airborne particulates in the nano size range (10-100 nm) with direct reading meters. It should be used in conjunction with the SBMS Interim Guidelines Nanoscale ESH (SMF) and an *Instrument Operation* procedure in the IH SOP series IH74xxx. The measurement is for airborne particulates

An area survey meter should be used to determine the range of baseline area levels in locations where nanoscale work is to be conducted. Survey meters are designed for conducting field surveys to determine the need for, and effectiveness of, engineering controls. It can also be used as a screening tool to determine the need for medical surveillance and potential exposures. Currently all employees who work with nanoscale materials are to be identified to OMC.

Current exposure standards are not applicable to nanoscale materials due to the unique properties and unknown health effects of these materials. Standard methods for airborne particulates such as total particulate, respirable particulate, and fibers are inappropriate for exposure monitoring on the nanoscale. Best management practices are being adopted at BNL to control employee exposure especially to the higher risk free particulates.

There are currently no approved methods for employee exposure assessments for nanoscale work. However an area survey meter can be used as a screening tool to identify those areas that may need further employee assessment, additional administrative controls or respiratory protection. It can also be used to identify those individual tasks, which present potential exposures.

2.0 Responsibilities

2.1 This procedure is administered through the SHSD Industrial Hygiene Group. Members of the SHSD Industrial Hygiene Group are required to follow this procedure. Other BNL organizations that provide BNL with field monitoring or other hazard assessment services are required to follow this SOP.

2.2 ***Industrial Hygiene Professional:*** The *Industrial Hygiene Professional* of SHSD and other BNL organizations are to be qualified in accordance with the unified IH training guidelines established by the IH Group. These individuals will conduct or supervise industrial hygiene hazard assessments and personal exposure monitoring using this procedure. These *IH Professionals* are responsible for:

- Interpreting, reporting, and documenting personal exposure monitoring in accordance with the requirements of this procedure, other appropriate SOPs, and generally accepted professional standards and practices.
- Ensuring a quality report is prepared that documents the exposure, evaluates the relevance to exposure standards, and recommends protective and corrective actions.
- Ensuring the final report is provided in a timely manner to all appropriate parties.
- Ensuring that the appropriate data is correctly and completely entered into the BNL IH exposure monitoring database (i.e. *Compliance Suite*®).
- Ensuring that original records of sampling and analysis enter the SHSD *Record Custodian* filing system.

2.3 ***Industrial Hygiene Technician (Sampler)*:** The industrial hygiene technician is to be qualified by the IH Group to conduct industrial hygiene exposure monitoring. The sampler is responsible for collecting exposure monitoring samples in accordance with the guidance of the *IH Professional* and the requirements of all SOP's pertinent to the particular monitoring requirements (i.e. Chain of custody, equipment check in/out, equipment operation, recordkeeping, etc.).

2.4 ***Compliance Suite® data entry:*** The management of the person conducting the sampling is responsible for entering complete and correct data into the BNL IH exposure monitoring database (i.e. *Compliance Suite*). This task may be assigned to one or more individuals who act as the data entry person for an organization, however, it remains the responsibility of the line management of the *Sampler* to ensure this task is fulfilled within 21 calendar days of the end of the sampling event.

3.0 Definitions

Engineered Nanomaterials (eg. nanotubes, C60 Buckminster fullerenes, Au/CdSe/TiO2 particles etc.) materials consisting of, or containing structures with at least one dimension between 1 and 100 nanometers (nm*)*. Naturally occurring nanoparticles such as from diesel exhaust are excluded.

Occupational Exposure Limit (OEL): The maximum time weighted average (TWA) or ceiling value exposure permitted for employee exposure, based on the lesser of the OSHA Permissible Exposure Limits (PEL) or ACGIH Threshold Limit Value (TLV). Neither ACGIH nor OSHA has published an OEL for nanoparticles at this time. A PEL/TLV for the macro size particle of a substance may not represent the relative hazard of nanoparticles of the same material.

4.0 Prerequisites

4.1 **Training prior to using this procedure:**

4.1.1 Demonstration of proper operation of the procedure to the satisfaction of the IH Group Leader or designated Program Administer. See Section 7 for qualification requirements.

4.1.2 Other appropriate training for the area to be entered (check with ESH coordinator or FS Representative for the facility).

4.1 **Area Access**:

4.1.1 Contact the appropriate Facility Support Representative or Technician to obtain approval to enter radiological areas.

4.1.2 Verify with the appropriate Facility Support Representative or Technician if a Work Permit or Radiological Work Permit is needed or is in effect. If so, review and sign the permit.

4.1.3 Use appropriate PPE for area.

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5.0 Precautions

5.1 **Hazard Determination:** The operation of an area survey meter or use of this procedure in itself does not cause exposure to any chemical, physical, or radiological hazards.

5.1.1 By its very nature, a nanoscale survey meter may be used in areas where airborne nanoscale particulates exist or are suspected to be present.

5.1.2 OMC requires that all employees potentially exposed to nanoparticles be identified. This will include the sampler.

5.2 **Personal Protective Equipment:** Appropriate PPE for hands, feet, skin, head, or eyes as well as respiratory protection may be needed for the area being entered due to nanoscale particles or other hazards. Check with your S&H representative.

5.3 **Environmental Impact:** The meters used for nanoparticles measurement may generate Hazardous Waste. See the procedure for the meter to be used.

5.4 **Job Risk Assessment:** Consult the *Job Risk Assessment* SHSD-JRA-05 for the hazards and controls of this SOP.

6.0 Procedure

6.1 All monitoring work for nanoscale particulates should be approved by the SHSD Nanomaterials Program Administrator. Discuss the experiment and monitoring needs with the Program Administrator.

6.2 Prepare a short written plan to proceed with the monitoring effort showing a sketch of the area, equipment and proposed sample locations/frequency/tasks and any other information requested by the Program Administrator.

6.3 Review the ESR or work permit to determine the appropriate meter and protective measures.

6.3.1 Determine the particulate size range of the experiment.

6.3.2 Determine if there is a possibility for airborne radiological materials. Do ***NOT*** use IH equipment in these areas without express written permission from the Program Administrator.

6.3.3 Plan and conduct hazard assessments and exposure monitoring using the procedure outlined in *IH 60500 Planning Sampling & Reporting Personnel Exposure Monitoring Results*

- Exposure Assessment Sampling Strategy,
- Data input to database
- Initial Notification of Employee Monitoring Results, and
- Preparation of a formal report on the exposure monitoring or hazard assessment.

6.4 Operate, calibrate and/or zero the meter as per the Instrument Operation SOP.

6.5 Take measurements by approaching the source from further away, (i.e. known clean area to suspect area.) Take measurements in accordance with the monitoring plan. The purpose is to identify potential exposures and hazards. Determine what typical operating positions are and where maximum exposures are possible.

6.6 **Recording readings:**

6.6.1 Use a *SHSD Direct Reading Meter form* to record readings and additional required information.

6.6.2 Return meter and original sampling form to the SHSD IH Laboratory. Copy goes to the ESH Coordinator.

6.6.3 Ensure a copy of the hazard evaluation is sent to the IH Laboratory, the Occupational Medicine Clinic, the department ESH coordinator, individual(s) surveyed, and supervisor of the individual(s) surveyed.

7.0 Implementation and Training

Prior to using this procedure, the user:

7.1 Demonstrates proper operation of this procedure and related instruments to the satisfaction of SHSD IH Manager or designee. Qualification is tracked via the meters used to implement this procedure.

7.2 Completes other appropriate training for the area to be entered (check with ESH coordinator or FS representative for the facility).

7.3 Completes OT&Q Training and medical surveillance required for any PPE used on the job or for other hazards encountered in the work area.

7.4 Ensure employee is identified on the OMC notification list for nonmaterial employees.

8.0 References

8.1 BNL SBMS Interim Guidelines *"Nanoscale ESH"*
8.2 *DOE Order 440.1A*
8.3 DOE Policy P 456.1 *"Approach to Nanomaterials ESH"*
8.4 *BNL Implementation Plan for DOE Policy P 456.1*
8.5 *TSI Model 3007 Condensation Particle Counter Operations and Service Manual*

9.0 Attachments

9.1 Theory of Nanoscale Field Measurements

10.0 Documentation

Document Development and Revision Control Tracking		
Prepared By: *(Signature And Date On File)* J. Peters Date 09/22/06	Reviewed By:	Approved By: *(Signature And Date On File)* R. Selvey IH Group Leader Date 06/18/07
ESH Coordinator/ Date: *none*	Work Coordinator/ Date: *none*	SHSD Manager / Date *none*
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Revision Log

Purpose: ☐ Temporary Change ☐ Change in Scope ☐ Periodic review ☐ Clarify/enhance procedural controls

Changed resulting from: ☐ Environmental impacts ☐ Federal, State and/or Local requirements ☐ Corrective/preventive actions to non-conformances ☐ none of the above

Section/page and Description of change:

(signature on file) SME Reviewer/Date:	Reviewer/Date:	Reviewer/Date:

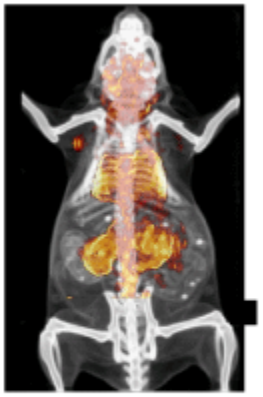
Attachment 9.1

Theory of Nanoscale ESH Field Measurements

Although there are numerous approved methods for monitoring worker exposure to particulates, these methods do not specifically measure the nanoscale. Regulatory exposure levels for these particulates were established based on health effects research of larger size particles. Many of these larger particles may be trapped and removed by the bodies defense mechanisms.

Nanoscale materials (10-100 nm) exhibit unique properties. These properties are not consistent with the same materials of larger size (>100 nm). In many instances, the properties of nanoscale particles are assumed to be the result of the vastly increased surface area and its effects on activity.

Nanoscale materials also behave differently once they enter the body. Some of these materials have been demonstrated to cross the blood brain barrier, alveolar lining of the lung or the placenta, whereas the larger particles may not.
Many of the materials that are being studied are bound to a substrate (eg. attached by a binding agent or grown from and attached to a substrate) or are held in solution. This minimizes the potential for release of free particles. Also, the majority of nanoscale work at BNL uses a very small amount of the starting material or product.



In Vivo distribution of CdSe nanocrystals in the mouse. PET image

In areas where airborne nanosize particulates may be generated BNL has imposed best management practices such as: closed systems, work in chemical hoods/glove boxes, water traps, HEPA filters, etc.

There are many other sources of nanoscale particles such as welding and combustion processes. This has been demonstrated and accounts for large numbers of particles in ambient air. Therefore it is necessary for determination of background readings in areas to be monitored. The total number of background particles can vary significantly hour by hour, day to day, and by season. For this reason, it is imperative that extensive background readings be taken to ensure appropriate interpretation of the results.

The HVAC system in a particular area is very important to the final analysis. Unlike a clean room, very few HVAC intakes are HEPA filtered and the fresh air contains the ambient levels outdoors. In addition, some systems add to the total number of nanoscale particles due to fuel combustion. Thus, it is important to understand the HVAC dynamics of an area to be monitored and ensure that monitoring is conducted under various system conditions.

Monitoring of airborne particulates in the nanoscale must be done in a coordinated effort with the Program Administrator. Thus, no monitoring should be conducted without an approved monitoring plan.

Zeroing the meter is one of the most important steps toward obtaining comparable measurements. Current research indicates nanoscale particles (10-100 nm) are trapped effectively by HEPA filters. Therefore, the manufacturer's operation manual requires zeroing with a HEPA filter prior to monitoring. This demonstrates the instrument is clean and ready for use.

Area surveys are conducted by use of the Condensation Particle Counter (CPC). Personal exposures are inferred by the area monitoring results. Without clear exposure guidelines the results can only state that an exposure did or did not occur.

The CPC may be used to collect various types of area monitoring information. One purpose is to document typical background levels in a laboratory prior to nanoscale experimentation. This can be done many times over an extended time period to identify the range of particulate concentrations. However, for exposure potential, readings must be conducted just prior to experimentation for comparison with readings during the experimental process.

A second purpose is to determine if there is a release during the experimental process. Each monitoring event will be unique and must be designed to provide the correct information necessary to make useful conclusions and recommendations. It is especially important to monitor activities, which are suspected to have a higher risk for airborne release and thus personal exposure (eg. opening a closed system, removing a boat or other container with dry particulate, etc.).

The CPC is a data logging instrument and may be stationed in one location throughout the experimental process. It can also be carried by hand to collect spot measurements over several locations at various times throughout the experiment. These considerations must all be covered in the approved air monitoring plan.