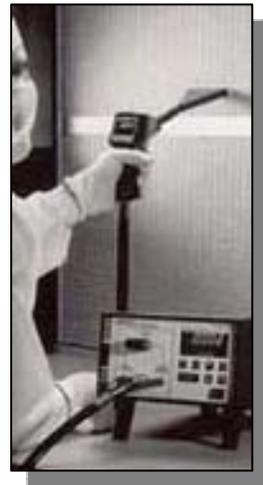


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1.0 Purpose/Scope

This procedure provides methods for the in-place efficiency testing of HEPA filter systems at BNL. It is part of the HEPA Surveillance Program described in IH62200.

The test described in this SOP involves Emery 3004 (poly-alpha-olefin) being injected into a HEPA filtered exhaust ventilation system during testing. Penetration of this challenge agent through the filter is measured downstream of the injection site and filter.

High-efficiency particulate air (HEPA) filters are important components of many air pollution control systems. Due to their general reliability and high level of performance, these filters are commonly used in the nuclear field to minimize the release of radioactive particulate matter. HEPA filters are also used on laboratory fume hood and glove box systems, as well as in Class II biological safety cabinets (to remove potentially-infectious bioaerosols), and on special vacuum cleaner systems used for the collection of hazardous materials (e.g., asbestos debris).

HEPA filters are manufactured to remove $\geq 99.97\%$ of the particles with a mean diameter of

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0.3 um from an air stream. This specification is evaluated at a centralized DOE Filter Test Facility prior to release to end users such as BNL. Upon installation in the field, these filters must again be evaluated. This second phase of evaluation is known as “in-place” testing and is designed to measure not only the particle removal efficiency of the HEPA filter but also of associated ductwork, gasketing, and the filter housing box. The criterion for the acceptance of an in-place test is a particle removal efficiency of $\geq 99.97\%$, unless the facility being tested has its own BNL approved performance specification.

2.0 Responsibilities

- 2.1 This procedure will be implemented through the SHSD Industrial Hygiene Group.
- 2.2 Personnel from the Industrial Hygiene Group (Level 1 Tester) will perform HEPA filter system testing and evaluation for BNL. Communication with, and cooperation from, RCD Facility Support Group and division ESH Coordinators will also be needed to coordinate this activity.
- 2.3 Tests are to be performed by a Industrial Hygiene Group *Level 1 Tester* who has demonstrated the competence to satisfactorily perform the tests as evidenced by experience and training.
- 2.4 In areas with radiological contamination, the *Level 2 Assistant* should be from RCD so as to provide Health Physics *Radiological Work Permit* coverage.

3.0 Definitions

Level 1 Tester: A BNL defined title for the highest level of competency in qualified employees. The qualification requirements for this position are defined in the *Implementation and Training* portion of this SOP.

Level 2 Assistant: A BNL defined title for the lower level of competency for employees. These employees serve a role as a fully supervised assistant in field-testing. This position often represents a temporary assignment of very short duration (1-3 days). The qualification requirements for this position are defined in the *Implementation and Training* portion of this SOP.

Surveillance Tests: Tests that monitor the condition of systems that have previously passed an *Acceptance Test*. In particular, a *Surveillance Test* consists of an in-place leak test performed periodically to establish the current condition of a nuclear air treatment system and its components, with respect to bypasses and damage to filters and absorber.

4.0 Prerequisites

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- 4.1 Prior to testing a HEPA filter system, verify the calibration and operability of the test equipment.
- 4.2 Prior to testing a HEPA filter system, the Level 1 Tester contacts the appropriate RCD Facility Support Representative or Technician to obtain approval and clearance to enter the test area. This is to include RCD coverage for health physics issues as required by RCD.
- 4.3 Prior to testing a HEPA filter system, the Level 1 Tester or RCD contacts the System Owner to ensure that the ventilation system is not in active use to avoid inadvertent contamination of equipment and exposure to personnel.

5.0 Precautions

HEPA exhaust ventilation systems are very likely to have radiological or chemical contamination. Do not perform work described in this SOP until you contact persons knowledgeable with the system and have been informed all HEPA testers of the hazards of the equipment and measures to avoid inadvertent contamination of equipment and exposure to personnel. Only open the photometer in areas where radiological contamination can be contained and not result in surface contamination. Have the photometer surveyed for radiological contamination before handling internal parts.

5.1 Hazard Determination:

- 5.1.10 By its very nature, a HEPA test may be done in areas where chemicals or radiation contamination is known or suspected to be present. Inhalation of these contaminants can have significant health effects. These hazards must receive a hazard evaluation by a cognizant ESH professional.
- 5.1.11 The operation of this meter involves exposure to a low hazard chemical (test aerosol, Emery 3004) that does not pose a high exposure risk.
- 5.1.12 The meter design does not cause significant ergonomic concerns in routine use.
- 5.1.13 PPE is needed to perform this test. See Section 4.5.

5.2 Personal Protective Equipment

- 5.2.10 Hand: Contact with aerosol liquid (Emery 3004) should be minimized but does not pose a significant health risk. Use of this meter in areas of known or

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suspected chemical or radiological contamination requires the use of disposable gloves. Exam-style, splash gloves are acceptable. Acceptable elastomers are: Nitrile, PVC, and Natural Rubber.

5.2.11 Body:

- If contact of the body with contaminated surfaces is anticipated, a disposable suit is to be used. Acceptable CPC materials include: Tyvek®, KleenGuard®, and cotton. Disposable garments must be discarded as hazardous waste if contact with contamination has occurred.
- If contact with potentially contaminated surfaces is not expected, body covering is optional. However, if personal clothing items become contaminated, they must be surrendered for BNL cleaning or disposal.

5.2.12 Foot:

- If contact of the feet is anticipated with contaminated surface, disposable shoe coverings, boots or booties is to be used. Acceptable CPC material include: Tyvek®, KleenGuard®, and rubber.
- If contact with potentially contaminated surfaces is not expected, shoe coverings are optional. However, if personal shoes become contaminated, they must be surrendered for BNL cleaning or disposal.

5.2.13 Respiratory: Under normal use, respiratory protection is not required. If chemical or radiological levels from contamination in the area exceed the OSHA, ACGIH, or DOE standards, respirators are required. A half face or full face APR or PAPR respirator with appropriate cartridge or an air line respirators may be used up to assigned protection factor listed in the BNL's Respiratory Protection Selection and Issuance SOPs.

5.2.14 Eye: Safety Glasses with side shields are required.

5.3 Environmental Management and Waste Disposal:

5.3.10 The operation converts all the Emery 3004 into an aerosol with compressed air. In a test of a passing filter, the aerosol is trapped on the filter. In a system with a leaking filter, some or all of the aerosol is discharged to the environment up the exhaust stack. The concentration of aerosol in the exhaust air has negligible environmental consequences.

5.3.11 The Emery 3004 purchased by the IHG is used until it is all consumed in testing. If needed, the Emery 3004 is to be disposed of as a hazardous liquid via EWMSD.

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5.4 **Job Risk Assessment:** Consult the *Job Risk Assessment* [SHSD-JRA-01](#) for the risk analysis of this operation based on the hazards and controls of this SOP.

6.0 Procedure

Summary: Filter efficiency is determined by challenging a HEPA filter with an aerosol and measuring the aerosol concentration both upstream and downstream to calculate the percentage removed by the filter system.

Equipment:

- Emery 3004 or equivalent approved alternative
- Aerosol generator
- Aerosol detector
- Sampling train (Tygon tubing and probes)
- Source of clean, medium-pressure (e.g., 50-75 PSI) air

6.1 Prior to testing a HEPA filter system, contact:

- RCD Facility Support Representative or FS Technician to obtain approval and clearance to enter the test area
- System Owner to ensure that the ventilation system is not in active use.

6.2 Identify the aerosol release and sampling point locations. The upstream filter sampling point should be at least 10 duct diameters from the aerosol release/system entry point to provide for a well-mixed suspension in the air mass. Similarly, the downstream sampling point should be located at least 10 duct diameters downstream from the filter housing. Where sampling points cannot be located at these distances due to the physical configuration of the ductwork, efforts should be made to maximize these distances to the greatest possible extent.

6.3 Activate the ventilation system or otherwise verify that the ventilation system is operating.

6.4 Inspect the HEPA filter system and its associated ductwork and mechanical components for any obvious signs of damage, e.g., missing or damaged seals, breached ductwork, excessive rust, unusually loud motor noise. Notify Plant

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Engineering and the RCD Facility Support Representative of these conditions.

- 6.5 Attach sample collection tubing to detector and warm-up photometer in the “clear” mode until a stable baseline reading is obtained. Self-calibrate and zero the instrument according to manufacturer’s procedures. Insert sample probes into the duct centerline at both the upstream and downstream sampling points. For sampling locations with existing sampling ports or nozzles, attach sample lines as appropriate.
- 6.6 Assemble the aerosol generator system, i.e., ensure adequate supply of aerosol-producing medium, attach inlet regulator and gauge, and affix aerosol release nozzle. Insert generator nozzle into air stream, upstream of HEPA filter, at a point as described above. For laboratory hood systems, it is often most expedient to release the challenge aerosol directly into the fume hood. In this case, position the generator so that the nozzle protrudes at least 6 inches into the hood and lower all hood face sashes to the level required to provide a minimum face velocity of 100 feet per minute.
- 6.7 Attach the compressed air supply line (from house air system or compressed gas cylinder) to the generator inlet regulator. Ensure that the generator regulator is open and deliver compressed air to the generator. The concentration of the challenge aerosol is a function of both the delivered air pressure and the volume of air exhausted through the ventilation system. For typical laboratory fume hood HEPA systems (e.g., air flows of about 1000-5000 ft³/min), the aerosol generator inlet regulator pressure should be adjusted to about 25 PSI. For significantly larger or smaller systems, the aerosol generator inlet pressure will need to be adjusted to provide at least a four order-of-magnitude difference between upstream (challenge) and downstream concentrations. Note that manufacturer’s specifications limit the maximum operating pressure for most generators to less than 100 PSI.
- 6.8 Inject aerosol into ventilation system until a stable measurement is obtained.
- 6.9 Measure upstream and downstream aerosol concentrations as follows:
 - a. Record static pressure drop across filter(s) if a gauge is present
 - b. Measure upstream aerosol concentration
 - c. Return to “clear” mode and re-zero instrument if necessary
 - d. Measure downstream aerosol concentration

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- e. Return to “clear” mode and re-zero instrument if necessary
- f. Repeat steps b - e until sequential upstream and downstream readings are within
- g. Record upstream and downstream concentrations.

6.10 Calculate particle removal efficiency of the filter as follows:

$$\text{Removal Efficiency (\%)} = \frac{C_u - C_d}{C_u} \times 100$$

Where: C_d = downstream aerosol concentration
 C_u = upstream aerosol concentration

- 6.11 Record data and findings on *HEPA Filter Test Report* form (see Attachment 9.2). Unless other specified in the SBMS Subject Area: *Exhaust Ventilation* or the equipment operating specifications, the acceptable HEPA filter removal efficiency results are $\geq 99.97\%$.
- 6.12 Affix results sticker at test location, fume hood face, or other appropriate location.
- 6.13 HEPA filter systems are to be tested at the frequency determined by the SBMS Subject Area *Exhaust Ventilation*, or as required by other facility-specific specifications.
- 6.14 Record-keeping: Provide a copy of the *HEPA Filter Test Report* to the ESH Coordinator, the RCD Facility Support Representative, and any other interested parties. Retain the original test report in accordance with the record keeping requirements of SHSD procedures.
- 6.15 If the unit has been used on a radiological exhaust system(s), at the end of sampling, have a Facility Support Representative survey the equipment for radiological contamination. Then cap the hose and cap the inlet to the meter for storage.

7.0 Implementation and training

- 7.1 *Level 1 Tester* has the highest level of competency in qualified employees. The

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qualification requirements for this position are defined in the *Implementation and Training* of SOP IH62200.

- 7.2 *Level 2 Assistant has a lower level of competency in this method. These employees serve a role as a fully supervised assistant in field-testing. This position often represents a temporary assignment of very short duration (1-3 days). There is no formal qualification requirement necessary for this position as they follow the directions of the Level 1 tester. The role in this SOP is limited to the actions requested and directed by the Level 1 tester.*

8.0 References

- 8.1 American National Standards Institute (ANSI) standard N510: *Testing of Nuclear Air Treatment Systems*.
- 8.2 BNL SHSD IH Group Procedure: IH62200 *HEPA Filter Surveillance Program*.
- 8.3 American Conference of Governmental Industrial Hygienists (ACGIH). *Industrial Ventilation: A Manual of Recommended Practice* (current edition).
- 8.4 SBMS Subject Area: *Exhaust Ventilation*

9.0 Attachments

- 9.1 *HEPA Filter System Test Results Sticker/Label*
- 9.2 *In-Place HEPA Filter Test Report*

10.0 Documentation

Document Development and Revision Control Tracking		
PREPARED BY: R. Wilson Author Date 5/21/96	REVIEWED BY: G. Adams Group Leader Date 5/31/96	APPROVED BY: M. O'Brien OHS Section Head Date 6/11/96
ESH Coordinator/ Date: <div style="text-align: center;"><i>none</i></div>	Work Coordinator/ Date: <div style="text-align: center;"><i>none</i></div>	SHSD Manager / Date <div style="text-align: center;"><i>none</i></div>

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E. Tucker DQAR Date 6/10/96	Training Coordinator / Date: <i>none</i>	Filing Code: IH52
Facility Support Rep. / Date: <i>none</i>	Environ. Compliance Rep. / Date: <i>none</i>	Effective Date: 06/15/96
ISM Review - Hazard Categorization <input type="checkbox"/> High <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Low/Skill of the craft	Validation: <input type="checkbox"/> Formal Walkthrough <input type="checkbox"/> Desk Top Review <input type="checkbox"/> SME Review Name / Date:	Implementation: Training Completed: Tracked in BTMS Procedure posted on Web: 06/01/07 Hard Copy files updated: 06/01/07 Document Control on forms: 06/01/07

Revision Log		
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Technical Review completed. Compared to ANSI N510-R1995). No modifications needed.		
Robert Selvey 05/09/00 (<i>signature on file</i>) SME Reviewer/Date:	Reviewer/Date:	Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Revised to SBMS format. Minor text changes made. Attachments 8.1, 8.2 and 8.3 deleted. Attachment 8.4 updated.		
Robert Selvey 07/07/00 (<i>signature on file</i>) SME Reviewer/Date:	SME Reviewer/Date:	SME Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Revised Sample Form (Attachment 2) to facilitate data entry into new Microsoft Access database. Removed 07/07/00 strikeout markings. Re-numbered Attachments.		
Robert Selvey 10/27/00 (<i>signature on file</i>) SME Reviewer/Date:	SME Reviewer/Date:	SME Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Revised Precautions section adding Hazard Assessment, PPE, and Waste.		
Robert Selvey 02/01/01 (<i>signature on file</i>) SME Reviewer/Date:	(<i>signature on file</i>) SME Reviewer/Date:	(<i>signature on file</i>) SME Reviewer/Date:

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Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Converted IH-FP-6.1 to new numbering system IH62300. Minor format changes.		
R. Selvey 03/08/01 (signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Revised format for Section 7 for <i>Implementation and Training</i> . Revised Environmental Impact analysis. Added precaution for RCD and System Owner notification and HP coverage.		
R. Selvey 02/23/04 (signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Additions to Section 5 Precautions and Step 6.17 - opening photometer contamination hazard.		
R. Selvey 07/09/04 (signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change: Moved Hazards from Section 4 to Section 5. Added Step 5.5 for JRA.		
R. Selvey 06/01/07 (signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:
Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input checked="" type="checkbox"/> none of the above Section/page and Description of change:		
(signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:	(signature on file) SME Reviewer/Date:

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ATTACHMENT 9.1

HEPA Filter System Test Results Sticker/Label

In-Place HEPA Filter test			
Date	Effic. (%)	Pass/Fail?	Technician
Report any problem to: Safety & Health Services Division ext. 3900			

Safety & Health Services Division
Industrial Hygiene Group

DATABASE RECORD ID#	SHSD UNIT ID#	
---------------------	---------------	--

DIVISION	BUILDING	ROOM/AREA
BLDG MANAGER	FS REP/TECH	OTHER CONTACT
SYSTEM DESCRIPTION		
SYSTEM TYPE <input type="checkbox"/> FIXED IN-PLACE <input type="checkbox"/> PORTABLE HANDLR	MANUFACTURER	FILTER NUMBER
SITE OF FILTER		

GENERATOR Nucon F1000-SN-10	GENERATOR SN 924SN1005392	AEROSOL Emery 3004
DETECTOR Nucon F1000-DDF	DETECTOR SN <input type="checkbox"/> 924DDF4592	<input type="checkbox"/> 822DDF106-97
DETECTOR CALIB. DATE	COMMENTS	

TECHNICIAN R.D. Wilson	SIGNATURE	TEST DATE
----------------------------------	-----------	-----------

Filter/Room Number	ΔP	Upstream Reading	Downstream Reading	Removal Efficiency ¹	Comments

¹Based upon formula:

$$\text{Removal Efficiency(\%)} = \frac{C_u - C_d}{C_u} \times 100$$

Where: C_d = downstream aerosol concentration
 C_u = upstream aerosol concentration

