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DOE-STD-3025-99
February 1999

Superseding
DOE NE F 3-43
February 1990

DOE STANDARD

QUALITY ASSURANCE INSPECTION AND TESTING OF HEPA FILTERS



U.S. Department of Energy
Washington, D.C. 20585

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FOREWORD

This Department of Energy standard supercedes DOE NE F 3-43 and is approved for use by all DOE components and their contractors.

This standard was developed primarily for application in U.S. Department of Energy programs. It contains specific direction for HEPA filter testing performed at DOE-accepted HEPA Filter Test Facilities (FTFs).

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may improve this document should be sent to the Office of Nuclear Safety Policy and Standards (EH-31), U.S. Department of Energy, Washington, D.C. 20585, by letter or by using the self-addressed Document Improvement Proposal form (DOE F 1300.3) appearing at the end of this document.

DOE technical standards, such as this standard, do not establish requirements. However, all or part of the provisions in a DOE standard can become requirements under the following circumstances:

- (1) they are explicitly stated to be requirements in a DOE requirements documents; or
- (2) the organization makes a commitment to meet a standard in a contract or in an implementation plan or program plan required by a DOE requirements document.

Throughout this standard, the word "shall" is used to denote actions that must be performed if the objectives of this standard are to be met. If the provisions in this standard are made requirements through one of the two ways discussed above, then the "shall" statements would become requirements. It is not appropriate to consider that "should" statements would automatically be converted to "shall" statements as this action would violate the consensus process used to approve this standard.

NOTICE

The "Preparing Activity" wishes to establish continuity between this standard (DOE-STD-3025-99) and its direct predecessor, entitled "DOE Filter Test Facilities Quality Program Plan (NE F 3-43)". The original standard was first issued by DOE as a Nuclear Energy (NE) standard on July 1986.

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1. SCOPE

This standard establishes essential elements for the quality assurance inspection and testing of HEPA filters by U.S. Department of Energy (DOE)-accepted Filter Test Facilities (FTF). The standard specifies HEPA filter quality assurance inspection and testing practices established in DOE-STD-3022-98, *DOE HEPA Filter Test Program*, and provides a basis for the preparation of written operating procedures for primary FTF functions.

1.1 Applications

This standard applies only to the operations conducted at DOE-accepted Filter Test Facilities.

1.2 Inclusions

This standard contains applicable protocols for inspecting and testing HEPA filters. It identifies currently approved test aerosols and test methods. Appendices to the standard provide specific procedures for acceptance of new test aerosols, and for calibration, test, and qualification of alternate test methods.

2. APPLICABLE DOCUMENTS

The following documents are a part of this standard to the extent specified herein. Unless otherwise stated, the current issue date and revision number of a referenced document shall apply, including addenda and/or amendments. In the event of a conflict between provisions of this standard and provisions of the referenced documents, the text of this standard shall take precedence. Appeals in this matter may be addressed to the DOE "Preparing Activity," which is designated as the DOE entity responsible for issue and interpretation of this standard.

2.1 Department of Energy Standards and Publications

DOE-STD-3020-97 - Specifications for HEPA Filters Used by DOE Contractors

DOE-STD-3022-98 - DOE HEPA Filter Test Program

DOE-STD-3026-99- Filter Test Facility Quality Program Plan (formerly DOE F NE 3-44)

ERDA 76-21 - Nuclear Air Cleaning Handbook

2.2 Department of Defense Military (MIL) Specifications

MIL-F-51079 - Filter, Medium, Fire Resistant, High Efficiency

2.3 National Consensus Standards

2.3.1 American Society of Mechanical Engineers (ASME)

ASME AG-1 Code, section FC - HEPA Filters

ASME 510-1980 - Testing of Nuclear Air-Cleaning Systems

2.3.2 Institute of Environmental Sciences, Mt. Prospect, Illinois

IES-RP-CC-001.3 - Recommended Practices for HEPA Filters

2.3.3 Underwriter Laboratories

UL 586 - Standard for High Efficiency, Particulate, Air Filter Units

3. DEFINITIONS

3.1 Acceptance Test

Inspection and testing of a nuclear grade filter to verify certain characteristics or properties which determine acceptance or rejection of that filter.

3.2 Airflow Resistance

An index of the energy required to maintain airflow through a filter. Airflow resistance is measured in terms of the air pressure difference (pressure drop) across a filter at a specified flow rate (e.g. see section 5.2.2, Table-1, Standard DOE-STD-3020-97).

Note: The initial airflow resistance of a new filter serves as an index of the filter's potential loading capacity.

3.3 Count Geometric Mean Diameter (dg)

$$\ln d_g = \frac{\sum n_i \ln d_i}{N}$$

where n_i = the number of particles in the i^{th} size category,

d_i = diameter of particles in the i^{th} size category, and

$N = \sum n_i$ = the total number of particles.

3.4 Geometric Standard Deviation (σ_g)

$$\ln \sigma_g = \left[\frac{\sum n_i (\ln d_i - \ln d_g)^2}{N - 1} \right]^{1/2}$$

3.5 Di-Octyl Phthalate (DOP)

Also known as di-ethylhexyl phthalate or DEHP. For purposes of this standard, an aerosol of di-octyl phthalate droplets in clean filtered air.

3.6 Di-Octyl Sebacate (DOS)

Also known as di-ethylhexyl sebacate or DEHS. For purposes of this standard an aerosol of di-octyl sebacate droplets in clean filtered air¹.

3.7 Filter Test Facility (FTF)

A facility accepted by the DOE specifically to conduct quality assurance inspections and tests of HEPA filters.

3.8 High Efficiency Particulate Air (HEPA) Filter

A throwaway, extended-media, dry type filter with a rigid casing enclosing the full depths of the pleats. Aerosol collection efficiency of the filter shall be at least 99.97% for 0.3 micrometer diameter particles. The maximum airflow resistance shall be as specified in Section 5.2.2, Table 1 of DOE-STD-3020-97.

3.9 High-Flow Alternative Test System

A method of testing HEPA filters rated at greater than 250 cubic feet per minute (cfm) that consists of a laser aerosol spectrometer, a microcomputer, an aerosol diluter and a Laskin nozzle system to generate test aerosol. Penetration is determined at discrete aerosol particle sizes in the range where maximum penetration occurs.

¹ Dennis, Richard, editor, "Handbook on Aerosols," US DOE/ERDA TID 26608, p. 111, 1976.

3.10 Low-Flow Alternative Test System

A test method to evaluate penetration characteristics of HEPA filters with design air flow rates of 250 cfm or less. The measurement technique is the same as that for the High-Flow Alternative Test System.

3.11 Nuclear Facility

Nuclear Facility - Nuclear facility means reactor and nonreactor nuclear facilities. This definition is taken from 10 CFR 830, Nuclear Safety Management, Section 830.3, Definitions. "Nonreactor nuclear facility" as well as "reactor" are defined in detail in this section of the Code of Federal Regulations.

3.12 Nominal Airflow Rating

The flow rate at which HEPA filters are identified by the manufacturer and confirmed by the FTF. Nominal airflow ratings for various size filters are listed in DOE-STD-3020-97 (Section 5.2.2, Table 1).

3.13 Operating Technician

An individual who has been trained and qualified in accordance with Section 9 of this standard to inspect and test HEPA filters.

3.14 Particle Collection Efficiency

For FTF activities, the measure of filter effectiveness, expressed as a percent, determined from the equation:

$$E = 100 - P$$

where P = percent penetration

3.15 Penetration

The downstream test aerosol concentration, expressed as a percentage of the upstream test aerosol concentration.

3.16 Penetrometer

A machine for determining test aerosol penetration and airflow resistance of HEPA filters which incorporates an approved aerosol and aerosol generator, a penetration meter, manometers for measuring resistance to airflow, a flow meter for determining test airflow, and a chuck assembly for encapsulating and holding the filter under test.

3.17 Preparing Activity

The DOE organization responsible for issue and interpretation of this standard.

3.18 Standard Orifice Plate

A secondary standard for measuring airflow through the Penetrometer. Orifice plates shall be calibrated using a National Institute of Standards Technology (NIST) traceable standard as a primary standard.

3.19 Test Aerosol

The aerosol produced from a substance approved by DOE for testing HEPA filters.

4. GENERAL PROVISIONS

Each HEPA filter procured for installation in a DOE nuclear facility shall be submitted for testing at a Filter Test Facility (FTF). The tests are performed in accordance with section 5 of this standard, the customer's written specifications or procurement documents, and any special written instructions from the customer. Unless otherwise instructed, FTF tests and inspections shall include:

- Visual inspection for compliance with purchase order, e.g., type, size, quantity received, shipping damage, and Qualification Certification.
- Visual inspection for manufacturing defects and compliance with construction and materials requirements.
- Penetration at 100% (all filters) and penetration at 20% (size 3 and higher) of nominal airflow rating.
- Airflow resistance at 100% of test airflow.

- Verification that the filter make and model is approved by DOE.

Maximum penetration allowed is 0.03% (0.0003) at an aerosol particle diameter of 0.3 micrometers. If a higher penetration is measured, the filter shall be rejected and the customer notified that the filter does not meet the penetration requirement. When tested with a DOE-approved laser spectrometer test method, the maximum penetration and the aerosol particle size of maximum penetration shall be reported in addition to the penetration at 0.3 micrometers diameter. However, penetration at 0.3 micrometers diameter shall be the only criterion used to judge whether a filter is rejected for excess penetration.

Maximum airflow resistance (see Section 5.2.2, Table 1 of DOE-STD-3020-97) is 1.0 inches of water gage (in. H₂O) (250 Pa) across the filter pack for size 4 (nominal 500 cfm) through size 6 (nominal 1250 cfm) filters, and 1.3 in.H₂O (325 Pa) for filters size 1 (nominal 25 cfm) through size 3 (nominal 125 cfm) and filters size 7 (nominal 1500 cfm) and size 8 (nominal 2000 cfm). The resistance shall be reported to the nearest 0.1 in. H₂O (25 Pa). There shall be no waivers from penetration or resistance requirements, nor shall defects in the filter media be repaired at the FTF. It is the responsibility of the purchaser and the manufacturer to determine proper disposition of non-conforming filters.

5. PROCEDURES

All FTF operations shall be conducted in accordance with written procedures that address the subjects and inform to this standard. All procedures shall contain specific acceptance criteria. Each FTF shall prepare, maintain, and operate in accordance with detailed procedures which cover, as a minimum, the following functions:

- Receiving inspection.
- Un-boxing, handling, re-boxing, and storage of filters.
- Inspection for defects, damage, and compliance with purchase order specifications.
- Verification of compliance with qualifications test requirements, e.g., over-pressure resistance, fire and heated air test, and resistance to rough handling (QPL listing).
- Documentation and records keeping.

- Operating and calibration procedures for each penetration and resistance test device.
- Test and inspection reports, including disposition and retention.
- Labeling of accepted and rejected filters.
- Segregation and disposition of rejected filters.
- Shipping of accepted filters.
- Preparation of semiannual reports to DOE.
- Training and qualification of personnel.
- Surveys or precautions taken for protection of health, safety, and the environment.

6. RECEIPT OF FILTERS

6.1 Receiving Inspection

All filter packages shall be inspected upon receipt at the FTF. Damaged cartons or cartons improperly oriented shall be opened immediately and the filters inspected. A description of observed damage shall be recorded in the filter inspection and test report.

6.2 Initial Handling and Storage

Filter handlers shall be properly trained to handle filter boxes carefully. Cartons shall be oriented with arrows on the filter cartons pointed "up". Filter cartons shall be stacked not more than three (3) high, and stored in a clean, dry location. Unless otherwise required, storage facilities for HEPA filters shall be equipped with temperature and humidity controls.

6.3 Pre-Test Filter Damage Inspection

Prior to testing, each filter shall be visually examined for possible damage, compliance with purchaser's specifications, and workmanship. Damage to filters noted during the pre-test inspection shall be recorded on the filter inspection and test report. Filters obviously damaged shall not be further tested, but shall be immediately rejected.

The damage inspection shall, as a minimum, include: verification of general workmanship, filter type, size, gasket installation and material, separators, frame dimension, squareness, face guards, and required labels or markings. Filters shall be inspected for looseness of filter packs, excessive slump or distortion, loose gaskets, breaks or tears, or patching of the filter medium.

7. PENETRATION AND RESISTANCE TESTING

7.1 Testing Requirements and Test Methods

Following visual inspection, each filter, completely encapsulated in the test apparatus, shall be tested for penetration at 100% of the nominal air flow rating, and filters rated at 125 cfm (0.059 m³/s) or greater shall also be tested at 20% of the nominal airflow rating. Each filter shall be tested for resistance to airflow at 100% of the nominal airflow rating. Test air flow rates shall be measured in actual cubic feet per minute (acfm), not standard cubic feet per minute. The filter test apparatus shall be equipped with "chucks" which encapsulate the HEPA filter in the test position. Self contained (nipple ended) filters shall not be routinely tested for resistance to airflow. Operating and test procedures shall be prepared for each test device and shall include, as a minimum, the following elements:

- Filling the generator reservoir and verification of fluid level.
- Daily verification of airflow rates using NIST traceable orifice plates. Flow rates shall be adjusted to within $\pm 2\%$ of the orifice plate calibration value.
- Adjustment and verification of critical airflows (and temperatures for thermal test method only).
- Calibration of filter test equipment which determines particle size, penetration, and resistance. Calibration of instruments which are used to calibrate the filter test equipment.
- Calibration schedules.
- Design and use of adapters to permit tests of non-standard filters or special test procedures.
- Operating and calibration procedures.
- Operation, service, and maintenance of test equipment, including the system exhaust air cleaning device.

For penetration and resistance testing, two Penetrometer systems have long been authorized. Both Penetrometer systems operate using "hot" aerosol. They are:

- The Q-107 for testing filters with rated airflows of 250 cfm (0.12 m³/s) and above.
- The Q-76 for testing filters with rated airflows below 250 cfm (0.12 m³/s).

Currently, a laser spectrometer analyzer system, the High Flow Alternative Test System (HFATS), operating with "cold" aerosol, is the method of choice for testing filters with rated airflows of >250 cfm. It is used in conjunction with the Q-107 system. Provisions for qualifying new test methods appear in Appendix 1 to this standard.

7.2 Test Aerosols

Test aerosol materials, currently approved by DOE for FTF testing are Di-octyl Phthalate (DOP) and Di-octyl Sebacate (DOS). Provisions for qualifying new test aerosols appear in Appendix 2 to this standard.

8. INSPECTION AND TEST REPORTS, AND LABELING

8.1 Inspection and Test Report for HEPA Filters

A report or data sheet (see Appendix 3) shall be prepared for each customer order. The report shall include as a minimum:

- Identification of the FTF.
- Name of customer.
- Customer order number(s).
- Date of shipment receipt at FTF.
- Date of inspection and test.
- Customer's specification or standard (if applicable).
- Filter manufacturer.

- Filter description (model or designation number).
- Nominal airflow rating.
- Test flow air temperature.
- Ambient relative humidity in room at time of test.
- Barometric pressure at time of test.
- Name of operating technician and supervisor responsible for test.
- Serial number of each filter tested.
- Resistance (in. wg or Pa) across filter pack at nominal airflow rating.
- Penetration at nominal airflow rating.
- Penetration at 20% of rated airflow [filters 125 cfm (0.059m³/s) and above].
- Remarks: Reason for rejection.

P = penetration

R = resistance

O = other: describe briefly

When tests are conducted with the HFATS, the maximum penetration and the aerosol particle size of maximum penetration shall be reported in addition to the penetration at 0.3 micrometers diameter. However, penetration at 0.3 micrometers diameter shall be the only criterion used to judge whether a filter is rejected for excess penetration.

Penetration results shall be reported to the nearest .01%. the maximum penetration and the aerosol particle size of maximum penetration shall be reported in addition to the penetration at 0.3 micrometers diameter. However, penetration at 0.3 micrometers diameter shall be the only criterion used to judge whether a filter is rejected for excess penetration. For example, a reading of 0.023% shall be reported as 0.02%; a reading of 0.026% shall be reported as 0.03%.

8.2 Inspection and Test Report for Respirator Canisters

When respirator canisters are tested at FTFs, a data report shall be prepared for each customer order or shipment which shall include the following as a minimum:

- Name of customer.
- Customer order number.
- Date of receipt.
- Date of inspection and test.
- Customer's specification.
- Manufacturer's name and designation.
- Number of respirator canisters in shipment.
- Number of canisters accepted.
- Number of canisters rejected.
- Remarks.
- Authorized signature.

8.3 Labeling

8.3.1 Accepted Filters. Each accepted HEPA filter shall be identified with a permanent "Accepted" label (yellow). A suggested "Accepted" label design is shown in Appendix 4, and includes the following:

- Identification of FTF.
- Penetration at nominal airflow rating.
- Resistance at nominal airflow rating.

- Penetration at 20% of nominal airflow rating [filters 125 cfm (0.059m³/s) and larger].

- 8.3.2 Rejected Filters. Each rejected HEPA filter shall be identified with a permanent "Rejected" label (red). A suggested "Rejected" label design is shown in Appendix 4.
- 8.3.3 Accepted Respirator Canisters. As a minimum, accepted respirator canisters shall be dated. The date shall be applied with a marking pen or by means of a label.
- 8.3.4 Rejected Respirator Canisters. Rejected canisters shall be marked, or physically deformed and segregated to prevent commingling with accepted canisters.

9. PERSONNEL

All personnel who inspect, test, supervise, or interpret the results of inspections and tests of HEPA filters at the FTFs shall be qualified in accordance with section 9.1 of this standard. Non-FTF personnel who handle HEPA filters or canisters, including shipping, receiving, and materials-handling personnel shall, as a minimum, be instructed in the requirements for proper handling, stacking, and storage of HEPA filters. Precautions and recommendations to be observed in the handling and storage of HEPA filters are given in section 9.1.1 of this standard and in Appendix C of the "Nuclear Air Cleaning Handbook" (ERDA 76-21).

9.1 Qualification

The FTF operating contractor shall ensure that personnel selected to conduct, supervise, or interpret the results of FTF inspections and tests are qualified by experience, formal training or instruction, and are physically capable of carrying out the functions for which they are responsible.

- 9.1.1 Materials Handling. Personnel assigned to handle the HEPA filters shall be instructed in the proper procedures for:

- Handling, stacking, storing, un-boxing, re-boxing, crating, and placing filters on pallets.
- Operation of appropriate materials handling equipment, such as fork-lift industrial trucks, hoists, or conveyers.

- Verifying compliance with qualification requirements by review of records.
- Inspection for shipping damage at time of receipt.
- Preparing of filters for shipping, including the proper loading in transport vehicles.

9.1.2 Inspection and Testing. Personnel responsible for inspection and testing of HEPA filters, for the supervision of inspection and testing, or for the interpretation of inspection and test results shall have had formal training and demonstrated performance or comprehension in the following:

- All applicable provisions of this standard.
- Applicable specifications for HEPA Filters used at DOE nuclear facilities.
- Materials, construction and performance specifications of HEPA filters.
- Use and interpretation of filter specifications and customer purchase criteria, with particular attention to ASME AG-1 Code, Section FC (formerly Military Specifications MIL-F-51068), MIL-F-51079, and Institute of Environmental Sciences publication IES-RP-CC-001.3.
- Performance specifications for test devices and other instruments used at the FTF.
- Procedures for handling, inspection, testing data, recording, labeling, and disposition of accepted and rejected filters.
- Proficiency in the operation, adjustment, and maintenance FTF instruments and equipment.

9.1.3 Certification of Test Results. Personnel responsible for interpretation or certification of inspection and test results shall, in addition to the requirements of section 9.1.2 of this standard, have demonstrated proficiency in the following:

- Data evaluation and analysis, including validation of test results.

- Interpretation of applicable standards, specifications, and customer purchase-order requirements relative to the acceptability of filters.
- Determination of the appropriate rejection status when compliance with all specified requirements cannot be demonstrated.
- Preparation and issuance of appropriate documentation of inspection and test results.
- Assessment of manufacturer's materials of construction and certifications, and compliance of filters to such certifications.
- Personnel in this category have the authority to sign data forms and reports attesting to the accuracy and completeness of the reported data or results.

9.2 Physical Qualifications

Personnel responsible for supervision of inspection and testing activities or for interpretation of inspection and test results shall meet appropriate physical qualifications as evidenced by satisfactory completion of physical examination. The physical examination shall be performed by a qualified industrial physician, and shall include the following:

- Visual acuity, including near vision, depth perception, and color discrimination.
- Physical capability for performing job related tasks.
- Hearing acuity.

9.3 Training

Personnel responsible for HEPA filter inspection and testing, for supervision of inspection and testing, or for interpretation of inspection and test results, shall satisfactorily complete a formal training course. This course shall address the principles of HEPA filter testing. The course shall be equivalent to the Harvard University School of Public Health In-Place Filter Testing Workshop. New hires shall receive on-the-job training and instruction by qualified personnel to become completely familiar with the equipment, instrumentation, and procedures. FTF management is responsible for

establishing ongoing personnel maintenance and re-certification programs that assure personnel remain qualified to carry-out required FTF activities.

9.4 Documentation

Physical and technical qualifications of personnel responsible for inspection and testing, supervision of inspection and testing, and interpretation of inspection and test results, shall be documented. Documentation shall include written evidence of the dates and extent of instruction and formal training, and shall be signed by a responsible supervisor. The supervisor's signature will certify satisfactory demonstration of the individual's ability to perform all job functions.

9.4.1 Retention of Records. Personnel records shall be retained for the duration of the individual's assignment to the FTF, and shall be subject to audit and re-certification by demonstration as specified by facility procedures. Re-certification will be required at intervals to be defined in facility operating procedures

10. SEMIANNUAL REPORT

At the end of each fiscal year (September 30) and half fiscal year (March 31), each FTF shall prepare a report describing test activities for the previous 6-month period, including a tabulation of test data as described below. Copies shall be sent only to the Technical Support Contractor and to DOE. Further distribution of HEPA filter test data shall be at the discretion of DOE.

10.1 Report Content

The content of the semiannual report shall meet the requirements specified in section 10.2 of this standard. Narrative information, including explanations of trends or problems observed during the report period, shall be provided.

10.2 Data Summary

A summary of HEPA filter test data during the report period shall be presented in table form. As a minimum the tabulation shall provide the following data for each HEPA filter tested:

- Name of purchaser and manufacturer.
- Nominal airflow rating in cfm.

- Number of each size received and tested.
- Number of filters accepted.
- Number of filters rejected.
- Reason for rejection [penetration, resistance, other (explain)].
- A sample form for the semiannual report appears in Appendix 5.

11. ACCURACY AND CONSISTENCY OF FTF MEASUREMENTS

Consolidation of DOE filter testing at one FTF makes it necessary that a new metric be developed for measuring accuracy and consistency of FTF measurements. A new method is being developed in coordination with DOE, the FTF, and the Technical Support Group. The modified procedure will be incorporated in this standard through a Change Notice.

APPENDIX 1- QUALIFICATION OF NEW TEST METHODS AND EQUIPMENT

1.1 SPECIFICATIONS

Only test equipment and measurement techniques approved by the DOE shall be used for quality assurance testing of HEPA filters at the FTFs. DOE approval shall be contingent on satisfactory completion of the following specifications.

1.2 PARTICLE SIZE

1.2.1 Particle Size Range

The new instrument and/or test technique shall be capable of determining aerosol penetration in the particle diameter ranged from 0.1 micrometers to greater than 0.3 micrometers in discrete measurable particle size ranges no larger than 0.05 μm . Particle size measurements shall have a precision and accuracy of $\pm 10\%$.

1.3 RESISTANCE

1.3.1 Measurement Capability

The new instrument and/or test technique shall be capable of measuring airflow resistance within an accuracy and precision of $\pm 5\%$ of a filter under test at its nominal airflow rating.

1.3.2 Calibration

Pressure and temperature measuring instruments, orifice plates, mass-flow meters and other instruments critical to performance of the proposed test technique shall be calibrated by the use of standards traceable to recognizable NIST standards.

1.4 PENETRATION

1.4.1 Penetration Measurement

The test method shall be capable of determining penetration up to 0.03% $\pm 0.005\%$ in the particle diameter range from 0.1 μm to 0.2 μm . Aerosol dilution will be permitted only after demonstration that the overall test efficiency and reliability have not been adversely affected, nor have the dilution techniques adversely affected particle size or concentration.

1.4.2 Generator Capacity

The generator shall produce an aerosol quantity sufficient for reliable determination of minimum filter penetration of 0.005%.

1.4.3 Test Aerosol Concentrations

Test aerosol concentrations shall meet the requirements of Appendix 2.4.1.

1.4.4 Test Flow Rates

The measurement and testing techniques shall be capable of testing HEPA filters at nominal airflow rating

1.5 OTHER FACTORS

1.5.1 Maintainability and Operability

The test equipment shall be readily operable by trained technicians. Components that require repair or realignment by skilled personnel should be of a modular design such that they can be replaced by the trained technician.

1.5.2 Aerosol Sampling

Upstream and downstream concentrations measured by the new test equipment shall be demonstrated to be representative of the respective total concentrations within $\pm 5\%$. Establishment of representativeness can be achieved by multiple sampling (across the area of the downstream face of a filter and across the cross-section of the chuck, upstream of the filter under test), using an averaging procedure described in ANSI N510-1980 or by using an alternate procedure approved by the DOE.

1.6 APPROVAL OF PENETROMETER AND TEST PROCEDURES

1.6.1 Notice of Intent

Organizations desiring to receive DOE approval of a penetrometer or test procedure for quality assurance testing of HEPA filters shall notify the DOE FTF Coordinator in writing and shall provide preliminary data which demonstrates how the specifications

of A5.5 will be met and provides plans for further tests and analyses that are deemed necessary.

1.6.2 Approval

1. The application for DOE approval will be sent to the Technical Review Committee for review and comment. Consensus (majority) approval by the Technical Review Committee will be solicited.
2. Following resolution of comments from the Technical Review Committee, the DOE "Preparing Activity" will be petitioned for approval of the penetrometer or test procedure.

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APPENDIX 2 - TEST AEROSOL CERTIFICATION

2.1 SPECIFICATIONS

Substances used as test aerosols for quality assurance testing at FTFs shall be DOE approved (see 2.5.).

2.2 HEALTH AND SAFETY

2.2.1 Toxicity

Studies shall be performed or validated to show that use of test aerosols present no unacceptable occupational risk when used to perform the tests specified herein. The studies must consider the expected exposure pathways (skin absorption, inhalation) and the fate of the inhaled material in terms of material transfer, residence times, critical organs, and results.

Toxicity assessments should consider quantities and concentrations of materials and exposure pathways which approximate realistic occupational or accidental exposure.

2.2.1.1 Engineering Design as Alternative to Toxicity Testing. When toxicity testing has not been performed, or toxicity test results are inconclusive, candidate test aerosols can be used in FTFs if compliance with the following requirements has been demonstrated.

- Engineering design and construction is adequate to prevent test aerosols from contaminating breathing air in the FTF (aerosol confinement).
- Engineering design and construction of exhaust air handling systems is adequate to minimize quantities of test aerosols released to the surrounding environment.
- Applicable exposure limits (concentration guidelines) are established as maximum concentrations for breathing air within the FTFs and for exhaust air from exhaust stacks.
- Air sampling or monitoring programs are adequate to determine compliance with the above exposure limits.

2.2.2 Fire and Explosion Safety

Proposed test substances including their aerosol forms shall be analyzed and/or tested to determine that their use under normal testing conditions will present no unacceptable risks due to fire or explosion.

2.3 HAZARDOUS, TOXIC AND MIXED WASTE MANAGEMENT

HEPA filter test aerosols shall be selected to avoid generation of EPA regulated wastes by contamination of filters during test activities. Substances known to result in generation of Hazardous Wastes regulated by the Resources Conservation and Recovery Act (RCRA), or Toxic Wastes regulated by the Toxic Substances Control Act (TSCA), shall not be acceptable candidates for HEPA filter test aerosols.

2.4 TEST AEROSOL CHARACTERISTICS

2.4.1 Mandatory Requirements

The test agent shall produce an aerosol with the following characteristics as measured by an approved Penetrometer:

The aerosol shall have a size distribution and concentration sufficient to permit precise (see A5.4.1) penetration determinations in the size range from 0.1 μm to $>0.3 \mu\text{m}$ using an approved aerosol measurement device. The aerosol shall be composed of spherical particles.

The aerosol material shall have a density less than 2 g/cm^3 .

2.5 APPROVAL OF TEST AEROSOLS

2.5.1 Notice of Intent

1. Persons or organizations desiring to qualify a new test aerosol for DOE HEPA filter test activities shall first notify the DOE FTF Coordinator or the Technical Support Group. If requested, the FTF Coordinator will assist in preparing the required petition for submittal to DOE.
2. The petition shall include preliminary data to demonstrate compliance with subparts 2.2, 2.3 and 2.4. Preliminary evidence of compliance may be demonstrated by literature review, Material Safety Data Sheets (MSDS), test and



analysis, or discussion of further analysis and testing which the petitioner feels is necessary.

2.5.2 Approval of Proposed Test Aerosols


1. The petition for DOE approval will be sent through the DOE FTF Coordinator to the Technical Review Committee for review, comment and recommendation. The committee consists of persons representing government, universities and industry. Consensus (majority) approval by the Technical Review Committee will be solicited.
2. Application for final DOE approval shall be accompanied by all supporting test data and evaluations conducted for that test aerosol.
3. Resolution of comments and receipt of consensus agreement from the Technical Review Committee is necessary for DOE approval.
4. Following resolution of comments from the Technical Review Committee, the DOE "Preparing Activity" will be petitioned for approval of the proposed test aerosol.

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APPENDIX 4 - LABELS

	DOE HEPA FILTER TEST FACILITY EAST TENNESSEE TECHNOLOGY PARK OAK RIDGE, TENNESSEE 37831		
FILTER TEST RESULTS			
Resistance (in wg.)	Penetration at 100% Flow	Penetration at 20% Flow	Date of Test

BJCF-236 (10-08)



DATE

P.O. NO.

PURCHASER

FILTER TEST RESULTS

FILTER SER. NO.	FINDINGS*	RESISTANCE IN W.G.	PENETRATION, %	
			100% FLOW	20% FLOW

REJECTION CODES:
 CD - CARRIER DAMAGE
 F - FRAME

FG - FACE GUARDS
 FF - FILTER PACK
 G - GASKET

M - MEDIUM
 P - PENETRATION
 R - RESISTANCE

BUCF-240
 (10-98)

FRONT



BECHTEL JACOBS COMPANY LLC
 OAK RIDGE FILTER TEST FACILITY
 EAST TENNESSEE TECHNOLOGY PARK
 OAK RIDGE, TENNESSEE

BUCF-240 BACK

INSPECTOR

BACK

APPENDIX 5 - SEMIANNUAL REPORT

This Appendix shows a suggested report format that includes the required tabular data that will simplify extracting data for analysis. Other aspects of the semiannual report, including any narrative, may be provided at the discretion of the individual FTF.

HEPA Filter Data Summary

Customer or Purchaser (a)	Manufacturer and Model	Rated Capacity (cfm)	Number Received	Number Initially Accepted	Number Rejected (b)

a. Place "D" after name if it is a DOE contractor that is not billed for service

b. Symbols for Rejections:

P excessive penetration

R excessive resistance

L label

M media damage

G loose or damaged gasket

CD carrier damage

NS noncompliance with specification

F damaged frame

LP loose package or sagging media

OT other

CONCLUDING MATERIAL

Review Activity:

DOE

DP-21/23/25/31/33

EH-11/30/63

EM-23

NE-44

ER-8.1

Field Offices

AL

CH

ID

NV

OR

SR

RF

Preparing Activity:

DOE-DP-45

Project Number:

4460-0003

National Laboratories

INEL

Area Offices

Amarillo Area Office

Kirtland Area Office