



ENGINEERING STANDARD

HEPA FILTER REQUIREMENTS

STANDARD NO: 15888

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DATE: 4/15/04

REVISION: 4

ESB TECH COMMITTEE: VENTILATION AND FILTRATION
TECHNICAL COMMITTEE

Approved by: T. M. Monahon, Signature on File

Chairman, Engineering Standards Board

REVISION HISTORY

REV	DATE	DESCRIPTION OF REVISION
0	11/10/99	Initial Issue
1	6/19/00	Added clarification of HEPA filters covered by this standard in 1.1 & 1.2 Added section 5.8
2	11/14/01	Added a maximum total life of 5 years for filters that perform a safety function and have the potential to become wet (5.7) . Added section 5.1.3 & 5.1.4
3	3/26/03	Added "General Section" 5.1; added sections 5.4.2, 5.4.3, & 5.6.4; added references 6.7 & 6.8 and edited section 5.3.
4	4/15/04	Removed "asbestos" service requirements from the standard (Section 1.1). Added 5.1.3. Made editorial changes.

1.0 PURPOSE & SCOPE

- 1.1 This standard provides requirements for High Efficiency Particulate Air (HEPA) filters used at SRS in radioactive/radioactive hazardous material service with a glass-fiber media, rated for a flow capacity of 20 cfm and greater at maximum of 1.3 inch water column differential pressure.
- 1.2 For HEPA filters with a glass fiber media rated for a flow capacity of less than 20 cfm at maximum of 1.3 inch water column differential pressure, the requirements include the total life, shelf life and operating life requirements of this standard only.

2.0 DOE ORDER AND STANDARDS APPLICABILITY

- 2.1 DOE STD 3020-97 "Specification for HEPA filters used by DOE Contractors" (Information only)

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3.0 NATIONAL CODES AND STANDARDS APPLICABILITY

- 3.1 ASME AG-1 Code, Section FC, HEPA Filters
- 3.2 ASME N509 Nuclear Power Plant Air Cleaning Units and Components
- 3.3 ASME N510 Testing of Nuclear Air Treatment Systems
- 3.4 Applicable National Codes and Standards are also specified in the SRS Specification M-SPP-G-00243 *"High Efficiency Particulate Air (HEPA) Filters, Fire Resistant"*
- 3.5 National Codes and Standards incorporated by reference in this document shall be the revision number and date at the time this document is invoked in the Design Output Documents, or as otherwise noted.

4.0 DEFINITIONS

- 4.1 In-Service Life – The time from when a HEPA filter is placed in service until it is removed from service. In-service life shall include when a filter is placed in the filter housing even if placed in standby service.
- 4.2 Shelf Life – The time from when the HEPA filter is manufactured (filter is stamped with date) until it is placed into service.
- 4.3 Safety Calculation – Calculations used in a Safety Analysis
- 4.4 Testable System – A system designed where a leak test can be performed after the filter is installed
- 4.5 Total Life – The total allowable life of a HEPA filter used at SRS. The total life includes the shelf life plus the in-service life.

5.0 REQUIREMENTS

5.1 General

- 5.1.1 HEPA filters shall not be installed in a system where design flows exceed the normal rated capacity of the filter as established in ASME-AG-1, unless safety calculations document a larger airflow or where approved by the Design Authority for systems where safety calculations are not required.
- 5.1.2 For new or replacement filters, separatorless type filters are preferred for use at SRS unless specified otherwise by the design authority.
- 5.1.3 For new facilities, enclosed (encapsulated, nipple-connected, closed-faced, self-contained) HEPA filters shall not be used. They are not currently recognized by applicable code (AG-1) and have inherent problems with both acceptance and in-place leak testing of the filter assembly.

5.2 Specification

- 5.2.1 HEPA filters covered in section 1.1 shall be purchased using SRS Specification M-SPP-G-00243 *"High Efficiency Particulate Air (HEPA) Filters, Fire Resistant"*, which is controlled by the Ventilation and Filtration Technical Committee with a review cycle of every two years.

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5.2.2 Where Specification M-SPP-G-00243 is incorporated by reference in this document it refers to the latest revision in Document Control.

5.2.3 For projects or modifications where new HEPA filter housings are required the HEPA filters shall not be purchased with the housings. To better maximize filter service life, comply with the filter storage level requirements, and monitor filter shelf life, HEPA filters are to be provided from Stores or by direct purchase to support system start-up and testing.

5.3 Testing

5.3.1 Testing to be performed by the vendor or by offsite facilities are specified in Specification M-SPP-G-00243.

5.3.2 Leak Testing at SRS

5.3.2.1 In-place leak testing of HEPA filter installation shall be done in accordance with Manual 2Y1 "HEPA Filter Testing Procedures", Procedure 104 "General Surveillance Testing of HEPA Filters".

5.3.2.2 Prior to acceptance for operation of a new testable HEPA filter installation, in-place aerosol leak testing of the HEPA filter system shall be made to ensure leak-tightness of construction and acceptability of the components furnished.

5.3.2.3 Testable HEPA filter installations shall be leak tested after each filter change, before the filter is declared operable, to verify components function per design.

5.3.2.4 In-place leak testing shall be performed at scheduled intervals for installed testable HEPA filter systems to detect deterioration of filters, gaskets or other causes that could result in leaks. Testing shall also be done in a manner that will detect airflow that may bypass the HEPA filters. The schedule for these tests is normally provided in the facility Operational Safety Requirements (OSR) documents or the Technical Safety Requirements (TSR) documents. For testable filters not listed in either document, the time period shall be a maximum 18 months unless specified differently by the design authority.

5.3.3 Leak Testing and Filter Efficiency Testing

It is important not to use leak test results for efficiency ratings of the HEPA filters. Leak testing at SRS uses 0.7 micron particles in field conditions and provides leak tests results for the HEPA filter system, while efficiency tests of HEPA filters use 0.3 micron particles in laboratory conditions and provide efficiency results for the HEPA filter.

5.4 Storage, Handling, and Receipt Inspection

5.4.1 Storage, handling and receipt inspection shall be performed in accordance with Specification M-SPP-G-00243.

5.4.2 HEPA filters shall not be stored in temperatures that exceed 120 degrees F.

5.4.3 Temporary Storage/Staging Areas

For rules that apply to the temporary storage/staging of HEPA filters see Manual 3B, Procedure 4-1, Attachment I.

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5.5 HEPA Filter Inspection Prior to Installation

- 5.5.1 Remove filter unit carefully from its carton following handling guidance provided in Specification M-SPP-G-00243.
- 5.5.2 Examine front and rear faces for any punctures, tears, or holes in the filter media. A strong light behind the filter aids in examining its opposite face. Observe each pleated ridge; breaks or cracks are most frequent here. Look for sagging pleats and separators.
- 5.5.3 Do not try to repair damaged filter media. If breaks, cracks, sagging pleats or separators are found, discard the HEPA filter.
- 5.5.4 Inspect the seal around the face of the pack to verify that it is complete and unbroken. Inspect gasket or fluid seal for damage.
- 5.5.4.1 If the seal is not complete, the seal is broken, or damaged, then repair gaskets using vendor's directions. Only qualified site personnel can repair fluid seals, contact the Manager of the Filter Test Group for assistance.

5.6 Installation

- 5.6.1 When HEPA filters are installed in systems where the air flow through the filter is horizontal, always install filters with the pleats vertical. Installation of filters with pleats horizontal may cause the media to sag and the sealant to break away at the frame.
- 5.6.2 Install filter with the arrow pointing in the direction of the airflow unless specified otherwise by the Design Authority.
- 5.6.3 Filters shall be handled with care and not forced into position.
- 5.6.4 Filter clamping or locking mechanisms should be inspected for damage before the filter is installed. Vendors recommended operation of these devices should be followed during installation of the filters.

5.7 Filter Life

- 5.7.1 Total Life - The maximum allowable life (shelf life + in-service life) of a HEPA filter used at SRS shall not exceed 10 years.
- 5.7.2 Shelf Life - The shelf life for a HEPA filter used at SRS shall be no greater than 3 years unless specified otherwise by the filter manufacturer.
- 5.7.3 In Service Life – An in-service life shall be established for each HEPA filter. The in-service life of a HEPA filter can be influenced by many factors as outlined in Figure 7.1 and HEPA filter wetting below. Figure 7.1 should be used in establishing the in-service life of HEPA filters and in determining when a filter requires replacement.

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5.8 HEPA Filter Wetting

- 5.8.1 HEPA filters are not designed to operate under any amount of wetting. Moisture, either from airborne droplets or condensation, can plug the filter and result in failure by over-pressurization. Filters that become wet and then are dried lose tensile strength and might not be able to withstand 10 inches of water pressure differential across the filter as specified in ASME AG-1, FC-5140. Also, wetting of the filter by a contaminated liquid can cause contamination in the liquid to seep through the filter to the cleaner side.
- 5.8.2 For new HEPA filter systems, under normal operating conditions, where Safety Calculations or calculations used for ALARA based reductions rely on filter tensile strength to perform a safety function then the filter system shall be designed to prevent the filter media from becoming wet. Where accidental wetting can occur, such as from fire protection systems or condensation, then the filter in-service life shall not exceed 5 years.
- 5.8.3 For existing HEPA filter systems (supported by Safety Calculations or to provide an ALARA based reduction) where the filter is suspected of being wetted (condensation from high humidity, accidental wetting, etc.) an evaluation shall be performed by the Design Authority to establish filter in-service life. The in-service life shall be based on the amount of wetting (depletion of tensile strength) that can be tolerated. The evaluation should consider such factors as the highest-pressure differential the filter is expected to see, systems in place to detect filter failure, and operating experience with the system.

5.9 Outdoor Installations

- 5.9.1 When encapsulated HEPA filters are to be placed in outdoor installations verify that the filter is satisfactory for outside use.

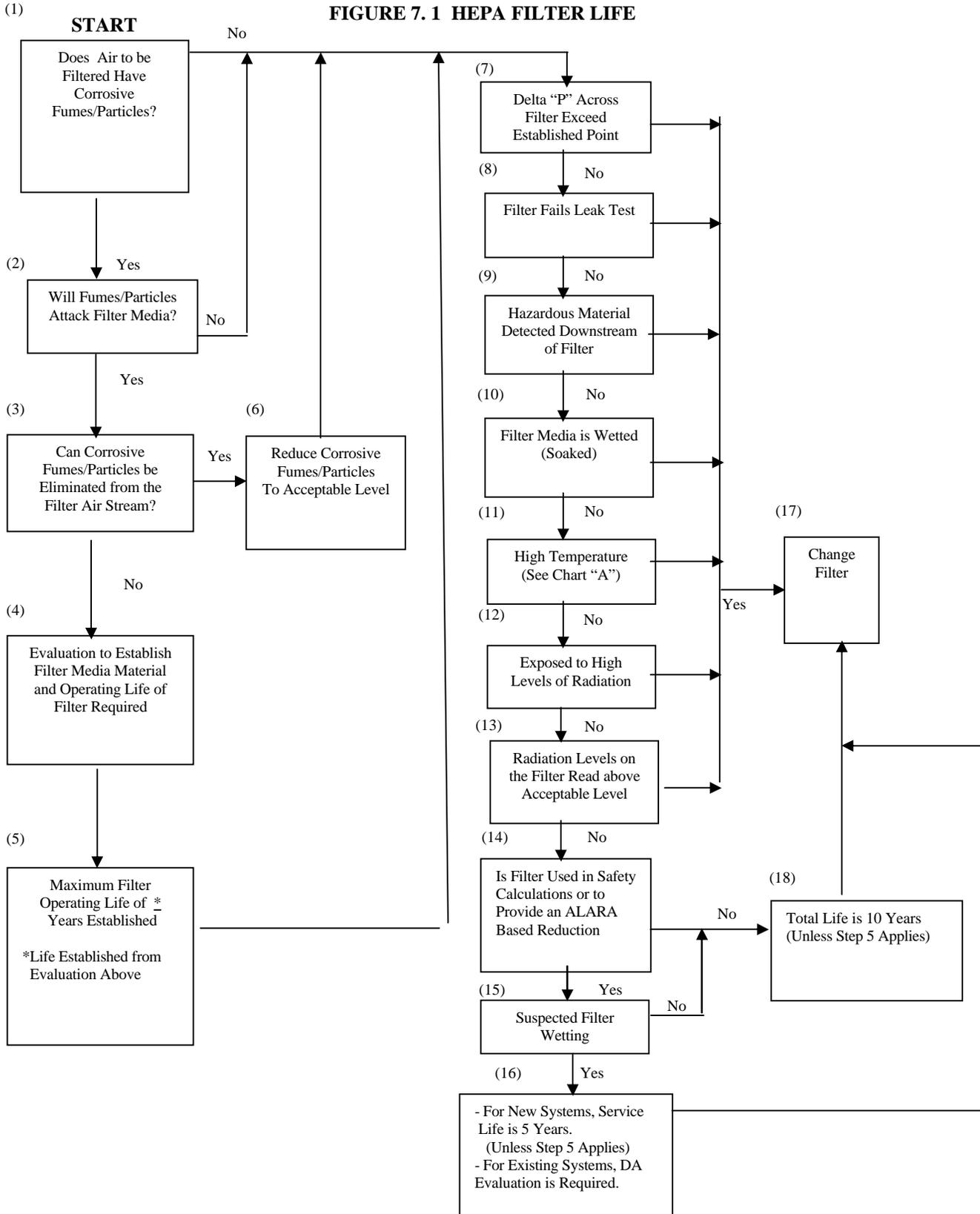
6.0 REFERENCES

- 6.1 Underwriters' Laboratories Standard UL-586, "High Efficiency Air Filters Units", Seventh Edition
- 6.2 LLNL, UCRL-AR-134141, Maximum HEPA Filter Life , June 1999
- 6.3 Nuclear Air Cleaning Handbook, DOE-HDBK-1169-2003
- 6.4 LLNL, UCRL-99444 "The Effect of Age on the Structural Integrity of HEPA Filters, August 1988
- 6.5 LLNL, UCRL-AR-133354, Rev. 1 "HEPA Filter and In-Place Leak Testing Standard", June 1999
- 6.6 Letter from Flanders Filters, Inc. letter Dated 27 Sept 1999, Klocke to McAndrews, "HEPA Filter Wetting Questions"
- 6.7 WSRC-TM-95-1 Std 15889, "Confinement Ventilation Systems Design Criteria"
- 6.8 Manual 3B, Procedure 4-1 "Site Storage Procedure", Attachment # I "Staging Definition Requirements"

7.0 FIGURES, TABLES and CHARTS

- 7.1 Figure - Selection of Design Criteria and Requirements for HEPA Filter Total Life
- 7.2 Chart A - Limiting Service Temperatures for Standard HEPA Filters

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Instructions for determining actual HEPA filter life

The following steps are identified in Figure 7.1

- Step 1. Does air to be filtered have corrosive fumes/particles?
If No go to Step 7
If Yes go to Step 2
- Step 2. Will corrosive fumes/particles attack the HEPA filter media, filter seal, filter bonding agents, filter casing, etc.?
If No go to Step 7
If Yes go to Step 3
- Step 3. Can corrosive fumes/particles be reduced to an acceptable level from the filtered air stream?
If No go to Step 4
If Yes go to Step 6
- Step 4. This step requires an evaluation by the Design Authority to determine the best materials for the filter assembly based on the corrosive fume/particles being filtered. After the Design Authority specifies the filter assembly materials, he shall specify the operating life for the HEPA filters based on the corrosive atmosphere.
- Step 5. List the in-service life (operating life) in years established in Step 4.
Go to Step 7
- Step 6. System to remove corrosive fumes/particles, before the air is filtered, is designed and installed.
Go to Step 7
- Step 7. Has the Delta "P" across the filter reached the established design point for filter changing (normally the design point is 4 to 5 inches water gauge) as specified by the Design Authority and based on system design?
If Yes go to Step 17
If No go to Step 8
- Step 8. Did the filter fail the established site in-service leak test?
During the installation of new filters all necessary steps shall be taken to reseal the filter to pass the test. If No go to Step 9
If Yes go to Step 17
- Step 9. Was a level of hazardous material in the air stream, determined to be unacceptable by the Design Authority, detected down stream of the HEPA filter?
If No go to Step 10
If Yes go to Step 17
- Step 10. Was the filter media soaked (saturated) by water?
A filter should be considered saturated when it is known that water droplets are in the filtered air stream and the Delta "P" across the filters exceeds the design change point (see Step 7). Filters that become wet shall not be dried and returned to service when filtering hazardous material as they lose their tensile strength and will not hold up to overpressurization.
If No go to Step 11
If Yes go to Step 17

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- Step 11. Did the filter see high temperatures as listed in Chart "A"?
 For special high-temperature HEPA filters see the vendor's catalog data for limiting service temperatures.
 If No go to Step 12
 If Yes go to Step 17
- Step 12. Was the filter exposed to an absorbed dose of 3.5 E7 Rads or greater? Exposure of HEPA filters to high levels of radiation can result in significant reduction in the moisture resistance (and therefore strength) of fiberglass media.
 If No go to Step 13
 If Yes go to Step 17
- Step 13. Did the radiation levels from the filter read above the established acceptable level set by the Design Authority?
 Radioactive contamination collected on filters above the recommended level can cause additional disposal cost and exceed ALARA requirements.
 If No go to Step 14
 If Yes go to Step 17
- Step 14. Is HEPA filter protection used in the development of safety calculations or to provide an ALARA based reduction? Filters used in safety calculations or to provide an ALARA based reduction shall function within their design parameters.
 If No go to Step 18
 If Yes go to Step 15
- Step 15. Can the filter media become wet?
 If No go to Step 18
 If Yes go to Step 16
- Step 16. All new HEPA filters installations directed to this step have maximum shelf life of 3 years and a maximum in-service life of 5 years unless the operating life in step 5 applies and the total life span is shorter.
 For existing HEPA filter installations (installed Prior to 11/15/01) an evaluation is required by the Design Authority to establish the filters in-service life based on the amount of wetting (depletion of tensile strength) that can be tolerated.
- When the established in-service life of the filter is exhausted go to Step 17
- Step 17. All HEPA filters directed to this step shall be changed or taken out of service. HEPA filters shall not be returned to service and shall be changed when the schedule permits.
- Step 18. All HEPA filters directed to this step have a total life span of 10 years unless the operating life in Step 5 applies and the total life span is shorter. HEPA filters used in this category should be the filters with the shortest actual storage time (shelf life) this will provide the longest operating life and the most economical usage. The exception to this is for the filters specified in Step 5, if the operating life is 7 years or less then filters with the maximum time in storage should be used.

When the established total life of the filter is exhausted go to Step 17

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7.2 Chart A
Limiting Service Temperatures
For Standard HEPA Filters

Table 1

Recommended limiting service temperatures for steel-framed fire-resistant HEPA filter units sealed with elastomeric adhesive. (modified from Table 3.5 NACH)

Sealant Used	Temperature to which filter was exposed (°F)				
	Up to 10 min ^a	Up to 2 hr	Up to 48 hr	Up to 10 Days	> 10 years
HT-30-FR ^b	750	350	325	300	260
Z-743 ^c	750	325	300	275	200
EC-2155 ^d	750	250	220	200	200
Polyurethane Foam	750	325	300	275	230
Loctite Corp 05408501					250*
Flanders 05420102					250*

^a Some reduction in efficiency may occur after 5 min of exposure.

^b Goodyear

^c Pittsburgh Plate Glass

^d Minnesota Mining and Manufacturing (3M)

* Maximum temperature rating (not listed in NACH)

Table 2

Recommended limiting service temperature for wood-framed fire-resistant HEPA filter units^a
(modified from Table 3.6 NACH)

Frame Material	Temperature to which filter was exposed (°F)				
	Up to 10 min	Up to 2 hr	Up to 48 hr	Up to 10 days ^b	> 10 years ^b
¾-in. thick plywood ^{a, c}	750	300	275	200	180

^a Subject to sealant limitations given in Table 1 above.

^b Maximum temperature of 120°F where relative humidity is 75% or higher.

^c Exterior grade fire-retardant treated.

NOTE: For special High-Temperature HEPA filters, see the vendor's catalog data for limiting service temperatures.