# PROCUREMENT SPECIFICATION FOR NON-STANDARD NUCLEAR GRADE HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS

## Design Verification Required
- **Yes** ☐
- **No** ☒

## USQ Number
- **N/A** ☒

## PrHA Number
- **N/A** ☒

## Description of Change and Justification

HNF-S-0477, Procurement Specification for Non-Standard, Nuclear Grade, High Efficiency Particulate Air (HEPA) Filters (For Filters That Do NOT Conform to ASME AG-1) was a site wide procurement specification when the Hanford site was managed under a single contract. The document is not under Tank Farm Operations configuration control. In addition, HNF-S-0477 has not been updated since 2005 and there have been changes to both ASME AG-1, Code on Nuclear Air and Gas Treatment and to DOE-STD-3020. This revision updates the HNF-S-0477 to be under the Tank Farm Operations Contract configuration control with a new document number and incorporates changes necessary to comply with the current revisions of ASME AG-1 and DOE-STD-3020.

## Approvals

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General Procurement Specification for Non-standard Nuclear Grade High Efficiency Particulate Air (HEPA) Filters

DE Schoepflin:

Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

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Key Words: HEPA, Filter, Non-AG-1, Legacy Systems

Abstract: WRPS requirements for procurement of HEPA filters that may not be fully qualified to ASME AG-1 Section FC or Section FK. Filters of this type are primary for legacy systems and special processes do not allow the use of standard ASME AG-1 qualified HEPA filter.
# TABLE OF CONTENTS

1.0 **SCOPE** ........................................................................................................................................................... 1
   1.1 PURPOSE.......................................................................................................................................................... 1
   1.2 APPLICABILITY............................................................................................................................................. 3
   1.3 LIMITATIONS............................................................................................................................................... 3

2.0 **DEFINITIONS AND ABBREVIATIONS** ........................................................................................................... 5
   2.1 DEFINITIONS............................................................................................................................................... 5
   2.2 ABBREVIATIONS....................................................................................................................................... 7

3.0 **REFERENCES** ............................................................................................................................................... 8
   3.1 CODES, STANDARDS, AND SPECIFICATIONS ......................................................................................... 8

4.0 **REQUIREMENTS** ......................................................................................................................................... 10
   4.1 GENERAL REQUIREMENTS......................................................................................................................... 10
   4.2 MATERIAL REQUIREMENTS......................................................................................................................... 10
   4.3 DESIGN REQUIREMENTS............................................................................................................................. 13
   4.4 PERFORMANCE REQUIREMENTS............................................................................................................... 16
   4.5 FABRICATION REQUIREMENTS................................................................................................................. 19

5.0 **INSPECTION AND TESTING** ...................................................................................................................... 22
   5.1 QUALIFICATION TESTING............................................................................................................................ 22
   5.2 FILTER PRODUCTION TESTING.................................................................................................................. 23
   5.3 DOE FILTER TEST FACILITY QUALITY ASSURANCE TESTING .......................................................... 24

6.0 **MARKING AND IDENTIFICATION** ................................................................................................................ 25
   6.1 FILTER MARKING AND IDENTIFICATION................................................................................................. 25
   6.2 PACKAGE MARKING AND IDENTIFICATION............................................................................................ 25

7.0 **PACKAGING, SHIPPING, AND STORAGE** .................................................................................................. 27
   7.1 PACKAGING................................................................................................................................................ 27
   7.2 SHIPPING.................................................................................................................................................. 27
   7.3 STORAGE................................................................................................................................................... 28

8.0 **QUALITY ASSURANCE** ............................................................................................................................... 29
   8.1 QUALITY ASSURANCE PROCUREMENT CLAUSES.................................................................................. 29
   8.2 SUPPLIER QUALITY ASSURANCE PROGRAM............................................................................................ 29
   8.3 SUPPLIER RECORDS.................................................................................................................................. 31
   8.4 SCHEDULE.................................................................................................................................................. 31
   8.5 PERSONNEL QUALIFICATIONS/CERTIFICATIONS ................................................................................. 31
   8.6 DELIVERABLES......................................................................................................................................... 31

9.0 **EXCEPTIONS** .............................................................................................................................................. 32
   9.1 PROPOSED/TENTATIVE ASME AG-1 CHANGES.......................................................................................... 32
   9.2 HEPA FILTER INTERPRETATIONS AND CLARIFICATIONS...................................................................... 32
   9.3 PRE-AWADE SPECIFICATION EXCEPTIONS............................................................................................. 32
   9.4 POST-AWARD SPECIFICATION EXCEPTIONS............................................................................................ 33

10.0 **ACCEPTANCE OF ITEMS** ............................................................................................................................ 34

APPENDIX A.............................................................................................................................................................. 35
RPP SPEC-60635, NON-STANDARD HEPA FILTER DATA SHEET (REVISION 0).................................................. 35
1.0 SCOPE

This procurement specification establishes performance, design, construction and testing requirements for Non-Standard (i.e., not ASME AG-1 compliant) Nuclear Grade, High-Efficiency Particulate Air (HEPA) filters intended for use in Tank Operations Contractor (TOC) nuclear air-cleaning system applications.

1.1 PURPOSE

This specification ensures compliance to the substantive HEPA filter requirements associated with Washington Administrative Code (WAC), Chapter 246-247 and also incorporates select supplemental requirements from Department of Energy (DOE) standard DOE-STD-3020-2015, Specification for HEPA Filters Used by DOE Contractors.

The main purpose of this specification is to support procurement of replacement filters for existing non-standard HEPA filter applications within the TOC scope of work on the Hanford Site. Non-standard filters represent a category of nuclear grade HEPA filters where one or more design features, materials of construction, or qualification tests depart from ASME AG-1 specified requirements. The effectiveness of non-standard HEPA filters has been proven through application and has been determined acceptable for use in many existing Department of Energy (DOE) nuclear air cleaning applications. Examples of ASME AG-1 related compliance issues for Non-standard filters include, but are not limited to: filter sizes other than those identified in ASME AG-1 Table FC-4110 Nominal Sizes and Ratings; atypical filter configurations (e.g., enclosed or self-contained filters), construction materials not recognized by ASME AG-1 (e.g., non-standard gasket material and sealants needed for high temperature applications); filters not fully qualified in accordance with ASME AG-1 mandated design qualification tests (e.g., seismic testing), alternate quality assurance programs and others.

Critical aspects of quality, performance, design, construction, acceptance, and testing for the procurement of non-standard HEPA filters are delineated within this specification for application in the TOC Scope of work. Although not fully-compliant with ASME AG-1 Section FC HEPA Filters or Section FK Special HEPA Filters, procurements made in accordance with this specification will achieve an acceptable level of equivalency to ASME AG-1 to meet the substantive performance requirements for abatement technology as mandated through Washington Administrative Code (WAC), Chapter 246-247. For purposes of this specification, the following substantive requirements for HEPA filters are applicable:

- HEPA filters shall be fabricated using ASME AG-1 qualified filter media (i.e., media in accordance with ASME AG-1 Mandatory Appendix FC-I.) whenever possible.

- HEPA filter design, construction, fabrication, testing, storage, handling, and shipping shall be conducted in accordance with an approved ANSI/ASME NQA-1 Quality Assurance Program when used in Safety Class or Safety Significant applications. General Service applications may utilize other quality programs such as International Organization for Standardization (ISO) with HEPA SME approval.
Supplier shall apply their respective quality program for all HEPA filter procurements unless exempted by the HEPA SME. The safety function shall be identified on the HEPA filter data sheet, or if not specified, shall be as follows "The safety function of Nuclear grade HEPA Filters provided by the seller according to this specification is to remove a minimum of 99.97% of upstream concentration of 0.3 µm particles at the design rated flow and 20% of rated flow. This safety function shall be verified by performance testing in accordance with MIL-STD-282, ASME AG-1 Section FC-5120 or an approved equivalent”.

HEPA filter production testing (i.e., tests for aerosol penetration, flow, and resistance) shall be performed in accordance with MIL-STD-282, ASME AG-1 Section FC or an approved equivalent.

HEPA filters shall demonstrate a minimum aerosol test efficiency of 99.97% when tested using an essentially mono-dispersed aerosol with approximately 0.3 micrometer sized particles.

HEPA filter materials shall be compatible with anticipated service conditions as described in Appendix A, “RPP-SPEC-60635, Non-Standard HEPA Filter Data Sheet (Revision 0)”.

NOTES for TOC Buyers

(1) Filters procured using this specification may be ordered as Safety Class, Safety Significant or General Service as specified on the HEPA filter data sheet. In all cases, the vendor shall apply their quality assurance program with the following safety function: “The safety function of the Nuclear HEPA Filters procured under this specification is to remove a minimum of 99.97% of upstream concentration of essentially mono-dispersed aerosol with approximately 0.3 micrometer sized particles at the design rated flow and 20% of rated flow. This safety function shall be verified by performance testing in accordance with MIL-STD-282, ASME AG-1 Section FC-5120 or an approved equivalent.

(2) The TOC Prime contractor, including their subcontractors shall use this specification when procuring filters that are not compliant to ASME AG-1, Section FC or Section FK filters not included in RPP-SPEC-28675.

(3) Some filter configurations may require that the seller take exception to portions of this specification. All exceptions must be evaluated by the HEPA SME or HVAC Engineering Discipline Lead to verify they meet the requirements for legacy filters per DOE-STD-3020-2015 Paragraph 5.5 and appendix B

(4) For procurement of Standard HEPA filters (i.e., ASME AG-1, Section FC compliant) use specification RPP-SPEC-60522. For passive radial and round axial breather filters use RPP-SPEC-28675. Contact the HEPA SME or HVAC Engineering Discipline Lead for questions on which specification to use.
1.2 APPLICABILITY

1.2.1 This specification applies to procurement of non-standard, nuclear grade, rectangular, cylindrical/round, radial, open-faced, encapsulated and fire-resistant high efficiency particulate air (HEPA) filters to be installed in

- Nuclear facility (Hazard Category 1, 2, 3 and radiological facilities) confinement ventilation systems or
- In habitability systems (e.g. filters that protect workers who must not evacuate in emergency situation because of the necessity to shut down or control the situation.

1.2.2 RPP-SPEC-28675, *Radial HEPA Filter Procurement Specification* should be used for 40 CFM radial HEPA filters and 15 CFM circular axial flow HEPA filters installed on Hanford tank farm passive ventilation systems.

1.2.3 This specification applies to extended-media dry type HEPA filters intended for use in air and gas streams with a maximum continuous temperature of 250°F (120°C) or for high temperature HEPA filters, up to 1,000°F (540°C). Four basic types of HEPA filter media pack configuration are allowed. The four types are defined as Type A, Type B, Type C and Type D per ASME AG-1, Subsubarticle FC-4130 and subparagraph FK-1121.2.

- This specification includes requirements to conduct independent quality assurance testing at a DOE Filter Test Facility (FTF). The Supplier is not responsible for DOE FTF-applicable requirements (i.e., Specification Section 5.3 and DOE FTF label requirements per steps 6.1.2 and 6.2.3.).

1.2.4 Upon request, TOC will consider revising this specification to allow the use of additional filter types and/or material options, providing the proposed change meets the performance requirements, material requirements and filter construction requirements of IEST-CC-RP-CC001.5, or ASME AG-1, Section FC/Section FK. Other approved standard for HEPA filter construction and testing may be used with HEPA SME approval as shown on the data sheet.

1.2.5 This specification does not apply to HEPA–equivalent type filters which use non-standard filter media (e.g., metal-sintered, carbon-composite, ceramic filters, etc.).

1.3 LIMITATIONS

1.3.1 This specification shall not be used to procure ASME AG-1 Section FC compliant HEPA filters. (Specification RPP-SPEC-60522 applies to ASME AG-1 compliant filters).

1.3.2 RPP-SPEC-28675, *Radial HEPA Filter Procurement Specification* should be used for 40 CFM radial HEPA filters and 15 CFM circular axial flow HEPA filters.

1.3.3 Not all IEST-RP-CC001.5 approved construction grades and material options are allowed by this specification (e.g., particleboard, plastic, or aluminum alloy frames (cases), etc.)
RPP-SPEC-60635 Rev. 0

IEST-RP-CC001.5 applicability limitations are defined in Sections 4.0, 5.0 and 6.0 of this specification.
2.0 DEFINITIONS AND ABBREVIATIONS

2.1 DEFINITIONS

Acceptance Test: Inspection and testing of a filter to verify certain characteristics or properties which determine the acceptance or rejection of that filter.

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.

DOE Filter Test Facility: A facility established by the DOE specifically to conduct quality assurance inspections and tests of HEPA filters.

General Service: The classification assigned to Structures, Systems, and Components not required to provide a safety class or safety significant function. All structures, systems, and components are, as a minimum, classified as general services unless it has been determined and documented that a higher classification is required.

HEPA Filter Subject Matter Expert (SME): The HEPA SME is the TOC assigned HEPA Filter Subject Matter Expert. The HEPA SME is the Buyer’s Technical Representative for all TOC HEPA procurements. Since the HEPA SME is typically not the assigned DA for the installed system, the HEPA SME must coordinate the resolution of procurement issues with the ordering engineer, as appropriate. Either the HEPA Design Authority or HVAC Engineering Discipline Lead may fulfill this function for TOC.

High Efficiency Particulate Air (HEPA) Filter: A throw away, extended-media, dry-type filter with a rigid casing enclosing the full depth of the pleats. The filter shall exhibit a minimum efficiency of 99.97% when tested with an aerosol consisting of essentially mono-dispersed 0.3 micrometer diameter test aerosol particles.

Non-Standard Filters: Nuclear grade HEPA filters that are not fully compliant to the requirements of ASME AG-1 Section FC, HEPA Filters. Non-standard filters include filter designs, shapes and sizes that are not recognized by ASME AG-1 Section FC, or Section FK and also include authorized filter designs that have not been qualified by the filter manufacturer.

Nuclear Grade Filters: Rectangular, square, round, and nipple–connected Type B Filters constructed and tested in accordance with MIL-STD-262 and IEST-RP-CC-001.5.

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

Qualification Test: A test, often destructive, of a prototype or randomly selected production filter to establish its capability to meet certain functional and specification requirements. Test results are considered to typify performance of filters of the same design (includes materials and configuration, size may vary) and manufactured by the same process.

Rated Flow: The flow rate at which HEPA filters are identified by the manufacturer and confirmed by the DOE FTF. Nominal airflow ratings for standard HEPA filters are identified in ASME AG-1, Table FC-4110 and Section 4.4.2, Table 1 of this specification.
Standard Filters: Nuclear grade HEPA filters that are compliant with ASME AG-1 Section FC, HEPA Filters requirements.

Quality Levels: A grading level that can be assigned to work activities, items, or services used to differentiate the importance to nuclear safety, cost, schedule, mission success, or regulatory compliance. Quality level ranges are (from highest to lowest) QL-1, QL-2, QL-3, and QL-0.

Quality Level - 1 is assigned to Safety Class (SC) items and services that are high risk, and the QA program employed by the vendor is important to the acceptability and suitability of the item or service to perform as specified. Acceptance methods shall be specified, including acceptance and other applicable performance criteria documented and verified before use of the item or service.

Quality Level - 2 is assigned to Safety Significant (SS) items and associated services not designated as Quality Level 1, where items and associated services pose a moderate project risk. The QA program employed by the vendor is important to the acceptability and suitability of the item or service to perform as specified. Acceptance methods shall be specified including acceptance and other applicable performance criteria documented and verified before use of the item or service. Some of the required characteristics may be examined less rigorously than for Quality Level – 1.

Quality Level - 3 is assigned to General Service (GS) items and services that are important to project mission and represent a level of project risk where controls beyond standard commercial practices are considered necessary to ensure the item or service is suitable for its intended purpose. Procurement documents describe the method of acceptance to establish confidence that the item/service is suitable for its intended purpose. If post installation testing is specified as acceptance criteria, the verification activity is the post installation test.

Safety Class: Classification assigned to Structures, Systems, and Components, including portions of process systems, whose preventive or mitigative function is necessary to limit radioactive hazardous material exposure to the public, as determined from safety analyses.

Safety Significant: Classification assigned to Structures, Systems, and Components that are not designated as safety class structures, systems, and components, but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses.
2.2 ABBREVIATIONS

acfm....................................................................................................... actual cubic feet per minute
ANSI..................................................................................... American National Standard Institute
ASME........................................................................American Society of Mechanical Engineers
ASTM.......................................................................... American Society of Testing and Materials
AVS................................................................................................ Acquisition Verification Services
DA.............................................................................................. Design Authority
DOE.......................................................................................... Department of Energy
EDL.......................................................................................... Engineering Discipline Lead
FTF............................................................................................... Filter Test Facility
HEPA..................................................................................... High Efficiency Particulate Air
QA............................................................................................. Quality Assurance
QPL.......................................................................................... Qualified Product List
RFQ.......................................................................................... Request for Quote
scfm.......................................................................................... standard cubic feet per minute
SME.......................................................................................... Subject Matter Expert
TOC...................................................................................... Tank Operations Contractor
UL........................................................................................ Underwriters’ Laboratories
WAC........................................................................................ Washington Administrative Code
wg................................................................................................. Water Gauge
3.0 REFERENCES

3.1 CODES, STANDARDS, AND SPECIFICATIONS

As a minimum, codes, standards, and specifications referenced in this specification are a part of this specification to the extent specified herein. The latest document edition and addenda shall apply, unless otherwise noted.

Note: All ASME AG-1 references made in this document are based on ASME AG-1-2015.

3.1.1 American Society of Mechanical Engineering (ASME)

ASME AG-1-2015, Code on Nuclear Air and Gas Treatment
- Division I General Requirements, Section AA, Common Articles
- Division II Ventilation Air Cleaning and Ventilation Air Conditioning,
  - Section FC HEPA Filters
  - Section FK Special HEPA Filters

ASME NQA-1-2008, Quality Assurance Requirements for Nuclear Facility Applications, including NQA-1a-2009 Addenda

ASME B 18.21.1, Washers: Helical Spring Lock, Tooth Lock and Plain Washers (Inch Series)

3.1.2 American Society for Testing and Materials (ASTM)

ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

ASTM A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

ASTM A320, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service

ASTM A581, Standard Specification for Free-Machining Stainless Steel Wire and Wire Rods

ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process

ASTM A740, Standard Specification for Hardware Cloth (Woven or Welded Galvanized Steel Wire Fabric)

ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM D92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
3.1.3 **Department of Defense Military Standards**  
MIL-F-51068, *Filters, Particulate, (High Efficiency Fire Resistant)* (Cancelled)

3.1.4 **Engineered Wood Association**  
APA PS-1, *Voluntary Product Standard PS 1 Structural Plywood* (Form No. L870A)

3.1.5 **Institute of Environmental Sciences and Technology**  
IEST-RP-CC001.5, *HEPA and ULPA Filters*  
IEST-RP-CC007.2, *Testing ULPA Filters*

3.1.6 **International Organization for Standardization**  
ISO 9000 *Quality management systems – Fundamentals and vocabulary*  
ISO 9001, *Quality management systems – Requirements*  
ISO 9004 *Managing for the sustained success of an organization – A quality management approach*  
ISO 19011, *Guidelines for auditing management systems*

3.1.7 **Society of Automotive Engineers (SAE)**  
SAE AS 8660, *Silicone Compound, NATO Code Number S -736*

3.1.8 **U.S. Department of Energy Standards**  
DOE-STD-3020-2015, *Specification for HEPA Filters Used By DOE Contractors*  
DOE-STD-3025-2007, *Quality Assurance Inspection and Testing of HEPA Filters*

3.1.9 **Underwriters Laboratories**  
UL 586, *Standard for Safety, High Efficiency, Particulate, Air Filter Units*

3.1.10 **Washington Administrative Code**  
Chapter 246-247, *Radiation Protection – Air Emissions*
4.0 REQUIREMENTS

4.1 GENERAL REQUIREMENTS

4.1.1 Supplier shall provide HEPA Filters in accordance with this specification.

4.1.2 Physical attributes of a filter (e.g., size, material, configuration, etc.) shall be as specified in Appendix A, (hereon referred to as the HEPA Filter Data Sheet). If a conflict exists between specification requirements, the HEPA Filter Data Sheet or procurement documentation, the Supplier shall request formal direction from the Buyer on how to proceed, prior to initiating fabrication.

4.1.3 The HEPA Filter Data Sheet may include additional or supplemental testing and documentation requirements. When included, such requirements are also conditions for filter acceptance.

4.1.4 As a minimum, HEPA filters procured using this specification shall meet IEST-RP-CC001.5 requirements for Performance Level “Type B”, Construction Grade 1 or 2.

4.1.5 All filters shall be inspected and tested at the DOE Filter Test Facility (FTF) prior to Buyer acceptance. Accommodations shall be made to have filters shipped directly from the Supplier to the DOE FTF.

4.2 MATERIAL REQUIREMENTS

4.2.1 General

Where possible, materials of construction should conform to ASME AG-1, Article FC-3000. However, materials per IEST-RP-CC001.5, Section 6, are also allowed as delineated in Section 4.2 of this specification.

Use of alternate materials and material substitutions shall be identified and submitted to the Buyer for review and approval prior to initiating fabrication.

Not all materials authorized for use by ASME AG-1 or IEST-RP-CC001.5 are authorized for use per this specification (e.g., Aluminum frames, plastic, Kraft paper separators, etc.)

4.2.2 Filter Case Material

The following case materials are acceptable for use per this specification. Reference the HEPA Filter Data Sheet for selected case material.

a. Stainless Steel, Type 304/304L per ASTM A240/A240M, USS 14 gage with a minimum sheet thickness of 0.0720 inches (1.83 mm).

b. Stainless Steel, Type 409 (muffler grade ferritic stainless steel) per ASTM A240/A240M, USS 14 gage with a minimum sheet thickness of 0.0720 inches (1.83 mm).
c. Stainless Steel, Type 409 (muffler grade ferritic stainless steel) per ASTM A240/A240M, USS 16 gage sheet as a minimum, with a minimum thickness of 0.0625 inches (1.59 mm).

d. Stainless Steel, Type 304/304L per ASTM A240/A240M, USS 16 gage sheet as a minimum, with a minimum thickness of 0.0625 inches (1.59 mm).

e. Stainless Steel, Type 316/316L per ASTM A240/A240M, USS 16 gage sheet as a minimum, with a minimum thickness of 0.0625 inches (1.59 mm).

f. Galvanized carbon steel per ASTM A653/A563M, 16 gage USS sheet as a minimum, with a minimum thickness of 0.0625 inches (1.59 mm).

g. Plywood per APA PS 1, exterior type or marine exterior, minimum grade A (interior side)-C (exterior side), ¾ inch (19 mm) thick with a flame spread classification of 25 or less when tested as specified in ASTM E84. Particle board is not acceptable.

4.2.3 Gasket Materials

Depending on the frame type, two methods are acceptable for sealing a filter to its mounting frame. The following two methods shall not be used concurrently on the same mounting frame.

a. Gaskets shall be oil-resistant, expanded (closed-cell) elastomer in accordance with ASTM D1056, Grade 2C3 / 2C4.

Gaskets shall be ¼ inch (6 mm) thick by ¾ inch (19 mm) wide with split or cut surfaces (i.e., no mold skin). 3/8 inch (10mm) thick gaskets are allowed if specified on the HEPA Filter Data Sheet.

If specified on the HEPA Filter Data Sheet, special gasket material for High-temperature applications is acceptable.

b. Gelatinous Seal (Fluid Seal) shall consist of a self-adhesive and self-curing gel made of polydimethylsiloxane or an equivalent material.

The sealant shall be nonflammable as defined in ASTM D92 (e.g., no flash at 450 °F (232°C) or below). The gelatinous seal substance shall be corrosion resistant, shall not relax, crack, separate, or stick or adhere to the knife-edge, and shall be insoluble in water. Evaporation shall be less than 2% when tested in accordance with SAE AS 8660 for 24 hours at 390 °F (198 °C).

4.2.4 Filter Medium

Filter medium shall be nuclear grade and conform to requirements of ASME AG-1, Subsubarticle FC-3130 and Mandatory Appendix FC-I.

If specified on the HEPA Filter Data Sheet, Supplier shall provide filter media with enhanced chemical resistance properties for use in exhaust systems with potential HNO₃ or HF acid exposure. Asbestos is not an acceptable filter medium component.
4.2.5 Faceguards

This specification authorizes the use of the two faceguard material options. Reference the HEPA Filter Data Sheet for selected material.

a. Galvanized steel, 4 x 4 mesh, wire fabric (hardware cloth) made from wire having a minimum diameter of 0.025 inches (0.64 mm) and conforming to ASTM A740.

Galvanized faceguards shall not be used in combination with stainless steel case material, or in any application involving potentially corrosive airstreams.

b. Stainless steel, 4 x 4 mesh, wire fabric (hardware cloth) made from wire having a minimum diameter of 0.025 inches (0.64 mm), and conforming to ASTM E2016.

Standard faceguard material is SST type 304/304L; however, other SST types are also acceptable.

Stainless steel faceguards shall be installed on all filters requiring stainless steel case material.

4.2.6 Adhesives and Sealants

Adhesives and sealants used to splice the media, fasten gaskets to the filter frame, seal filter pack into the case, and attach faceguards to the frame shall be self-extinguishing, so that when dried or cured adhesive/sealant is subjected to spot-flame test of ASME AG-1, Subsubarticle FC-5160 or UL-586, it will not continue to support combustion after the source of combustion has been removed.

An Underwriter’s Laboratories UL-586 label shall be acceptable objective evidence for demonstrating compliance to spot flame requirement.

4.2.7 Separators

Note: Filter Separator features shall be as specified in the HEPA Filter Data Sheet.

a. Materials for filter separators (if required) shall be limited as follows:

Non-coated filter separators shall be made from corrugated aluminum per ASTM B209, Alloy 1100-H18, Alloy 3003-H18, or Alloy 5052-H38, 0.0015 inch (0.038 mm) minimum thickness.

b. Materials for Coated filter separators, (if required), shall be limited as follows:

Acid resistant (coated) filter separators shall be made from corrugated aluminum, 0.0015 in. (0.038 mm) thick, min., conforming to ASTM B209, Alloy 5052-H38, 3003-H18, or 1100-H18 coated on both surfaces with a vinyl-epoxy coating 0.8 to 1.2 mils thick. The applied coating shall meet the adhesion requirements, off-gas test, and flexibility test per ASME AG-1, Paragraph FC-4151.

The coating should be tinted to verify coverage of the separator.
c. Materials for Mini-pleat filter separators, (if required), shall be fabricated from ribbons of non-combustible adhesive threads, hot melt or glass fiber bonded to the filter media.

d. Materials for Separatorless filters, (if required), shall be folded in such a manner that the filter pack is self-supported by the convolutions of the adjacent folds.

4.2.8 Fasteners, Metal Case

Approved fasteners for the assembly of metal HEPA filter cases are listed below:

- Stainless steel bolts: 300 series per ASTM A320 or ASTM A193
- Stainless steel nuts: 300 series per ASTM A194
- Stainless steel washers: 300 series per ASME B18.21.1
- Stainless steel rivets: 300 series per ASTM A581

4.2.9 Fasteners, Wood Case

Approved fasteners for the assembly of Wooden HEPA filter cases are listed below:

- Nails: carbon steel, galvanized, zinc coated, aluminum per ASTM F1667
- Staples: carbon steel, galvanized, zinc coated, aluminum per ASTM F1667

4.3 DESIGN REQUIREMENTS

4.3.1 Filter Design

Whenever possible, filter design should conform to ASME AG-1, Article FC-4000. However, to support filter replacements for existing HEPA systems, this specification allows procurement of alternative (i.e., not ASME AG-1 qualified) filter designs, providing minimum design requirements per IEST-RP-CC001.5, Section 7, Design are satisfied.

4.3.2 Filter Case

Filter cases shall be designed and constructed in accordance with ASME AG-1, Subsubarticle FC-4120 and Article FC-6000, or IEST-RP-CC001.5, Sections 7 and 8, respectively. Acceptable filter case designs include the following:

a. Metal Case

Metal cases shall have a double-turned ¾ inch (19 mm) flange on each face, or a ¼ inch (19 mm) wide by ¾ inch (19 mm) deep fluid-seal socket, as specified by the HEPA Filter Data Sheet. The gasket sealing surfaces shall be square with the sides of the frame (i.e., within 3°) and be flat and parallel. Case panels shall be assembled into a frame by bolting or riveting the corners. Space between abutting panel sections shall be made leak tight with adhesive.
For Cylindrical and Radial Case Design - The metal case shall be seamless or continuously welded. If equipped with flanges, they shall be ¾ inch (19 mm) wide (minimum) and shall be seamless or continuously welded to the cylinder. ASME AG-1 Article FK-4000 Type 1, 2, & 4 designs are also acceptable. The filter seal shall be gasket or fluid seal as specified on the HEPA Filter Data Sheet.

Note: Wood frame HEPA filters are not recommended for purchase at TOC facilities. Prior to procuring wood frame HEPA filter contact HEPA SME for approval.

b. Wood Case

Wood case panels shall be joined with rabbeted joints and be assembled using an approved adhesive (see 4.2.6) followed by double nailing or double screwing using coated box nails, galvanized screw nails, or galvanized flat head wood screws. Points of fasteners shall not penetrate the inside or outside surfaces of the case. If fluid seal is required, filter frame shall have a routed channel 3/8 inch (9 mm) wide x ¾ inch (19 mm) deep. Inner surfaces and exposed edges of frame shall be thoroughly coated with sealant to minimize permeability. The finished case shall have no splinters or rough edges that present a puncture hazard for the worker.

4.3.3 Medium Filter Pack

Medium filter pack shall conform to ASME AG-1, Subsubarticle FC-4130. With the exception of radial filters, filter packs shall be made from a continuous sheet of filter medium and shall be pleated evenly to form a pack of equal depth throughout. Radial filters regardless of size are allowed one media splice per filter to join the two ends.

No medium patching is allowed. The inside surfaces of the case shall be coated with adhesive to secure and seal the filter pack (Vendor to note any exceptions made for 1000 °F High Temperature exhaust filters).

a. Filters with separators (Type A per ASME AG-1 Section FC):

Filter medium pack shall not extend beyond the exposed ends of the separators. Separators should extend approximately 1/8 inch (3 mm) beyond the pleats of medium. Separators shall not extend beyond the ends of the frame when the pack is bonded to the frame. The plane formed by the edges of the separators should be at least ¼ inch (6 mm) from the plane of the filter frame (less gasket). Filter pack shall be rigid within the frame and separators shall be perpendicular to the two opposing parallel sides of the frame. Pleats shall be straight and perpendicular to the case, and shall not deviate more than 1/4 inch (6 mm) from a line drawn from one end of the pleat to the other. To protect the medium, separators shall be provided with a "turned-edge" prior to corrugation.

b. Mini-pleat Filters (Type B per ASME AG-1 Section FC)

Mini-pleat filter packs shall be made from a series of flat panels of pleated filter media which are assembled in a V-panel fashion. Each media pack within a panel shall use a shallow pleated fold with a maximum height of 3/4 in. (19 mm).
Adjacent pleats shall be separated and supported by ribbons of glass fiber media or noncombustible threads glued to the filter media. When the panels are installed in the filter case, the top and bottom panels shall be sealed in a reservoir of adhesive at least 1/16 in. (1.6 mm) deep. The mating panels shall have a common glued metal joint. No panel shall vary more than 1/4 in. (6 mm) from a straight line connecting the fixed ends to the frame. Filter media and supports shall not extend beyond individual panel frames. No ribbons and/or media supports shall vary from a straight line by more than 1/4 in. (6 mm). Side panels shall be securely bonded to the side of the filter case with adhesive.

c. Separatorless Filters (Type C per ASME AG-1 Section FC)

Separatorless filters shall have corrugated or embossed medium folded in a manner that the filter pack is self-supported by the convolutions of the adjacent folds. When additional support is appropriate, dividers fabricated from materials compatible with the intended service shall be provided. The vertical plane formed by the ends of the folded medium shall not deviate more than 3/8 inch (9 mm) from the top to the bottom of the pleat, and shall be recessed at least 1/16 inch (1.6 mm) from the plane formed by the four sides of the filter frame. Where convolutions do not have crest-to-crest contact, spacing shall not be less than 1/16 inch (1.6 mm). The nesting of convolutions and abrupt kinks or deviations in the folds of the medium are not permitted. Trimmed edges of the filter element shall be firmly potted (fixed) into the sealant. The two flat edges shall have sufficient sealant to secure them to the frame sides. The medium pack shall be rigid within the frame.

d. Thread Separator Filters (Type D per ASME AG-1 Section FC)

Thread Separator filters shall be made by folding the media to the required depth. The filter media shall be separated and supported by ribbons of glass fiber media or self-extinguishing threads, glued to the filter medium. The filter pack shall be rigid within the case and the media pleats shall be perpendicular to two opposite parallel sides of the case. A deviation of ½ the pleat to pleat distance along any 2-in. length of pleat fold, are not acceptable. When panels are installed in the filter case, the top and bottom of the panels shall be sealed in a reservoir of potting adhesive at least 1/16 in. (1.6 mm) deep.

4.3.4 Gaskets

a. Elastomer gasket construction for rectangular filters shall conform to ASME AG-1, Figure FC-4110-1 and ASME AG-1 Paragraph FC-4141. Gaskets shall be glued firmly and continuously to the case on one or both faces, as specified in the HEPA Filter Data Sheet. Loose, peeling, or distorted gaskets are cause for rejection. The gasket shall not extend beyond more than 1/16 inch (1.6 mm) over either side of the seating surface at any point. Gaskets shall be either one piece or made up of strips joined at the corners by a notched or dovetail interlocking type joint. A gasket shall contain no more than four joints. Edges of the joint areas shall be thoroughly coated with adhesive. For round (cylindrical) or radial filters, the gasket shall be one piece.

b. Gelatinous Seal (Fluid Seal) shall conform to ASME AG-1, Paragraph FC-4142.
4.3.5 Separators

Separators shall be capable of withstanding continuous service under the specified operating conditions listed on the data sheet without swelling, sagging, or melting per ASME AG-1, Subsubarticle, FC-4150. In addition, if specified, coated separators shall conform to ASME AG-1, Paragraph FC-4151.

4.3.6 Face Guards

Faceguards shall be as specified on the HEPA Filter Data Sheet.

Faceguard edges shall be firmly embedded in adhesive inside the filter case, but not under the gasket. Wire edges, formed when slitting or shearing expanded-metal faceguards, shall be smoothed on both surfaces of the material before installation. In all cases, faceguards shall be installed such that projecting wires cannot puncture, abrade the media, or present a puncture hazard to personnel handling the filter.

4.3.7 High Temperature Filters

HEPA filters intended for use in high temperature environments (greater than 250° F) shall meet the requirements of IEST-RP-CC001.5 Type B filters, and be tested in accordance with IEST-RP-CC001.5, Paragraph 9.1. The filters shall have a metal frame meeting the requirements of this specification and utilize separator-type filter medium. The following High-temperature filter types are acceptable for use:

- High-temperature filter capable of temperatures up to 392°F when outfitted with gel seals and 500°F when provided silicone sponge gaskets. Pack to case sealant shall be RTV silastic-sealant rated for 500°F continuous service.
- High-temperature filter (exhaust applications only) shall be capable of temperatures up to 1000°F. Gaskets shall be glass packing type. Filter pack to case shall be sealed using a glass pack seal rated for continuous service up to 1000°F.
- Since High-temperature HEPA filters are not rated per UL-586, a UL-586 label is not required.

4.4 PERFORMANCE REQUIREMENTS

Mandatory HEPA filter performance requirements are listed below. Performance shall be demonstrated for each filter through Supplier-performed production testing.

Note: Unless otherwise exempted by the HEPA SME, production test results are subject to validation through the DOE FTF quality assurance testing.

4.4.1 Penetration

Aerosol penetration for tested HEPA filter shall not exceed 0.03% (0.0003) when challenged with essentially mono-dispersed aerosol particles of approximately 0.3 micrometers in diameter.

Penetration test shall conform to one of the following: MIL-STD-282, ASME AG-1 Sub-subarticle FC-5120, or IEST-RP-CC-007.2.
Penetration test shall be conducted at both 100% rated flow and 20% rated flow. Filters with a rated flow of less than 125 cfm need be tested at rated flow only unless otherwise noted on the HEPA Filter Data Sheet.

### 4.4.2 Airflow Resistance

**Note:** Production testing and DOE FTF Quality Assurance verification testing for airflow resistance may express flow rate in terms of actual cubic feet per minute (acfm), rather than ASME AG-1 specified standard cubic feet per minute (scfm). See section 9.0 for additional information.

a. Air flow resistance across a clean, standard-size and shape HEPA filter at rated flow shall not exceed Table 1 limits below (table based on ASME AG-1 Table FC-4110).

<table>
<thead>
<tr>
<th>Size Designation</th>
<th>Dimensions (inches)</th>
<th>Nominal Airflow (cfm)</th>
<th>Maximum Resistance (in wg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 x 8 x 3-1/16</td>
<td>25</td>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
<td>8 x 8 x 5-7/8</td>
<td>50</td>
<td>1.3</td>
</tr>
<tr>
<td>3</td>
<td>12 x 12 x 5-7/8</td>
<td>125</td>
<td>1.3</td>
</tr>
<tr>
<td>4</td>
<td>24 x 24 x 5-7/8</td>
<td>500</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>24 x 24 x 11-1/2</td>
<td>1000</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>24 x 24 x 11-1/2</td>
<td>1250</td>
<td>1.3</td>
</tr>
<tr>
<td>7</td>
<td>24 x 24 x 11-1/2</td>
<td>1500</td>
<td>1.3</td>
</tr>
<tr>
<td>8</td>
<td>24 x 24 x 11-1/2</td>
<td>2000</td>
<td>1.3</td>
</tr>
<tr>
<td>9</td>
<td>12 x 12 x 11-1/2</td>
<td>250</td>
<td>1.3</td>
</tr>
</tbody>
</table>

b. For non-standard HEPA filter shapes and sizes (i.e., Sizes not shown in Table 1) reference Table 2 for rated flow information.
### Table 2 Nominal Dimensions, Airflow Ratings, and Maximum Resistance for Non-standard HEPA Filters

<table>
<thead>
<tr>
<th>Dimensions (Inches)</th>
<th>Nominal Pack Depth (Inches)</th>
<th>Nominal Rated Airflow (acfm)</th>
<th>Maximum Resistance (in wg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rectangular / Square Filter (Height x Width x Depth)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 x 12 x 5-7/8</td>
<td>4 or 5-1/2</td>
<td>250</td>
<td>1.0</td>
</tr>
<tr>
<td>24 x 18 x 5-7/8</td>
<td>4 or 5-1/2</td>
<td>375</td>
<td>1.0</td>
</tr>
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<td>24 x 24 x 5-7/8</td>
<td>4 or 5-1/2</td>
<td>500</td>
<td>1.0</td>
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<tr>
<td>24 x 30 x 5-7/8</td>
<td>4 or 5-1/2</td>
<td>625</td>
<td>1.0</td>
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<tr>
<td>12 x 12 x 11-1/2</td>
<td>11</td>
<td>200</td>
<td>1.0</td>
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<td>12 x 12 x 11-1/2</td>
<td>11</td>
<td>250</td>
<td>1.3</td>
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<td>24 x 12 x 11-1/2</td>
<td>11</td>
<td>455</td>
<td>1.0</td>
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<tr>
<td>24 x 18 x 11-1/2</td>
<td>11</td>
<td>725</td>
<td>1.0</td>
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<td>24 x 24 x 11-1/2</td>
<td>11</td>
<td>1250</td>
<td>1.3</td>
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<td>24 x 30 x 11-1/2</td>
<td>11</td>
<td>1275</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Separatorless Round Filter (Barrel O.D. x Flange Diameter x Length)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-5/8 x 8 x 8</td>
<td>4</td>
<td>35</td>
<td>1.0</td>
</tr>
<tr>
<td>10-5/8 x 12 x 8</td>
<td>4</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Separator-Type Round Filter (Barrel O.D. x Flange Diameter x Length)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-5/8 x 8 x 5-1/4</td>
<td>3-1/16</td>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>6-5/8 x 8 x 8</td>
<td>5-1/2</td>
<td>35</td>
<td>1.0</td>
</tr>
<tr>
<td>10-5/8 x 12 x 8</td>
<td>5-1/2</td>
<td>100</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Separatorless Enclosed Filter (Frame Height x Width x Depth)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Nipple Filter</td>
<td>Two Nipple Filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 x 8 x 10</td>
<td>8 x 8 x 14</td>
<td>50</td>
<td>1.3</td>
</tr>
<tr>
<td>12 x 12 x 12</td>
<td>12 x 12 x 18</td>
<td>125</td>
<td>1.3</td>
</tr>
<tr>
<td>12 x 12 x 16</td>
<td>12 x 12 x 20</td>
<td>200</td>
<td>1.0</td>
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<tr>
<td>12 x 12 x 16</td>
<td>12 x 12 x 20</td>
<td>250</td>
<td>1.3</td>
</tr>
<tr>
<td>24 x 24 x 12</td>
<td>24 x 24 x 14</td>
<td>500</td>
<td>1.0</td>
</tr>
<tr>
<td>24 x 24 x 16</td>
<td>24 x 24 x 20</td>
<td>1000</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Separator-Type Enclosed Filter (Frame Height x Width x Depth)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Nipple Filter</td>
<td>Two Nipple Filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 x 8 x 8</td>
<td>8 x 8 x 12</td>
<td>25</td>
<td>1.3</td>
</tr>
<tr>
<td>8 x 8 x 10</td>
<td>8 x 8 x 14</td>
<td>50</td>
<td>1.3</td>
</tr>
<tr>
<td>12 x 12 x 12</td>
<td>12 x 12 x 18</td>
<td>125</td>
<td>1.3</td>
</tr>
<tr>
<td>12 x 12 x 16</td>
<td>12 x 12 x 20</td>
<td>250</td>
<td>1.3</td>
</tr>
<tr>
<td>24 x 24 x 12</td>
<td>24 x 24 x 14</td>
<td>500</td>
<td>1.0</td>
</tr>
<tr>
<td>24 x 24 x 16</td>
<td>24 x 24 x 20</td>
<td>1000</td>
<td>1.0</td>
</tr>
</tbody>
</table>
c. For non-standard HEPA filters not listed in either Table 1 or Table 2, airflow resistance shall be in accordance with IEST-RP-CC001.5, Paragraph 4.1.2. Dimensions (size) shall be as specified on the HEPA Filter Data Sheet.

4.4.3 Structural Integrity

a. Filters shall be capable of withstanding a pressure drop of 10 "wg (254 mm) across the filter pack for 60 minutes without experiencing physical damage or increase in penetration.

b. Unless exempted per the HEPA SME, structural integrity for filter designs shall be demonstrated through seismic qualification testing performed in accordance with ASME AG-1, Subarticle FC-4300 as follows:
   - Basic filter designs (e.g., ASME AG-1 Section FC Type A and C) shall be seismically qualified in a standard 1-high x 1-wide bag-in /bag-out filter housing. Seismic loads applied during testing shall meet or exceed requirements for UBC Zone 4.
   - Additional seismic testing (if required) shall be as specified in the HEPA Filter Data Sheet.
   - Test results shall be provided to the Buyer upon request.

4.5 FABRICATION REQUIREMENTS

4.5.1 Fabrication

As a minimum, filter fabrication shall conform to IEST-RP-CC001.5, Paragraph 8, Construction Requirements or ASME AG-1, Article FC-6000, Fabrication.

4.5.2 Filter Tolerances

Allowable tolerances for filter case dimensions are summarized in Table 3.

<table>
<thead>
<tr>
<th>Table 3 Filter Case Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>RECTANGULAR FILTER CASES</strong></td>
</tr>
<tr>
<td>Face Dimensions (Based on ASME AG-1)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Depth (dimension excludes gaskets)</td>
</tr>
<tr>
<td>Flatness and Parallelism of Face</td>
</tr>
<tr>
<td>Squareness (opposing corner-to-corner diagonals for each face)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Gasket Width</td>
</tr>
</tbody>
</table>
RECTANGULAR FILTER CASES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Filter Size (Nominal)</th>
<th>Allowable Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasket Seating Surface</td>
<td>All filters</td>
<td>Square with the sides of the frame (i.e., within 2°)</td>
</tr>
</tbody>
</table>

CYLINDRICAL AND RADIAL FILTER CASES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Filter Size (Nominal)</th>
<th>Allowable Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrel Diameter</td>
<td>OD 12 in. (305 mm) or larger</td>
<td>+0, -1/8 in. (-3 mm)</td>
</tr>
<tr>
<td></td>
<td>OD less than 12 in. (305 mm)</td>
<td>+0, -1/16 in. (-1.6 mm)</td>
</tr>
<tr>
<td>Depth (dimension excludes gaskets)</td>
<td>All filters</td>
<td>+1/16 in. (1.6 mm), -0</td>
</tr>
<tr>
<td>Flatness of Face</td>
<td>All filters</td>
<td>1/16 in. (1.6 mm)</td>
</tr>
<tr>
<td>Gasket Width</td>
<td>All Gasketed Filters</td>
<td>3/16 in. (19 mm) ±1/16 in. (1.6 mm)</td>
</tr>
</tbody>
</table>

4.5.3 Medium Installation

Note: High-temperature filter packs (1000 °F) are secured within the filter case using glass packing not adhesive.

Filter Pack shall be assembled to form a filter cartridge and shall be bonded to the frame at all contact surfaces.

Media shall be fastened to the sides and ends of the filter case with adhesive to completely seal the edges of the media to the filter case.

Patching of holes or tears in media is not permitted.

4.5.4 Gaskets

Gaskets shall not extend 1/16 inch (1.6 mm) over either side of the seating surface at any location. Edges of the joint areas shall be thoroughly coated with adhesive.

4.5.5 Gelatinous Seals

Sealant material shall be free of foreign material and without deformation. Unless a tolerance is specified in the data sheet, the channel shall be filled uniformly to the top without over filling the channel.

4.5.6 Face Guards

Faceguard edges shall be firmly embedded in adhesive inside the filter case, but not under the gasket, or enclosed within a metal “picture frame” for metal frame filters. Wire edges, formed when slitting or shearing expanded-metal faceguards, shall be smoothed on both surfaces of the material before installation. In all cases, faceguards shall be installed such that projecting wires cannot puncture or abrade the media, or present a puncture hazard to personnel handling the filter. Face guard installation is required on both the upstream and downstream faces.
4.5.7 Workmanship

The filter shall be free from foreign matter (dirt, oil, or viscous material) and damage, such as distorted or cracked frame, deformation or sagging of media, separators and faceguard, cracks in adhesive, cracks or holes in exposed portions of the media. All the dimensional and performance requirements of this specification are directed toward achieving the highest quality and workmanship possible.
5.0 INSPECTION AND TESTING

5.1 QUALIFICATION TESTING

5.1.1 Filter Media Qualification Test

Filter media qualification testing shall be performed in accordance with ASME AG-1 Mandatory Appendix FC-I (Articles FC-I-3000 and FC-I-4000.)

a. As a minimum, media qualification testing shall demonstrate physical and chemical properties of the media meet or exceed the following ASME AG-1 performance requirements:
   - Airflow resistance per FC-I-3210
   - Aerosol penetration per FC-I-3220
   - Tensile strength per FC-I-3230
   - Water repellency per FC-I-3240
   - Thickness per FC-I-3250
   - Combustible Material per FC-I-3260
   - Flexing Characteristics per FC-I-3270
   - Resistance to Radiation per FC-I-3234 and FC-I-3242
   - Workmanship per FC-I-3300

b. Filter media shall be re-qualified at least every five years and certified by an independent test facility.

c. If a filter media fails any or all of the requalification tests, the Supplier shall notify the Buyer what filter models used the media that failed requalification.

5.1.2 Filter Design Qualification Test

Filter design qualification testing should be performed in accordance with ASME AG-1, Article FC-5000. Filters submitted for qualification testing shall be either prototypes of the proposed design, or production filters of the specific design randomly selected from Manufacturer’s stock.

a. Independent qualification testing should demonstrate performance of an assembled filter meets or exceeds ASME AG-1 performance requirements. Qualification testing should consist of the following:
   - Resistance to Airflow per FC-5110
   - Test Aerosol Particle Penetration per FC-5120
   - Resistance to Rough Handling per FC-5130
   - Resistance to Pressure per FC-5140
   - Resistance to Heated Air per FC-5150
   - Spot Flame Resistance per FC-5160

As allowed per AG-1, Sub-subarticle FC-5160, an Underwriter’s Laboratories UL-586 label shall be acceptable objective evidence for demonstrating compliance to heated air or spot flame test requirements.
b. Filter designs should be re-qualified at least every five years and certified by an independent test facility.

5.2 FILTER PRODUCTION TESTING

Note: For self-contained filters, production testing for aerosol penetration and resistance to airflow may be completed prior to attachment of the assembly end caps and nipple connections.

5.2.1 Each filter shall be tested for aerosol penetration and resistance to airflow in accordance with IEST-RP-CC001.5, Paragraph 9.1, ASME AG-1 Section FC-5120 or HEPA SME approved method. The test shall be performed at 100% rated flow and 20% rated flow. Filters with a rated flow of less than 125 cfm shall be tested at the rated air flow only. Aerosol penetration shall not exceed 0.03% (0.0003) when challenged with essentially mono-dispersed particles of approximately 0.3 micrometers in diameter. Date of penetration testing shall be identified on the filter nameplate.

5.2.2 Required Supplemental Testing for Enclosed (Self-contained) HEPA filters

a. Bubble Leak Test shall be performed for each enclosed filter as follows:

Each self-contained HEPA filter shall be tested to verify the absence of leakage on exterior seams and joints of the frame. The test shall be conducted at rated flow (positive pressure) using a bubble solution. No evidence of leakage is allowed. The date and successful completion of bubble test shall be identified on the filter nameplate.

b. Pneumatic Pressure Boundary Test shall be performed for each enclosed filter as follows:

Note: The Supplier has the option to select either the Constant Pressure Method or Pressure Decay Test when performing the boundary leak test.

End caps with instrumentation connections shall be temporarily placed on the ends of the filter assembly to form the necessary pressure boundary. The specified test pressure shall be applied in direction of the normal operational pressure. Negative pressure shall be assumed, unless otherwise specified in the HEPA Filter Data Sheet. The test shall be performed in accordance with test methods described in ASME AG-1, Mandatory Appendix TA-III. Unless otherwise stated, test pressure shall be equal to -10” water gauge. Acceptance criteria/allowable leakage is <0.3% of total volume of filter assembly (e.g., enclosure and nipples) per hour. The date and results of the pressure boundary test shall be identified on the filter nameplate.
5.3 DOE FILTER TEST FACILITY QUALITY ASSURANCE TESTING

Note: This Section applies to the DOE Filter Test Facility.

5.3.1 Uniform Commercial Code (UCC) requirements governing acceptance and disposition of non-conforming goods apply. If during DOE FTF receipt inspection, a filter is identified as damaged and is considered unacceptable for use, the DOE FTF shall contact the buyer and seller (supplier) and inform them of the damage immediately.

5.3.2 DOE FTF inspection and testing shall be performed in accordance with DOE-STD-3025-2007, *Quality Assurance Inspection and Testing of HEPA Filters*. As a condition of acceptance, all filters must successfully pass DOE FTF inspection and testing requirements per Section 5 of DOE-STD-3025-2007.

5.3.3 DOE FTF shall prepare a report to document the test results and apply permanent test labels on the filter case and filter carton.

5.3.4 Accepted and rejected filters shall be marked as specified in Section 5 of DOE-STD-3025-2007.

5.3.5 If filter(s) fail DOE FTF inspection or testing, the DOE FTF shall notify both the Buyer and Supplier. The Supplier shall be responsible for either replacing failed filter(s), or crediting the Buyer, unless other accommodations are agreed upon between the Buyer and the Supplier.

5.3.6 After the completion of required inspections and tests, but immediately preceding repackaging of the filter, DOE FTF personnel shall re-inspect the fluid seal (if so equipped) to verify the sealant was not inadvertently damaged during DOE FTF handling.

5.3.7 DOE FTF shall repack accepted filters in a manner comparable to the original packaging received.

5.3.8 DOE FTF activities involving packaging, shipping, and storage of HEPA filters shall conform to Level B requirements per ASME NQA-1, Part II, Subpart 2.2.
6.0 MARKING AND IDENTIFICATION

6.1 FILTER MARKING AND IDENTIFICATION

6.1.1 Marking and labeling for each filter shall conform to the requirements of IEST-RP-CC001.5, Section 10, ASME AG-1 Subarticle FC-9100, and labeling requirements of this specification.

6.1.2 Filter case marking and identification shall include the following information:

- Manufacturer’s Name or Symbol
- Filter Model Number
- Filter Serial Number
- Rated Flow Capacity
- Test Airflow Direction
- Pressure Resistance at Rated Flow
- Percent Penetration at 100% Rated Flow
- Percent Penetration at 20% Rated Flow (if rated flow is 125 cfm or more)
- UL 586 Label (if applicable)

Note: Bolded items below represent additional labeling information that shall be provided with each filter (i.e. labeling not required by ASME AG-1)

- Reference applicable IEST Standard (IEST-RP-CC001.5)
- Type and Grade (per IEST-RP-CC001.5 sections 4.2 and 5)
- Date/Status of Bubble Leak Test (self-contained filters only)
- Results of Pressure Decay Test (self-contained filters only)
- Date of Filter Manufacture
- Date of Penetration Test
- Hanford Purchase Order (PO) Number and PO Line Item Number
- Procurement Specification Number and Revision
- DOE FTF Test Label (applied by DOE FTF personnel)

6.1.3 Review purchase order to ensure additional filter identification and labeling requirements are not applicable.

6.2 PACKAGE MARKING AND IDENTIFICATION

6.2.1 Marking and labeling for each filter carton shall conform to the requirements of ASME AG-1 Subarticle FC-9200 and the requirements of this specification.

6.2.2 Carton markings shall appear on a minimum of two sides, preferably on one side and the top end.
6.2.3 Carton markings shall include the following information:

- Manufacturer’s Name or Symbol
- Orientation Arrows and any other ASME AG-1 Required Text (e.g., Fragile, etc.)
- Filter Model Number

Note: Bolded items below represent additional labeling that shall be provided on each shipping container (i.e., non ASME AG-1 required labeling).

- Hanford Purchase Order (PO) Number (and PO Line Item Number)
- Filter Serial Number
- Procurement Specification Number and Revision
- DOE FTF Test Label (applied by DOE FTF personnel)
7.0 PACKAGING, SHIPPING, AND STORAGE

7.1 PACKAGING

7.1.1 Filters shall be individually packaged in wood or corrugated paperboard cartons having corner braces, inserts, or other means of shock prevention to protect the filter during shipment, handling, and storage. Shock prevention material shall not be constructed in such a way that it might puncture the filter medium if it comes into contact with the face of the filter.

7.1.2 Containers shall be designed so that they can be opened, and the filter removed, without damage to the container or filter and so that the container can be reused for shipment to alternate destinations.

7.1.3 Filters with fluid seals shall be packaged in a manner so as to prevent contact of the gelatinous seal with any portion of the shipping container during transport, and to minimize the potential for sealant contact with dirt or debris during DOE FTF and Acquisition Verification Services (AVS) receipt inspection and handling.

7.1.4 ASME AG-1 Section FC Type-A, Type-C and Type D filters shall be packed in cartons with the pleats oriented in a vertical position.

7.1.5 ASME AG-1 Section FC Type-B filters (mini-pleat design) shall be packed in cartons with the pleats oriented in a horizontal position.

7.2 SHIPPING

7.2.1 Shipping shall be in conformance with (ASME NQA-1, Part II, Subpart 2.2) Level B item designation requirements or as submitted by the seller and approved by the HEPA SME.

7.2.2 If possible, shipment shall be arranged so that the filter assemblies are not disturbed after they leave the Supplier’s facility until they are received at the address designated by the Buyer. Arrangements shall be made by the manufacturer to ensure filters are shipped directly to the DOE-FTF.

7.2.3 For large shipments, it is recommended that the entire shipment be shipped in a sealed dedicated trailer or rail car. At all times, the filters must be handled with care and orientated properly. Handling requirements (unique to filters) shall be clearly visible on the shipping carton.

7.2.4 Filters shall be shipped palletized or crated to minimize and simplify unit handling, particularly at public carrier interchange points. Standard pallet sizes shall be used by the Supplier. The pallet and filters shall be protected on all sides and the top by resilient material such as plywood or plastic. The pallet or crate protective sides and top shall be
RPP-SPEC-60635 Rev. 0

easily removed and reinstalled to allow for inspection and testing at the FTF and TOC receiving facilities. Shipping container designs shall be submitted for Buyer approval.

7.2.5 Individual filter cartons shall not be stacked more than 3 high. No other materials shall be placed on top of the filters during shipment. A packing list shall be glued securely to the outside of one carton. The packing list shall clearly state if the shipment is a partial shipment against the procurement documents. When requested and authorized by the Buyer, air freight shipments shall also be palletized in accordance with this specification.

7.2.6 The carrier shall be instructed that the Buyer’s personnel will be responsible for unloading filters at the Buyer’s receiving facility.

7.3 STORAGE

7.3.1 Storage at the Supplier’s facility shall be in accordance with Level B storage requirements per ASME NQA-1, Part II, Subpart 2.2 or as submitted by the seller and approved by the HEPA SME.
8.0 QUALITY ASSURANCE

8.1 QUALITY ASSURANCE PROCUREMENT CLAUSES

The following procurement quality assurance clauses supplement specification requirements and therefore apply to all HEPA filter procurements per this specification unless otherwise specified on the HEPA Filter Data Sheet.

B01 – QA Program Submittal and Pre-award Survey
B04 – Supplier Quality Assurance Program Evaluation (may be waived by HEPA SME)
B07 – Certified Quality Program
B32 – Identification of Items with Part Number/Model Number
B33 – Identification of Items with Product Data Sheet
B43 – Identification of Age Control
B52 – Inspection and Test Report
B76 – Procurement of Potentially Suspect or Counterfeit Items
B79 – Certificate of Conformance
B85 – Packaging/Shipping Procedures

8.1.1 Review Purchase Order for changes to procurement clauses.

8.2 SUPPLIER QUALITY ASSURANCE PROGRAM

8.2.1 Supplier shall have a documented quality program that is in conformance with ASME AG-1, Articles FC-8000 and AA-8000 or other approved quality assurance program as approved by the HEPA SME. The quality program shall ensure that products and services provided meet or exceed contract requirements. This program may be evaluated by the Buyer’s Quality Assurance organization. This evaluation may be waived on a case by case basis as specified on the HEPA Filter Data Sheet. The Supplier must successfully disposition any resulting findings or observations prior to award of contract.

Note: The specifying engineer shall adjust the quality assurance B clauses on the HEPA Filter data sheet as necessary to match quality level of the HEPA filter.

8.2.2 IF HEPA Filter SME has approved an exception to allow procurement of a HEPA filter as TOC Quality Level 3, Supplier quality assurance program requirements shall be as specified in the procurement documentation and HEPA Filter Data Sheet.

8.2.3 Supplier’s program shall be subject to review at all times by the Buyer. The Buyer reserves the right to verify the quality of work at the Supplier’s facility, including the Supplier’s subcontractor facilities.
8.2.4 Supplier shall, during the performance of this purchase order, submit any proposed change(s) to the quality assurance program to the Buyer for review and approval prior to implementation.
8.2.5 Supplier shall be notified by the Buyer of rejected filters, including the nature of the rejection. Unless otherwise negotiated between the Supplier and Buyer, the Supplier shall provide replacement filters until the stipulated quantity of filters is found acceptable. The Supplier shall provide, at the discretion of the Buyer, replacement filters and/or credit for any rejected filters.

8.2.6 The Buyer may elect to have qualification testing or verification of materials performed on any filters furnished to them. Failure of any filter submitted for qualification testing to meet specification requirements shall be cause for a re-evaluation of the Supplier’s quality assurance program, when deemed necessary by the buyer.

8.2.7 Supplier’s certificate of conformance shall be provided with each filter shipment [Ref. ASME AG-1 Subarticle FC-8200]. In addition to QA Clause B-79 requirements, the Certificate of Conformance shall provide the following:

- Copies of all filter case material certifications (if required by the purchase order.)

8.2.8 Upon Buyer request, Supplier shall, provide objective evidence that filter media qualification tests have been conducted by an independent laboratory in accordance with ASME-AG-1, Appendix FC-I-4100.

8.2.9 Upon Buyer request, and where requirement applicability has been established through either this specification or the procurement contract, Supplier shall provide objective evidence that specified filter qualification tests have been successfully performed.

8.2.10 The Buyer reserves the right to require a Corrective Action Report or Non-Conformance report to be generated by the Seller depending on the frequency and nature of DOE FTF rejections.

8.3 SUPPLIER RECORDS

The Supplier shall maintain all required records in accordance with their Quality Assurance Program.

8.4 SCHEDULE

See procurement documents for required delivery date(s).

8.5 PERSONNEL QUALIFICATIONS/CERTIFICATIONS

Supplier personnel performing independent inspection or verification activities shall be qualified or certified in accordance with the Supplier’s Quality Assurance Program.

8.6 DELIVERABLES

HEPA filters and documentation as specified per this procurement specification and associated procurement documents.
9.0 EXCEPTIONS

Note: The intent of this specification is to assure HEPA filter conformity to ASME AG-1 where possible. However, ASME AG-1 requirement interpretations, clarifications, and exceptions may sometimes be necessary to facilitate the procurement process.

9.1 PROPOSED/TENTATIVE ASME AG-1 CHANGES

Supplier performed production testing and DOE FTF verification testing have traditionally reported HEPA filter flow rate in terms of (acfm) and have not corrected flow measurements to standard conditions (scfm), as required by ASME AG-1, Subsubarticle FC-5120. Discussions within the ASME AG-1 Section FC project team are ongoing but a general consensus within the project team indicates that production test results should not require correction to standard conditions. It is worth noting that ASME AG-1, Section FK (Special Round and Duct-Connected HEPA Filters) specifies acfm rather than scfm. Until the Filtration subcommittee comes to a consensus on appropriate reporting criteria between section FC and FK, Test reports in acfm are acceptable unless otherwise noted on datasheet.

9.2 HEPA FILTER INTERPRETATIONS AND CLARIFICATIONS

9.2.1 ASME AG-1 Figure FC-4110-1, shows the standard gasket thickness is ¼ inch (6 mm). Where a thicker gasket is needed to maintain an effective seal, and if specified on the HEPA Filter Data Sheet, gasket thickness may exceed the ASME AG-1-specified ¼ inch (6 mm) value. However, under no circumstances shall gasket nominal thickness exceed 3/8 inch (9 mm). Use of non-standard gaskets must be identified on an approved engineering drawing.

9.2.2 ASME AG-1 Subsubarticle FC-4110 (b) states that the total medium area provided within filter pack shall be such that the maximum velocity is 5.0 ft/min at the rated flow. Some legacy filtration system housing designs specify a HEPA filter pack style that results in a slightly higher velocity at rated flow. Higher velocity filters are acceptable as long as the medium has passed the ASME AG-1 qualification testing, and the system falls under the criteria in DOE STD-3020-2015, Specification for HEPA Filters Used by DOE Contractors, Section 5.5 Legacy HEPA Filter Configurations.

9.3 PRE-AWARED SPECIFICATION EXCEPTIONS

Note With the exception of items described in Steps 9.1 and 9.2, the Supplier shall identify any specification requirements which cannot be fully satisfied. As a minimum, all exceptions shall be approved by the HEPA Filter Subject Matter Expert.

9.3.1 Prior to award of contract, the supplier shall identify all known requirement exceptions in the “Request for Quotation” (RFQ).
9.3.2 All issues shall be resolved to the satisfaction of the Buyer prior to awarding the contract. Resolution of issues shall be documented and saved with Purchase Order records.

9.4 POST-AWARD SPECIFICATION EXCEPTIONS

9.4.1 If specification or contract exceptions are identified after the contract has been awarded, the Supplier shall proceed as follows:

a. All fabrication work associated with the filter order shall cease pending formal direction from the Buyer.

b. Supplier shall immediately inform the Buyer of discrepancy and provide the following information:
   - Identify the specification and revision number;
   - Identify the criteria that cannot be met by the item and section number;
   - Present an explanation for the exception;
   - Present a proposal for resolution of the exception; and,
   - Present a price and schedule adjustment for resolution of the exception.

c. The Buyer, HEPA Filter SME, ordering Engineer (as applicable), and Quality Assurance Engineer will evaluate the Supplier’s documentation and make a determination regarding the proposed resolution.

d. All exception requests shall be documented per the Supplier’s Non-conforming Item policy.
10.0 ACCEPTANCE OF ITEMS

Acceptance of the filter shipment will not be made by the Buyer until each filter has been accepted by an Acquisition Verification Services (AVS) Quality Assurance inspector. With the exception of damage directly attributable to either the Shipper or the DOE FTF, failure to meet inspection, test, or verification requirements shall be cause for rejection.
RPP-SPEC-60635 Rev. 0

APPENDIX A

RPP SPEC-60635, Non-Standard HEPA Filter Data Sheet (Revision 0)
### RPP-SPEC-60635 Non-Standard HEPA Filter Data Sheet (Revision 0)

<table>
<thead>
<tr>
<th>CAT ID Number: ____</th>
<th>QL-1 Safety Class, unless approved by HEPA SME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requestor: ____</td>
<td>Date: ____</td>
</tr>
</tbody>
</table>

**Service / Application** (n/a for general spare part): ____  
**Material Analyst Group (MAG), if applicable:** ____  
**Recommended Manufacturer:** ____  | **Part Number:** ____

**Filter Shape:**  
- Rectangular/Square  
- Cylindrical/Round  
- Radial

**Special Hardware Options**  
- None  
- Extractor T-Clips  
- Lifting Bail (Round Filters)  
- 2" Extended Frame with Roughing Filter  
- U-Handles (option for Flander’s G-1 Housing)  
- Drilled Flanges, Specify: Hole Size-_____ and Spacing-_____  
- Other, Specify: ____

**Temperature Rating**  
- 250°F (120°C)  
- Other, Specify Temperature Range: ____

**Filter Media:**  
- Standard Media  
- HF Acid Resistance  
- HN03 Acid Resistance

**Frame Material Wood:**  
- ¾ Inch Thick Fire Retardant Plywood -OR-  
- ¾ Inch Thick Fire Retardant Marine Plywood

**Frame Material Steel:**  
- 14 Gauge Steel:  
  - Galvanized  
  - Type 409  
  - Type 304  
  - Type 304L  
  - Type 316  
  - Type 316L  
- 16 Gauge Steel:  
  - Galvanized  
  - Type 409  
  - Type 304  
  - Type 304L  
  - Type 316  
  - Type 316L

**Pack Type:**  
- 4 Inch Deep Separatorless  
- 11 Inch Deep Separatorless  
- Aluminum Separators, Not Coated  
- Aluminum Separators, with Protective Coating  
- Other, Specify: ____

**Frame Style:**  
- Rectangular/Square:  
  - Box Type Construction (Wood only)  
  - ¼ Inch Double Turned Flange (Metal only)  
- Cylindrical/Round:  
  - Single Flange, Flange Size: ____  
  - Double Flange, Flange Size: ____  
  - Fluid Seal, No Flanges  
  - Other, Specify: ____

**Nipple:**  
- One Nipple, Diameter: ____ , Depth: ____ , Location: ____  
- Two Nipple, Diameter: ____ , Depth: ____

**Notes/Other:** ____

**Pack to Frame Sealant**  
- Fire Retardant Urethane  
- RTV Silastic Silicone  
- Glass Packing (1000°F Filter)  
- Other, Specify: ____

**Pressure Boundary Test (Enclosed Filters only)**  
- Standard Test Pressure and Acceptance Criteria (-10” w.g. & <3% per hour)  
- Non-Standard, Specify Test Pressure: ____ & Acceptance Criteria: ____

**Gasket Type:**  
- No Gasket,  
- ¼” Thick Neoprene,  
- 3/8” Thick Neoprene,  
- Gel Seal,  
- Silicone Sponge,  
- Glass Packing,  
- Other, Specify: ____

**Gasket/Seal Location:**  
- Upstream,  
- Downstream,  
- Both (Gasket Only)

**Faceguard Type:**  
- Galvanized Steel  
- Stainless Steel  
- Other: ____

**Faceguard Location:**  
- Both Faces (Required)
## Filter Frame Style

### Square/Rectangular Filter

<table>
<thead>
<tr>
<th>Filter Size</th>
<th>Rated Flow</th>
<th>Press. Drop</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8” x 8” x 3-1/16”</td>
<td>25 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 1</td>
</tr>
<tr>
<td>8” x 8” x 5-7/8”</td>
<td>50 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 2</td>
</tr>
<tr>
<td>12” x 12” x 5-7/8”</td>
<td>125 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 3</td>
</tr>
<tr>
<td>12” x 24” x 5-7/8”</td>
<td>245 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>24” x 12” x 5-7/8”</td>
<td>250 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>24” x 18” x 5-7/8”</td>
<td>375 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>24” x 24” x 5-7/8”</td>
<td>500 cfm</td>
<td>1.0 in wg</td>
<td>AG-1 Designator: 4</td>
</tr>
<tr>
<td>24” x 30” x 5-7/8”</td>
<td>625 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>12” x 12” x 11-1/2”</td>
<td>200 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>12” x 12” x 11-1/2”</td>
<td>250 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 9</td>
</tr>
<tr>
<td>24” x 12” x 11-1/2”</td>
<td>455 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>24” x 18” x 11-1/2”</td>
<td>725 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
<tr>
<td>24” x 24” x 11-1/2”</td>
<td>1000 cfm</td>
<td>1.0 in wg</td>
<td>AG-1 Designator: 5</td>
</tr>
<tr>
<td>24” x 24” x 11-1/2”</td>
<td>1250 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 6</td>
</tr>
<tr>
<td>24” x 24” x 11-1/2”</td>
<td>1500 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 7</td>
</tr>
<tr>
<td>24” x 24” x 11-1/2”</td>
<td>2000 cfm</td>
<td>1.3 in wg</td>
<td>AG-1 Designator: 8</td>
</tr>
<tr>
<td>24” x 30” x 11-1/2”</td>
<td>1275 cfm</td>
<td>1.0 in wg</td>
<td></td>
</tr>
</tbody>
</table>

### Other: ___

### Round Filters

<table>
<thead>
<tr>
<th>Filter Size</th>
<th>Rated Flow</th>
<th>Press. Drop</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-5/8” dia. x 5-1/4’</td>
<td>20 cfm</td>
<td>1.0 in wg</td>
<td>With Separators</td>
</tr>
<tr>
<td>6-5/8” dia. x 8”</td>
<td>35 cfm</td>
<td>1.0 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>10-5/8” dia. x 8”</td>
<td>100 cfm</td>
<td>1.0 in wg</td>
<td>With or Without Separators</td>
</tr>
</tbody>
</table>

### Other: ___ dia. x ___

### Nipple Connected Filter

<table>
<thead>
<tr>
<th>Filter Size</th>
<th>Rated Flow</th>
<th>Press. Drop</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8” x 8” x 8”</td>
<td>25 cfm</td>
<td>1.3 in wg</td>
<td>With Separators</td>
</tr>
<tr>
<td>8” x 8” x 12”</td>
<td>25 cfm</td>
<td>1.3 in wg</td>
<td>With Separators</td>
</tr>
<tr>
<td>8” x 8” x 10”</td>
<td>50 cfm</td>
<td>1.3 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>8” x 8” x 14”</td>
<td>50 cfm</td>
<td>1.3 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>12” x 12” x 12”</td>
<td>125 cfm</td>
<td>1.3 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>12” x 12” x 18”</td>
<td>125 cfm</td>
<td>1.3 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>12” x 12” x 16”</td>
<td>200 cfm</td>
<td>1.0 in wg</td>
<td>Without Separators</td>
</tr>
<tr>
<td>12” x 12” x 16”</td>
<td>250 cfm</td>
<td>1.3 in wg</td>
<td>With Separators</td>
</tr>
<tr>
<td>12” x 12” x 20”</td>
<td>200 cfm</td>
<td>1.0 in wg</td>
<td>Without Separators</td>
</tr>
<tr>
<td>12” x 12” x 20”</td>
<td>250 cfm</td>
<td>1.3 in wg</td>
<td>With Separators</td>
</tr>
<tr>
<td>24” x 24” x 12”</td>
<td>500 cfm</td>
<td>1.0 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>24” x 24” x 14”</td>
<td>500 cfm</td>
<td>1.0 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>24” x 24” x 16”</td>
<td>1000 cfm</td>
<td>1.0 in wg</td>
<td>With or Without Separators</td>
</tr>
<tr>
<td>24” x 24” x 20”</td>
<td>1000 cfm</td>
<td>1.0 in wg</td>
<td>With or Without Separators</td>
</tr>
</tbody>
</table>

### Other: ___

---

**Note(s): _____**
RPP-SPEC-60635 Rev. 0

All Filters shall be tested at the DOE Filter Test Facility (FTF)
All Filters except high-temperature filters must be tested per UL586. Objective evidence shall include a UL-586 label.
FILTERS SHALL BE IN ACCORDANCE WITH SPECIFICATION RPP-SPEC-60635 Rev. 0
The following QA Clauses apply:
B01 – QA Program Submittal and Pre-award Survey
B04 – Supplier Quality Assurance Program Evaluation (may be waived by HEPA SME)
B07 – Certified Quality Program
B32 – Identification of Items with Part Number/Model Number
B33 – Identification of Items with Product Data Sheet
B43 – Identification of Age Control
B52 – Inspection and Test Report
B76 – Procurement of Potentially Suspect or Counterfeit Items
B79 – Certificate of Conformance
B85 – Packaging/Shipping Procedures
Other: _____

Notes, Specification Exceptions, QA clause changes or additional vendor instructions:

_____  

SME Approval: Name: _____ Date: _____