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USACE / NAVFAC / AFCEC / NASA UFGS-23 40 00.00 10 (October 2006)  
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Preparing Activity: USACE Superseding  
UFGS-23 40 00.00 10 (April 2006)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2014

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10/06

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### SECTION 23 40 00.00 10

#### CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) AIR FILTRATION SYSTEM 10/06

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NOTE: This guide specification covers the requirements for chemical, biological, and radiological air filtration systems.

Adhere to [UFC 1-300-02](#) Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a [Criteria Change Request \(CCR\)](#).

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## PART 1 GENERAL

### 1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically  
be deleted from this section of the project  
specification when you choose to reconcile  
references in the publish print process.

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The publications listed below form a part of this specification to the  
extent referenced. The publications are referred to within the text by the  
basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 52.2 (2012; Errata 2013) Method of Testing  
General Ventilation Air-Cleaning Devices  
for Removal Efficiency by Particle Size

ASME INTERNATIONAL (ASME)

ASME AG 1 (2012) Code on Nuclear Air and Gas  
Treatment

ASME BPVC SEC IX (2010) BPVC Section IX-Welding and Brazing  
Qualifications

ASME N509 (2002; R 2008) Nuclear Power Plant  
Air-Cleaning Units and Components

ASME N510 (2007) Testing of Nuclear Air - Treatment  
Systems

ASME NQA-1 (2012) Quality Assurance Requirements for  
Nuclear Facility Applications

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M (2013c) Standard Specification for  
Chromium and Chromium-Nickel Stainless  
Steel Plate, Sheet, and Strip for Pressure  
Vessels and for General Applications

ASTM D1056 (2007) Standard Specification for Flexible  
Cellular Materials - Sponge or Expanded  
Rubber

ASTM D2867 (2009) Moisture in Activated Carbon

ASTM E283 (2004; R 2012) Determining the Rate of Air  
Leakage Through Exterior Windows, Curtain  
Walls, and Doors Under Specified Pressure  
Differences Across the Specimen

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST RP-CC-001 (2009) HEPA and ULPA Filters

IEST RP-CC-008 (2007; Rev 2) Gas-Phase Adsorber Cells

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701 (2010) Standard Methods of Fire Tests for  
Flame Propagation of Textiles and Films

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-32101 (2012 - Controlled Distribution Document)  
Carbon, Activated, Impregnated,  
Copper-silver-Zinc-Molybdenum-Triethylenediamine  
(ASZM-TEDA) - Controlled Distribution  
Document

MIL-PRF-32016 (2002; Rev A) Cell, Gas Phase, Adsorber

MIL-STD-282 (2012; Rev A; Change 1 - Controlled  
Distribution Document) Filter Units,  
Protective Clothing, Gas-Mask Components  
and Related Products: Performance-Test  
Methods

UFC 3-310-04 (2012) Seismic Design for Buildings

U.S. DEPARTMENT OF ENERGY (DOE)

DOE HDBK-1169 (2003) Nuclear Air Cleaning Handbook

UNDERWRITERS LABORATORIES (UL)

UL 586 (2009) Standard for High-Efficiency  
Particulate, Air Filter Units

UL 723 (2008; Reprint Aug 2013) Test for Surface  
Burning Characteristics of Building  
Materials

UL 900 (2004; Reprint Feb 2012) Standard for Air  
Filter Units

1.2 SYSTEM DESCRIPTION

1.2.1 General

- a. Provide ductwork, fittings, and accessories as required to provide a complete installation and to eliminate interference with other construction. The [CBR Air Filtration System](#) shall include [ASTM A240/A240M](#) Type 304 stainless steel bag-in/bag-out housing, isolation dampers located where indicated, roughing filter, pre-filter, HEPA filters, carbon adsorbers, [post-filter], in-place test sections, and a [blow-through] [draw-through] fan unit mounted on a structural steel equipment skid as indicated. Provide the filtration system with filtration element removal trays, removable access doors, [filtration element banding kits,] pressure ports, pressure gauges, duct transitions, flexible connections, test blanks, and other appurtenances required for the specified operation.
- b. The filtration system shall have physical dimensions suitable to fit the space allotted. Sections of the filtration system shall be joined together in series to make a system that meets the required capacity.

The filtration system shall be mechanically tested for leaks while in the factory.

- c. The filtration system shall be suitable for continuous operation with an air stream temperature of up to 57.2 degrees C 135 degrees F and suitable for radioactive and chemical warfare service. The system shall also meet the applicable requirements of ASME AG 1, ASME N509, ASME N510, and UL 586. Systems located in temperature controlled areas that filter conditioned air or low temperature ambient air shall be [externally or internally insulated as indicated] [of double walled construction with thermal insulation in the interstitial space].

#### 1.2.2 Structural Design

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NOTE: Seismic protection is required for filtration systems that perform a safety function during and after a seismic event. Manufacturer's standard equipment is normally considered qualified for the requirements specified below. Review ASME AG 1, Section AA-4000, and provide specific additional requirements for the design application.  
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Structurally design and test the filtration system, components, and accessories and submit appropriate documentation and certification as required by ASME AG 1 Section AA. The service condition of the filtration system shall meet level [A] [B] [C] [D] service limits with the design loads indicated. The structural design of the filtration system, components, and accessories shall be verified by analysis, testing, or a combination of analysis and testing. The filtration system shall be subjected to [5] [\_\_\_\_\_] operating based earthquakes (OBE) and one safe shutdown earthquake (SSE) as indicated by the required response spectrum. Each OBE and SSE shall have a minimum test duration of [30] [\_\_\_\_\_] seconds. The filtration system, components, and accessories shall meet the seismic protection requirements specified in UFC 3-310-04 and Section 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

#### 1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority.

Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

CBR Air Filtration System[; G][; G, [\_\_\_\_]]  
Installation and Erection[; G][; G, [\_\_\_\_]]

#### SD-03 Product Data

Standard Products  
Welding[; G][; G, [\_\_\_\_]]  
Acceptance Tests  
Factory Tests[; G][; G, [\_\_\_\_]].  
Field Training

#### SD-06 Test Reports

Acceptance Tests

#### SD-07 Certificates

Field Acceptance Test  
Protective Shipping  
Carbon Adsorber

#### SD-10 Operation and Maintenance Data

Filtration Unit Manuals[; G][; G, [\_\_\_\_]]  
Operating and Maintenance Instructions[; G][; G, [\_\_\_\_]]

### 1.4 QUALITY ASSURANCE

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NOTE: Review ASME NQA-1 and include or exclude requirements as necessary. ASME NQA-1 is used for safety class filtration systems that perform a fail-safe function, typically for containment of highly toxic materials.

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#### 1.4.1 General

The filtration units and stand-alone isolation dampers shall be manufactured under a quality assurance program that meets the requirements stated in [ASME NQA-1](#).

#### 1.4.2 Welding

Welding procedures, welders, and welding operators shall be qualified in accordance with [ASME BPVC SEC IX](#). Submit a copy of qualified welding procedures, and a list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations. All welding performed shall meet the requirements specified in [ASME BPVC SEC IX](#) and as required by [ASME N509](#). Pressure retaining weld joints shall comply with the requirements of [ASME BPVC SEC IX](#).

#### 1.5 DELIVERY, STORAGE, AND HANDLING

Mount the filtration system with [protective shipping](#) skids, crated or covered, blocked, braced, and cushioned as necessary to prevent physical damage during shipping. Submit certification of compliance, including a certified list of materials. Protect equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Provide components and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design, and workmanship and have been in satisfactory commercial or industrial use for 5 years before bid opening. Submit a statement demonstrating successful completion of similar services on at least five projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section. Manufacturer's catalog data shall be included for the specified items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration.

- a. The 5-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 5 years shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 5-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 15,000 hours exclusive of the manufacturer's [factory tests](#), can be shown. Submit proposed schedule for factory tests, at least 2 weeks prior to the start of related tests.
- b. The equipment items shall be supported by a service organization. Asbestos and asbestos-containing products are not acceptable.
- c. Demonstrate compliance with contract requirements for the following:
  - (1) Filtration System
  - (2) Filtration Elements including Roughing Filter, Pre-filter,, HEPA



Filter, Carbon Adsorber, [Post-Filter], Gasket Seal, Fluid Seal and Bag-In/Bag-Out Assembly and Banding Kits

- (3) Isolation Dampers and Damper Operators
- (4) Fan Units
- (5) Flexible Connection
- (6) Pressure Gauge
- (7) Manufacturer's Quality Assurance Program
- (8) Testing Agency Qualifications

## 2.2 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number. Each filtration element access door shall have a metal nameplate of the same material as the filter housing, fastened to the exterior which states the critical replacement components and part numbers for the equipment contained inside. The nameplate shall include filtration element model number, filtration element efficiency, and size. Each filtration element housing shall be provided with an external metal pocket, for holding the operation and maintenance instruction manual, which shall be provided with the housing. If housing is exposed to the weather, metal pocket shall be weather resistant and equipped with weep holes. The instructions shall be complete and detailed for the actual filtration system provided.

## 2.3 FILTRATION SYSTEM HOUSING

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NOTE: A bag-in/bag-out housing is primarily used for filtration systems that continuously filter contaminants. For filtration systems in standby mode or that will not likely filter contaminants, a bag-in/bag-out housing is not required. A blow-through filtration system will be used when located in a contaminated environment and a draw-through filtration system arrangement will be used when located in a clean environment.

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All housings shall be of [single] [50 mm 2 inch double] [100 mm 4 inch double] wall construction, fabricated of a minimum 2 and 3 mm 12 and 14 gauge ASTM A240/A240M Type 304 stainless steel, with all pressure boundary joints, seams, and penetrations welded airtight. The housing shall conform to ASME N509. The housings shall be a [single] [dual] side servicing bank type arrangement. A housing two or more filtration elements wide shall be equipped with a filtration element removal rod. The housing design pressure shall be 5,000 Pa 20 inches wg. The housing shall be designed and constructed with an integral structural steel frame. Lifting lugs with a minimum of 50 mm 2 inch diameter eyeholes, made of the same material as the housing, shall be provided on the top of each filtration unit. All portions of the filtration system housing shall be free of sharp edges and burrs.

### 2.3.1 Filtration Element Access Door

Provide each filtration element location with an access door to remove the filtration element and replace it with another. Access doors shall be [single-wall] [double-wall insulated] type and fully gasketed to the filtration system housing. Each access door shall be rigid and provided with at least four tie-down latches[with locking hasps] [with tamper-proof fasteners]. The access door shall be designed such that, when removed, no sharp projections remain [and access to the bag-out port is not impeded]. [When the access door is closed, it shall not press against the bag-out port or the PVC bag.]

### 2.3.2 Filtration Element Sealing Mechanism

[Filtration elements provided with gasket seals shall have a sealing mechanism that is a replaceable unit, constructed of series 300 stainless steel, providing a total clamping force of 6200 N 1400 lbs per filtration element in accordance with DOE HDBK-1169.] [Filtration elements provided with fluid seals shall have a series 300 stainless steel replaceable sealing mechanism that engages and disengages the element on the housing mounting frame's knife edge.]

### 2.3.3 Casings and Insulation

Casings shall be field insulated as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS, paragraph: Casings. For double wall type casing sections all of the required insulation shall be placed inside the cavity area.

### 2.3.4 Housing Man-Entry Doors

Access Doors shall be [single wall] [50 mm 2 inch] [100 mm 4 inch thick double wall type injected with a minimum of 0.028 kg/cubic meter 2.2 pounds/cubic foot of polyurethane foam]. Each door shall have a [stainless steel] [hot dipped galvanized steel] finish of the same material as the housing front and back. [Interior and exterior panels shall bond to create a seamless rigid panel with a minimum insulating value of] [R-13] [\_\_\_\_\_]. Door panels shall [use a high density polyurethane thermal break and] incorporate an extruded gasket and shall be impervious to virtually all chemicals and be highly flexible in extreme heat or cold. Doors will include heavy duty stainless steel hinges and a minimum 200 by 200 mm 8 by 8 inch [single] [double] pane safety glass view windows with integral wire mesh reinforcing. Independent lab test shall confirm zero total CFM air leakage at 1250 Pa 5.0 inches wg static pressure for a 600 by 1500 mm 24 by 60 inch [out] [in] swing door with two hinges and two latch points operable from inside and outside the housing. Test method shall be ASTM E283.

## 2.4 FILTRATION ELEMENTS

Air filtration elements shall be listed in accordance with UL 900, except that high-efficiency particulate air filters and carbon adsorbers shall meet the requirements indicated.

### 2.4.1 Roughing Filter

The roughing filter shall be [50] [100] mm [2] [4] inch deep, rigid pleat panel filter, consisting of cotton and synthetic media, heavy gauge expanded metal support grid, and rigid board enclosing frame. The roughing filter shall be UL 586 Class II. The roughing filter shall have an

average atmospheric dust-spot efficiency of 25 to 30 percent based on ASHRAE 52.2. Initial resistance at [\_\_\_\_\_] m/s feet/second shall not exceed [\_\_\_\_\_] Pa inches wg.

#### 2.4.2 Pre-filter and Post-filter

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NOTE: Post filters are required by ASME N 509, are located downstream of adsorbers for carbon fines collection, and used for non-military applications.  
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The [pre-filter] [pre-filter and post-filter] shall be extended, dry media type, [100] [150] [300] mm [4] [6] [12] inch deep, with an average atmospheric dust-spot efficiency of 95 percent based on ASHRAE 52.2. Initial resistance at [\_\_\_\_\_] m/s feet/second shall not exceed [\_\_\_\_\_] Pa inches wg.

#### 2.4.3 High-Efficiency Particulate Air (HEPA) Filter

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NOTE: Frames constructed of plywood are usually used in applications where disposal of filters is by incineration.  
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HEPA filters and frames shall meet the materials, design, inspection, fabrication, quality assurance, and nameplate marked as specified in ASME AG 1, Section FC. HEPA filters shall have a 99.97 percent efficiency with a 0.3 micron diameter particle size as determined by the dioctyl phthalate (DOP) test method in accordance with IEST RP-CC-001. HEPA filters shall be qualified and labeled in accordance with UL 586. HEPA filters shall have the indicated capacity and pressure drop for clean filters. Filter frames shall be [Type II - stainless steel sheet, Type 304] [Type IV plywood] construction as defined in ASME AG 1, Section FC. The HEPA filter media shall be manufactured in accordance with ASME AG 1, Section FC. Filtration media frames shall have an integral perimeter gasket seal. Initial resistance at [\_\_\_\_\_] m/s feet/second of filter face area shall not exceed [\_\_\_\_\_] Pa inch wg.

#### 2.4.4 Carbon Adsorber

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NOTE: To remove all chemical warfare agents (included in FM 3-9) from an air stream use impregnated ASZM-TEDA carbon media. To remove chemical agents that only have low volatility (vapor pressure less than 1,000 pascals (4 inches wg)) use activated carbon conforming to ASME AG 1. Many toxic industrial chemical vapors are not effectively removed by ASZM-TEDA carbon.

Commercial carbon adsorbers are typically designed for 500 scfm when configured as a single stage system; however, designs for various air flow capacities 165 to 354 sL/s (350 to 750 scfm) are available as indicated in the table below.

Adsorber Air Flow Rate		
Nominal Adsorber Depth, mm (inches)	Single Stage, L/s (cfm)	Dual Stage, L/s (cfm)
355 (14)	177 (375)	354 (750)
405 (16)	236 (500)	472 (1000)
455 (18)	295 (625)	590 (1250)
510 (24)	354 (750)	708 (1500)

The air flow rates listed above are at 0.25 seconds residence time.

Care should be taken to maintain residence time of air passing through the carbon adsorber. For example, placing two adsorbers in series maintains the residence time while doubling the airflow capacity.

At 472 sL/s (1,000 scfm) the ASZM-TEDA adsorber uses a 12 x 30 mesh of carbon media that has a pressure drop of approximately 1,500 pascals (6 inches wg) per carbon adsorber stage. Activated carbon adsorbers, conforming to ASME AG 1 and using 8 x 16 mesh carbon, have a pressure drop of approximately 682 pascals at 472 sL/s (2.75 inches wg at 1,000 scfm) per carbon adsorber stage.

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Provide carbon adsorbers consisting of six 50 mm 2 inch thick panels configured as a V-bed similar to the shape of a Type I cell in accordance with IEST RP-CC-008. The adsorber shall consist of [ASZM-TEDA carbon conforming to MIL-DTL-32101] [non-impregnated highly activated carbon conforming to ASME AG 1, Section FF]. The carbon adsorber shall meet the requirements for airflow resistance, refrigerant leak test, and dimethylmethylphosphonate (DMMP) breakthrough life test, moisture content, cyanogen chloride (CK) gas life, gas life capacity testing. The carbon adsorber shall have an airflow rate capacity as indicated and be designed to adsorb chemical vapor with an overall system minimum residence time of [0.25] [\_\_\_\_\_] seconds. All inner and outer case materials shall be ASTM A240/A240M Type 304 stainless steel. [The adsorber design shall include a means to obtain samples of the adsorbent. The preferred method incorporates a set of sample canisters. Other methods or designs are acceptable if it can be shown that a representative sample of the total bed thickness is produced without voids or that result in a bypass condition.] Carbon adsorber frames shall have an integral perimeter [gasket seal] [fluid seal]. Submit documentation, including table and/or schematic, identifying outline or significant interface dimensions, certified list of materials, adsorbent type and its certified test reports, welder qualifications, certified test reports for all performance requirements specified, certification of compliance with specified packaging and shipping requirements.

#### 2.4.4.1 Airflow Resistance

The airflow resistance shall be [750 Pa 3.0 IWG +/- 10 percent] [1,500 Pascal 6.0 IWG] [[\_\_\_\_\_] Pascal IWG +/- 10 percent] at the rated air flow with an air stream temperature of 21 degrees C 70 degrees F and a barometric pressure of 760 mm 29.92 inches Hg. Each cell to be delivered to the Purchaser shall have been tested by the manufacturer prior to packaging. Airflow resistance and certification shall be marked on each cell. Reject any cell not meeting the airflow resistance requirement. Install the cell in the test tunnel in its service orientation and the airflow through the cell adjusted to [236 L/s 500 SCFM +/- 5 percent] [472 L/s 1,000 SCFM +/- 5 percent] [[\_\_\_\_\_] L/s SCFM +/- 5 percent]. Perform the following: 1) Record the barometric pressure. 2) Measure and record the air stream temperature. 3) Determine and record the difference in the static pressure head upstream of the cell to that downstream of the cell. Subtract the test fixture resistance so that the recorded resistance is that of the cell. If testing occurs at nonstandard conditions, the airflow resistance shall be calculated and recorded, and the test measurements corrected to standard conditions.

#### 2.4.4.2 Refrigerant Leak Test

Each cell to be delivered to the Purchaser shall have been tested by the manufacturer prior to packaging. During the test, the downstream concentration of the refrigerant gas shall not exceed 0.0005 times the upstream concentration. Reject cells that do not meet this requirement. Install the cell in the test tunnel in its service orientation and the airflow to [236 L/s +/- 12 L/s 500 SCFM +/- 25 SCFM] [472 L/s +/- 24 L/s 1,000 SCFM +/- 50 SCFM]. The cell shall be challenged with a refrigerant vapor (R-134a or equivalent) at a concentration equivalent to at least 20,000 times the minimum sensitivity of the monitor used to measure filter leakage. The challenge-gas injection port shall be located in such a manner to ensure uniform mixing of the tracer gas. The downstream test port shall be located to ensure a representative sample. Qualification data to verify test port selection shall be on file for inspection upon request. The leak tracer chemical (refrigerant) shall be injected continuously into the filter influent over an interval sufficient to ensure the effluent monitor is capable of accurately measuring the required leakage level.

#### 2.4.4.3 Dimethylmethylphosphonate (DMMP) Breakthrough Life Test

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**NOTE: For production lots consisting of a large number of filters, less than 10 percent of the filters can be tested to obtain a high level of confidence of acceptable performance.**  
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The adsorber cell being destructively tested for DMMP gas life value as specified for a minimum of [50] [\_\_\_\_\_] minutes when subjected to the rated air flow at 52 degrees C 125 degrees F, at less than 40 percent relative humidity and having an inlet concentration indicated. Test cells which are filled with an adsorbent meeting the specified requirements shall be randomly selected by the Contracting Officer from the lot. The number of cells required for DMMP testing, shall be 10 percent and rounded down for the total number of adsorbers in the lot, but not less than one. Therefore the required number of deliverables is equal to the number required for the system plus the number of cells to undergo this destructive testing. Each

test cell shall be hard-mounted to a rough handling machine in its service orientation and vibrated for 10 minutes at a frequency of 200 cycles per minute at an amplitude of 19.1 mm +/- 0.32 mm 3/4 inch +/- 1/8 inch in accordance with MIL-STD-282, Test Method 105.11. Immediately following the rough handling, the cells shall be DMMP breakthrough life tested in accordance at the same test facility the cells were rough handled in order to minimize carbon redistribution. If at least one cell fails to meet the criteria the lot shall be rejected. Adjust the filling procedure and submit another lot for DMMP breakthrough life test. Just prior to running the DMMP test, airflow resistance data shall be measured and recorded for the sample cell and the airflow resistance calculated at standard conditions as indicated. Cell shall be installed in test tunnel in its service orientation. Airflow shall be adjusted to [236 L/s 500 SCFM +/- 5 percent] [472 L/s 1,000 SCFM +/- 5 percent]. The test shall be run to cell life. The cell shall be tested for DMMP breakthrough life at the following test parameters:

Challenge Concentration	5,000 (400 mg/m3 1050 ppm +/- 80 ppm)
Breakthrough Concentration	0.02 mg/m3 0.004 ppm
Relative Humidity	less than 40 percent
Temperature	45 degrees C +/- 5 degrees C 113 degrees F +/- 9 degrees F

- a. For the adsorber cell to be acceptable, the breakthrough time for the DMMP concentration of the filter effluent to increase to 0.02 mg/m3 0.004 ppm shall be as indicated. While the challenge concentration is permitted to vary within the stated range during the course of the test, the breakthrough time measured Shall be normalized to the 5,000 mg/m3 1050 ppm concentration by the following calculation:
- b. Corrected breakthrough time = Measured breakthrough time x Average concentration during test x 5,000 mg/m3 1050 ppm.
- c. The DMMP vapor in air challenge concentration shall be created to ensure uniform mixing of the DMMP vapor with the air once it reaches the test cell. Qualification testing to verify the DMMP vapor concentration is uniform across the cell face shall be on file and available for inspection. The test tunnel shall be operated at the rated flow. The inlet face of the cell shall be challenged as specified above. The total time from the start of the cell challenge until the breakthrough concentration is reached (i.e. the life of the cell) shall be recorded as the breakthrough time. This testing shall be performed by the Government at the following location:

Quality Evaluation Laboratory, Engineering Directorate,  
U.S. Army Edgewood Research, Development and Engineering Center  
Aberdeen Proving Ground, MD 21010-5423  
(410) 436-2284  
(410) 436-4804 (FAX)

#### 2.4.4.4 Moisture Content/Cyanogen Chloride (CK) Gas Life Sampling

A minimum 0.45 kg one pound specimen of carbon shall be obtained during filling of the first cell, the middle cell, and the last cell of the day. Each carbon specimen shall be placed in an open container or in a cloth bag

and accompany its cell through the assembly line. The specimen shall not be exposed to refrigerant. The carbon specimen shall be labeled to match it to its adsorber cell. Upon completion of the lot, a sample shall be chosen from the specimens in each quarter of the lot. These 4 samples shall be shipped and tested by the Government at the location indicated above.

#### 2.4.4.5 Moisture Content

Sample carbon as indicated and moisture content of each carbon adsorbing cell shall not exceed 3 percent by weight when tested. The moisture content of the carbon samples shall be determined in accordance with ASTM D2867, except the oven temperature shall be 103 to 107 degrees C 217 to 225 degrees F and the drying time shall be 3 hours. Should any sample fail to meet the moisture requirements, all cells fabricated following the last cell represented by a sample carbon which did meet the requirement and before the carbon represented by the next carbon sample which does meet the requirement shall be removed from the production lot. These cells may be dried at a temperature not to exceed 66 degrees C 150 degrees F by blowing air less than 10 percent relative humidity at rated flow for 3 hours, immediately before packaging.

#### 2.4.4.6 CK Gas Life Test

After completion of all manufactures steps, the adsorber cell's carbon shall comply with the CK gas sorption requirement of MIL-DTL-32101 for unaged carbon. The CK Gas Life of the carbon samples shall be determined in accordance with MIL-DTL-32101. The production lot of cells shall be rejected if any sample fails to meet the CK gas life requirements as indicated.

#### 2.4.5 Gasket Seal

An interlocking dovetailed gasket shall be mounted and sealed to the perimeter of the upstream face of the filtration element frame in accordance with ASME AG 1, Section FC. The gasket shall be oil resistant expanded cellular elastomer conforming to ASTM D1056 Grade 2C2. The gasket shall be able to withstand the specified applied clamping force without loss of seal resilient memory.

#### 2.4.6 Fluid Seal

\*\*\*\*\*  
**NOTE: Fluid seals are limited to low-temperature  
filtration applications.**  
\*\*\*\*\*

Filtration element frames shall have an integral channel filled with a fluid seal. The fluid seal shall engage a continuous knife-edge on the housing mounting frame. The fluid seal shall be highly viscous, odorless, biostatic, self-healing, non-evaporating, non-Newtonian, radiation and chemical resistant, insoluble in water, silicone compound, and suitable for a temperature range of -50 to 202 degrees C -58 to 396 degrees F. The channel shall be sealed before the fluid seal is placed into the channel. The fluid seal shall not pull out of the groove or leave a residue on the housing mounting frame knife-edge.

## 2.5 BAG-IN/BAG-OUT ASSEMBLY AND BANDING KITS

Provide each filtration element access location with a bag-in/bag-out assembly and 0.20 mm 8 mil transparent PVC bag sized to completely enclose the element and suitable for 57.2 degrees C 135 degrees F ambient environment. Locate the assembly inside the access door. The bag shall have an elastic shock cord hemmed into its mouth and secured by a strap to the assembly to prevent bag slippage during the filtration element bagging procedure. The bag shall be tested at the factory to ensure it has no leaks. An additional quantity of [one complete set of] [\_\_\_\_\_] spare bags shall also be provided and turned over to the Contracting Officer. One complete banding kit shall be provided with each filtration unit equipped with a bag-in/bag-out assembly. The banding kit shall provide a secure clamping off of the bag between the housing and the spent filtration element. Each kit shall contain a banding tool, a bag-cutting tool, and two sets of plastic ties, stainless steel bands, and replacement bags. Additional tools required to complete the bag-in/bag-out procedure shall also be provided.

## 2.6 IN-PLACE DOP/GAS AEROSOL TEST SECTION

\*\*\*\*\*

**NOTE: Test sections are necessary to perform leakage tests and to locate leaks in multiple filter arrays. Filters or adsorbers placed in series will require a test and sample combination section between stages.**

**A swing-away mixing device is only used in leakage testing. The device swings out of the way in normal filtration operation.**

**Upstream injection and downstream sampling sections are required if particulate is to be filtered from the air stream.**

\*\*\*\*\*

Provide the test sections as an injection, sampling, and/or injection and sampling combination as indicated, constructed in a manner identical to the remainder of the filtration system housing and meeting the applicable design parameters of ASME N509. Where a second stage of [HEPA filters] [or] [carbon adsorbers] is required, use an injection and sampling combination test section between the first and second stages. The test sections shall be constructed such that adjoining parallel test sections are isolated from each other. This will permit [individual efficiency and mechanical seal test of each HEPA filter] [and] [mechanical seal tests of the carbon adsorber] and supporting framework in accordance with ASME N510. The pressure drop across each test section shall be no greater than 62 Pa at 472 L/s 0.25 inches wg at 1000 cfm during the test. Stationary baffle type test sections are not acceptable. The test section shall be furnished with swing-away mixing devices. Injection and sample ports and apparatus shall be provided to form an integral part of the test section.

## 2.7 IN-PLACE TEST REPORT

\*\*\*\*\*

**NOTE: If only gas adsorption is to be performed by the filtration system in lieu of upstream and downstream sampling sections, aerosol injection and**



sample ports may be used.

\*\*\*\*\*

[Provide upstream challenge aerosol inlet and sample ports for each [HEPA filter] [or] [carbon adsorber] section. The test port shall be a 13 mm 1/2 inch NPT Type 304 stainless steel coupling with plug, used for upstream sampling, located upstream of the HEPA filter and welded to the top side of the filtration system housing.] [Provide three additional test ports shipped loose for field installation into the ductwork; one used for injection upstream, one used for sampling before the filter housing, and one used for downstream sampling of the filtration system housing. Upstream inlet and sample port and downstream sample port shall be located to provide uniform mixing during field-testing as required by ASME N509 and ASME N510.]

## 2.8 WEATHER COVER

Protect filtration systems located in unsheltered areas by using an integral weather cover. The weather cover shall be constructed of the same material as the filter housing and mechanically fastened and gasketed to the filter housing.

## 2.9 ISOLATION DAMPERS

\*\*\*\*\*

**NOTE: Depending on system design requirements, isolation dampers may or may not be part of the filtration system design. The gasket material shall be butyl rubber for Class 0, zero leakage dampers, and EPDM for Class 1 low leakage dampers.**

\*\*\*\*\*

Provide isolation dampers as an integral part of the filtration system. [An individual damper shall be provided to isolate the filtration system.] [Multiple dampers shall be provided to isolate individual sections of the filtration system.] Dampers shall be classified, constructed, inspected, and tested in accordance with ASME N509 construction Class B as a single blade damper or a combination of single blade dampers. The leakage of the isolation dampers shall conform to ASME AG 1, Section DA, Class [0, zero leakage] [1, low leakage]. The blade/disk, frame, shafts, and linkages shall be constructed of Type 304 stainless steel. The dampers shall have Type 304 stainless steel disk with a [butyl rubber] [EPDM] gasket. The isolation damper disk gasket (seal) and shaft seal shall be replaceable. Each isolation damper shall be operated by an independent electrically-actuated drive mechanism [with manual backup]. Isolation dampers shall be of all welded design. [Isolation damper flanges shall have factory drilled 11 mm 7/16 inch holes, located on the filtration unit [as indicated] and shall be no more than 100 mm 4 inches apart as described in DOE HDBK-1169]. The flanges shall be reinforced with flat stock of the same material to provide a combined minimum thickness of 6 mm 1/4 inch.

### 2.9.1 Electrically and Manually Actuated Isolation Damper Operators

Damper operators shall operate in an automatic mode [with manual backup]. The electric/manual operator shall be of sufficient capacity to operate the damper under all conditions, and to guarantee tight close-off of the damper against all system pressures encountered. The maximum force required to manually actuate the damper shall be 11.3 kg 25 pounds. Controls shall be as specified in Section 23 09 23 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC

AND OTHER LOCAL BUILDING SYSTEMS.

#### 2.9.2 Fan Unit

Fans, airflow control dampers, and actuators shall be as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM. Fans shall be a single-inlet, centrifugal type, with the fan [inlet] [outlet] connected to the filtration unit with a flexible duct connector and duct transition to the filtration unit housing. The fan shall be controlled by [a manually] [an automatic electrically] actuated, [inlet vortex] [outlet opposed blade] damper suitable for the specified static pressure.

#### 2.9.3 Flexible Duct Connectors

A flexible duct connector approximately 152 mm 6 inches in width shall be provided where sheet metal connections are made to the fan unit. The flexible material, chemically resistant butyl rubber, shall be locked to metal collars and installed using normal duct construction methods. The flexible material shall withstand the indicated system pressures. The composite connector system shall comply with NFPA 701 and shall be classified as flame-retarded fabrics in UL 723.

#### 2.10 DUCTWORK AND DUCT TRANSITIONS

All ductwork and duct transitions shall be stainless steel and shall be as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.

#### 2.11 THERMAL INSULATION

Thermal insulation for ductwork and equipment shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.12 PRESSURE GAUGE

Pressure gauges shall be dial type, diaphragm operated, with two pressure relay switches for low and high limit relay control. The gauges shall incorporate adjustable switch point indicators for continuous indication of switch settings. Gauges shall be provided for roughing filter, pre-filter, HEPA filter banks, post filter, and total filter system pressure drop. Gauges shall be at least 98 mm 3-7/8 inches in diameter and shall have white dials with black figures with graduations. Gauges shall have a minimum range of 250 Pa 1 inch wg beyond the specified final resistance for the individual filter served. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with stainless steel compression fittings and tubing. All hardware shall be mounted in one location and tested at the factory. All gauges shall have a dual dial scale readout in units of pascals and inches water gauge.

#### 2.13 PRESSURE PORTS

\*\*\*\*\*  
**NOTE: Pressure ports are not needed for carbon  
adsorber elements.**  
\*\*\*\*\*

Static pressure ports shall be located on the filtration unit upstream and downstream of each roughing filter, pre-filter, HEPA filter bank, and

post filter. The port connections shall be 6 mm 1/4 inch 300 series stainless steel pipe nipples and caps.

## PART 3 EXECUTION

### 3.1 INSTALLATION AND ERECTION

CBR Air filtration systems shall be installed and erected in accordance with ASME N509, as indicated on the drawings, and in accordance with the manufacturer's diagrams and recommendations. Submit drawings consisting of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports, typical support details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and pressure gage tubing layout showing the location of all gages. Drawings shall include table and/or schematic identifying outline or significant interface dimensions and any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

### 3.2 ACCEPTANCE TESTS

All acceptance tests shall be in accordance with the procedures in ASME N510 and as required by MIL-PRF-32016. Submit proposed test schedules for adjusting and balancing, housing leak and pressure, air-aerosol mixing uniformity, damper operation and leakage, system bypass, performance tests of systems and test procedures, at least 2 weeks prior to the start of related testing. Submit certified test report for adsorbent filtration type, for filtration unit factory acceptance test, filtration unit field test, isolation damper acceptance test, air-aerosol mixing uniformity test, damper operation and leakage test, housing leak and pressure test, system bypass test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

#### 3.2.1 Visual Inspection

Perform visual inspection in accordance with ASME N510.

#### 3.2.2 Housing Leak and Pressure Test

\*\*\*\*\*  
NOTE: Use housing leakage rate of 0.20 percent of housing volume for all-welded man-entry steel housings and 0.05 percent for small single-filter housings.  
\*\*\*\*\*

The filtration system housing shall be factory leak tested in accordance with ASME N510, Section 6, using the pressure decay method. The maximum housing leakage rate acceptance criteria shall be in accordance with DOE HDBK-1169 table 4.5, which is [0.05] [0.20] percent of housing volume at 2480 Pa 10 inches wg pressure differential. The housing shall be tested both positively and negatively to the design pressure of [5,000] [ ] Pa [20] [ ] inches wg before performing the DOE HDBK-1169 housing leak acceptance criteria test.

### 3.2.3 Airflow Capacity and Distribution Test

The airflow across each filtration element bank shall be measured to verify that it meets the designed flow rate under actual field conditions. The test shall also verify that the airflow is distributed evenly across each filtration element bank as required by ASME N510 which is +/- 20 percent of the average airflow through each filter bank. All tests shall be in accordance with ASME N510.

### 3.2.4 Air-Aerosol Mixing Uniformity Test

A challenge gas shall be introduced into the air system to verify that it has uniformly mixed before entering the filtration element bank. The test procedure shall follow and comply with ASME N510.

### 3.2.5 Damper Operation and Leakage Test

The damper shall be tested to verify that it operates as specified. The air leakage rate through the isolation dampers shall be measured and recorded. The damper shall be functionally tested as required in ASME N510. [The leakage test method for Class 0 dampers shall be the pressure decay or bubble test method as specified in ASME AG 1 and ASME N510.] [The leakage test for Class 1 dampers shall be in accordance with ASME AG 1.]

### 3.2.6 System Bypass Test (Filter and Adsorber Mounting Frame)

The filtration elements at each [HEPA] [HEPA and Carbon Adsorber] mounting frame housing location shall be removed and replaced with a test blank. The filtration element housing and housing seal shall be tested in accordance with ASME N510. The air that bypasses the test blank shall be measured and recorded as an air leakage rate, repaired by seal welding and retested. Caulking or other temporary sealing measures are not allowed. The acceptable leakage rate shall be zero percent. After testing is completed the blank shall be removed and the filtration elements reinstalled. The test blank shall then be turned over to the Contracting Officer.

## 3.3 FIELD TRAINING

\*\*\*\*\*  
**NOTE: The number of hours of instruction should be determined based on the number and complexity of the systems specified.**  
\*\*\*\*\*

Submit proposed schedule for field training, at least 2 weeks prior to the start of related field training. Conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of [\_\_\_\_\_] hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved [Operating and Maintenance Instructions](#) and the [Filtration Unit Manuals](#). Submit [6] [\_\_\_\_\_] manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, troubleshooting guide, and recommended service organization (including address and telephone number)

for each item of equipment. Each service organization submitted shall be capable of providing [4][\_\_\_\_\_] -hour on-site response to a service call on an emergency basis.

#### 3.4 FIELD ACCEPTANCE TEST

\*\*\*\*\*  
NOTE: A number of factors will determine the  
efficiency of a carbon adsorber system; generally, 8  
x 16 mesh carbon granules provide at least 99.9  
percent efficiency. Select the appropriate  
concentration reduction value for the field tests.  
\*\*\*\*\*

After installation, the filtration system shall be field tested for leaks using a mechanical test method. The system shall also be tested for leaks between the filter element and its housing. Testing shall occur after installation and shall be performed by an independent testing agency in accordance with ASME N510. Submit testing agency certification prior to in-place filtration element testing in accordance with ASME NQA-1 or have demonstrated previous experience with similar systems as approved by the Contracting Officer. [The carbon adsorber system housing and carbon adsorber will be challenged with refrigerant vapor R-134a or equivalent with the downstream concentration not to exceed [0.001] [0.0001] times the upstream concentration.] [The HEPA filter DOP aerosol penetration will be less than 0.03 percent.]

-- End of Section --