UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 44 00.00 10

CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) AIR FILTRATION SYSTEM

02/16

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.3.1 General
1.3.2 Welding
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS
2.1.1 General
2.1.2 Structural Design
2.2 STANDARD PRODUCTS
2.3 NAMEPLATES
2.4 FILTRATION SYSTEM HOUSING
2.4.1 Filtration Element Access Door
2.4.2 Filtration Element Sealing Mechanism
2.4.3 Casings and Insulation
2.4.4 Housing Man-Entry Doors
2.4.5 Housing Leak and Pressure Test
2.5 FILTRATION ELEMENTS
2.5.1 Roughing Filter
2.5.2 Pre-filter and Post-filter
2.5.3 High-Efficiency Particulate Air (HEPA) Filter
2.5.4 Carbon Adsorber
2.5.4.1 Airflow Resistance
2.5.4.2 Refrigerant Leak Test
2.5.4.3 Dimethylmethylphosphonate (DMMP) Breakthrough Life Test
2.5.4.4 Moisture Content/Cyanogen Chloride (CK) Gas Life Sampling
2.5.4.5 Moisture Content
2.5.4.6 CK Gas Life Test
2.5.5 Gasket Seal
2.5.6 Fluid Seal
2.6 BAG-IN/BAG-OUT ASSEMBLY AND BANDING KITS

2.7 IN-PLACE DOP/GAS AEROSOL TEST SECTION
2.8 IN-PLACE TEST PORTS
2.9 WEATHER COVER
2.10 ISOLATION DAMPERS
2.10.1 Electrically and Manually Actuated Isolation Damper Operators
2.10.2 Fan Unit
2.10.3 Flexible Duct Connectors
2.11 DUCTWORK AND DUCT TRANSITIONS
2.12 THERMAL INSULATION
2.13 PRESSURE GAUGE
2.14 PRESSURE PORTS

PART 3 EXECUTION

3.1 INSTALLATION AND ERECTION
3.2 ACCEPTANCE TESTS
3.2.1 Visual Inspection
3.2.2 Airflow Capacity and Distribution Test
3.2.3 Air-Aerosol Mixing Uniformity Test
3.2.4 Damper Operation and Leakage Test
3.2.5 System Bypass Test (Filter and Adsorber Mounting Frame)
3.3 FIELD TRAINING
3.4 FIELD ACCEPTANCE TEST

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA | **UFGS-23 44 00.00 10 (February 2016)**

Preparing Activity: USACE | **Superseding UFGS-23 40 00.00 10 (October 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION 23 44 00.00 10

CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) AIR FILTRATION SYSTEM
02/16

****

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 item(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).

****

PART 1 GENERAL

1.1 REFERENCES

****

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 Reference Identifier (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.
****

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) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME AG-1	(2019) Code on Nuclear Air and Gas Treatment
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME N509	(2002; R 2008) Nuclear Power Plant Air-Cleaning Units and Components
ASME NQA-1	(2019) Quality Assurance Requirements for Nuclear Facility Applications

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2020) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D1056	(2014) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D2867	(2009; R 2014) Moisture in Activated Carbon
ASTM E283	(2019) Standard Test Method for 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	(2016; Rev 6) HEPA and ULPA Filters

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2019) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-32101	(2017; Rev B - Controlled Distribution Document) Carbon, Activated, Impregnated, Copper-Silver-Zinc-Molybdenum-Triethylenediamine (ASZM-TEDA)
MIL-PRF-32016	(2002; Rev A) Cell, Gas Phase, Adsorber
MIL-STD-282	(2015; Rev B) Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance-Test Methods

U.S. DEPARTMENT OF ENERGY (DOE)

DOE HDBK-1169	(2003) Nuclear Air Cleaning Handbook

UNDERWRITERS LABORATORIES (UL)

UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 900	(2015) Standard for Air Filter Units

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.**

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification 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[, [_____]]

Installation and Erection; G[, [_____]]

SD-03 Product Data

Standard Products

Welding

Acceptance Tests

Factory Tests

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[, [_____]]

Operating and Maintenance Instructions; G[, [_____]]

1.3 QUALITY ASSURANCE

****

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.

****

1.3.1 General

Manufacture the filtration units and stand-alone isolation dampers under a quality assurance program that meets the requirements stated in ASME NQA-1.

1.3.2 Welding

Qualify welding procedures, welders, and welding operators 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. Perform all welding in accordance with the requirements specified in ASME BPVC SEC IX and as required by ASME N509. Pressure retaining weld joints must comply with the requirements of ASME BPVC SEC IX.

1.4 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 SYSTEM REQUIREMENTS

2.1.1 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 must 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 physical dimensions must be suitable to fit the space allotted. Join together sections of the filtration system in series to make a system that meets the required capacity. Mechanically test the filtration system for leaks while in the factory.

c. The filtration system must 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 must also meet the applicable requirements of ASME AG-1, ASME N509, and UL 586. Systems located in temperature controlled areas that filter conditioned air or low temperature ambient air must be [externally or internally insulated as indicated] [of double walled construction with thermal insulation in the interstitial space].

d. The filtration system must meet the requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.1.2 Structural Design

****

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.

Coordinate seismic protection requirements with UFC 3-301-01.

****

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 must meet level [A] [B] [C] [D] service limits with the design loads indicated. Verify the structural design of the filtration system, components, and accessories by analysis, testing, or a combination of analysis and testing. The filtration system must 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 must have a minimum test duration of [30] [_____] seconds. Ensure the seismic protection requirements of the filtration system, components, and accessories comply with Section 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT.

2.2 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. Include manufacturer's catalog data for the specified items. Highlight the data to show model, size, options, etc., that are intended for consideration.

a. Include the 5-year experience applications of components and equipment under similar circumstances and of similar size. The 5 years must 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 must 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

2.3 NAMEPLATES

Provide equipment with a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number. Provide each filtration element access door with 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. Include filtration element model number, filtration element efficiency, and size on the nameplate. Provide each filtration element housing with an external metal pocket, for holding the operation and maintenance instruction manual, which must be provided with the housing. If housing is exposed to the weather, provide metal pocket that is weather resistant and equipped with weep holes. Provide instructions which are complete and detailed for the actual filtration system provided.

2.4 FILTRATION SYSTEM HOUSING

****

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.

****

Provide housings 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 must conform to ASME N509. Provide housings of a [single] [dual] side servicing bank type arrangement. Equip a housing two or more filtration elements wide with a filtration element removal rod. Design and construct the housing for a pressure of 5,000 Pa 20 inches wg and with an integral structural steel frame. Provide lifting lugs with a minimum of 50 mm 2 inch diameter eyeholes, made of the same material as the housing, on the top of each filtration unit. All portions of the filtration system housing must be free of sharp edges and burrs.

2.4.1 Filtration Element Access Door

Provide each filtration element location with an access door to remove the filtration element and replace it with another. Provide [single-wall] [double-wall insulated] type access doors, fully gasketed to the filtration system housing. Provide each rigid access door with at least four tie-down latches [with locking hasps] [with tamper-proof fasteners]. Design the access door 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 must not press against the bag-out port or the PVC bag.]

2.4.2 Filtration Element Sealing Mechanism

[Filtration elements provided with gasket seals must 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 must have a series 300 stainless steel replaceable sealing mechanism that engages and disengages the element on the housing mounting frame's knife edge.]

2.4.3 Casings and Insulation

Field insulate casings as specified in Section 23 30 00 HVAC AIR DISTRIBUTION, paragraph: Casings. Place all of the required insulation for double wall type casing sections inside the cavity area.

2.4.4 Housing Man-Entry Doors

Provide [single wall] [50 mm 2 inch] [100 mm 4 inch thick double wall type access doors injected with a minimum of 0.028 kg/cubic meter 2.2 pounds/cubic foot of polyurethane foam]. Finish each door with the same material as the housing front and back. [Bond interior and exterior panels to create a seamless rigid panel with a minimum insulating value of] [R-13] [_____]. Door panels must [use a high density polyurethane thermal break and] incorporate an extruded gasket and be impervious to virtually all chemicals and be highly flexible in extreme heat or cold. Provide 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. Using test method ASTM E283 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.

2.4.5 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.
****

Factory leak test the filtration system housing in accordance with ASME AG-1, Section 6, using the pressure decay method. The maximum housing leakage rate acceptance criteria is 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. Test the housing 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.

2.5 FILTRATION ELEMENTS

Provide air filtration elements listed in accordance with UL 900. High-efficiency particulate air filters and carbon adsorbers must meet the requirements indicated.

2.5.1 Roughing Filter

Provide [50] [100] mm [2] [4] inch deep UL 586 Class II roughing filter, rigid pleat panel filter, consisting of cotton and synthetic media, heavy gauge expanded metal support grid, and rigid board enclosing frame. Provide roughing filter having a particle size removal efficiency (PSE) of 25 to 30 percent based on ASHRAE 52.2. Initial resistance at [_____] m/s feet/second must not exceed [_____] Pa inches wg.

2.5.2 Pre-filter and Post-filter

****
NOTE: Post filters are required by ASME N 509, are located downstream of adsorbers for carbon fines collection, and used for non-military applications.
****

Provide extended, dry media type [pre-filter] [pre-filter and post-filter], [100] [150] [300] mm [4] [6] [12] inch deep, with a particle size removal efficiency (PSE) of 95 percent based on ASHRAE 52.2. Initial resistance at [_____] m/s feet/second must not exceed [_____] Pa inches wg.

2.5.3 High-Efficiency Particulate Air (HEPA) Filter

****
NOTE: Frames constructed of plywood are usually used in applications where disposal of filters is by incineration.
****

Provide HEPA filters and frames meeting the materials, design, inspection, fabrication, quality assurance, and nameplate marked as specified in ASME AG-1, Section FC, and having a 99.97 percent efficiency with a 0.3 µm micron diameter particle size as determined by the dioctyl phthalate (DOP) test method in accordance with IEST RP-CC-001. Qualify and label HEPA filters in accordance with UL 586. HEPA filters must have the indicated capacity and pressure drop for clean filters. Provide [Type II - stainless steel sheet, Type 304] [Type IV plywood] construction filter frames as defined in ASME AG-1, Section FC. Manufacture the HEPA filter media in accordance with ASME AG-1, Section FC. Provide filtration media

frames with an integral perimeter gasket seal. Initial resistance at [_____] m/s feet/second of filter face area must not exceed [_____] Pa inch wg.

2.5.4 Carbon Adsorber

****

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 Pa 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 235 sL/s 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
35514	177375	354750
40516	236500	4721000
45518	295625	5901250
51024	354750	7081500

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 1000 scfm the ASZM-TEDA adsorber uses a 12 x 30 mesh of carbon media that has a pressure drop of approximately 1,500 Pa 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 Pa at 472 sL/s 2.75 inches wg at 1000 scfm per carbon adsorber stage.

****

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 consists of [ASZM-TEDA carbon conforming to MIL-DTL-32101] [non-impregnated highly activated carbon conforming to ASME AG-1, Section FF]. Provide carbon adsorber meeting the requirements for airflow resistance, refrigerant leak test, dimethylmethylphosphonate (DMMP) breakthrough life test, moisture content, cyanogen chloride (CK) gas life, and gas life capacity testing. Provide carbon adsorber having an airflow rate capacity as indicated and designed to adsorb chemical vapor with an overall system minimum residence time of [0.25] [_____] seconds. Use ASTM A240/A240M Type 304 stainless steel for all inner and outer case materials.[Design the adsorber to 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.] Provide carbon adsorber frames with 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.

2.5.4.1 Airflow Resistance

The airflow resistance must 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. Test each cell to be delivered to the Purchaser at the manufacturer's location prior to packaging. Mark airflow resistance and certification 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, calculate and record the airflow resistance, and correct the test measurements to standard conditions.

2.5.4.2 Refrigerant Leak Test

Each cell to be delivered to the Purchaser must have been tested by the manufacturer prior to packaging. During the test, the downstream concentration of the refrigerant gas cannot 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]. Challenge the cell 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. Locate the challenge-gas injection port in such a manner to ensure uniform mixing of the tracer gas. Locate the downstream test port to ensure a representative sample. Qualification data to verify test port selection must be on file for inspection upon request. Inject the leak tracer chemical (refrigerant) continuously into the filter influent over an interval sufficient to ensure the effluent monitor is capable of

accurately measuring the required leakage level.

2.5.4.3 Dimethylmethylphosphonate (DMMP) Breakthrough Life Test

****
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.
****

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 will be randomly selected by the Contracting Officer from the lot. The number of cells required for DMMP testing is 10 percent, 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. Hard-mount each test cell to a rough handling machine in its service orientation and vibrate 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, DMMP breakthrough life test the cells 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, reject the lot. Adjust the filling procedure and submit another lot for DMMP breakthrough life test. Just prior to running the DMMP test, measure and record airflow resistance data for the sample cell and the airflow resistance calculated at standard conditions as indicated. Install cell in the test tunnel in its service orientation. Adjust airflow to [236 L/s 500 SCFM +/- 5 percent] [472 L/s 1,000 SCFM +/- 5 percent]. Run the test to cell life. Test the cell 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 must be as indicated. While the challenge concentration is permitted to vary within the stated range during the course of the test, normalize the breakthrough time measured to the 5000 mg/m3 1050 ppm concentration by the following calculation:

b. Corrected breakthrough time = Measured breakthrough time x Average concentration during test x 5000 mg/m3 1050 ppm.

c. The DMMP vapor in air challenge concentration must be created to ensure uniform mixing of the DMMP vapor with the air once it reaches

the test cell. Have qualification testing to verify the DMMP vapor concentration is uniform across the cell face on file and available for inspection. Operate the test tunnel at the rated flow. Challenge the inlet face of the cell as specified above. Record the total time from the start of the cell challenge until the breakthrough concentration is reached (i.e. the life of the cell) as the breakthrough time. This testing will 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)

2.5.4.4 Moisture Content/Cyanogen Chloride (CK) Gas Life Sampling

Obtain a minimum 0.45 kg one pound specimen of carbon during filling of the first cell, the middle cell, and the last cell of the day. Place each carbon specimen in an open container or in a cloth bag and accompany its cell through the assembly line. Do not expose the specimen to refrigerant. Label the carbon specimen to match it to its adsorber cell. Upon completion of the lot, choose a sample from the specimens in each quarter of the lot. Ship these 4 samples for testing by the Government at the location indicated above.

2.5.4.5 Moisture Content

Sample carbon as indicated and moisture content of each carbon adsorbing cell cannot exceed 3 percent by weight when tested. Determine the moisture content of the carbon samples in accordance with ASTM D2867, except the oven temperature is 103 to 107 degrees C 217 to 225 degrees F and the drying time is 3 hours. Should any sample fail to meet the moisture requirements, remove 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 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.

2.5.4.6 CK Gas Life Test

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

2.5.5 Gasket Seal

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

2.5.6 Fluid Seal

****

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

****

Provide filtration element frames having an integral channel filled with a fluid seal. The fluid seal must engage a continuous knife-edge on the housing mounting frame. The fluid seal must 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. Seal the channel before the fluid seal is placed into the channel. The fluid seal cannot pull out of the groove or leave a residue on the housing mounting frame knife-edge.

2.6 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. Provide the bag with 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. Test the bag at the factory to ensure it has no leaks. Provide an additional quantity of [one complete set of] [_____] spare bags to the Contracting Officer. Provide one complete banding kit with each filtration unit equipped with a bag-in/bag-out assembly. The banding kit must provide a secure clamping off of the bag between the housing and the spent filtration element. Provide with each kit a banding tool, a bag-cutting tool, and two sets of plastic ties, stainless steel bands, and replacement bags. Also provide additional tools required to complete the bag-in/bag-out procedure.

2.7 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. Construct

the test sections 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 AG-1. The pressure drop across each test section must 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. Furnish the test section with swing-away mixing devices. Provide injection and sample ports and apparatus to form an integral part of the test section.

2.8 IN-PLACE TEST PORTS

****

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. Provide a 13 mm 1/2 inch NPT Type 304 stainless steel coupling with plug test port, 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. Locate upstream inlet and sample port and downstream sample port to provide uniform mixing during field-testing as required by ASME N509 and ASME AG-1.]

2.9 WEATHER COVER

Protect filtration systems located in unsheltered areas by using an integral weather cover. Construct the weather cover of the same material as the filter housing and mechanically fasten,including gasket, to the filter housing.

2.10 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. [Provide an individual damper to isolate the filtration system.] [Provide multiple dampers to isolate individual sections of the filtration system.] Classify, construct, inspect, and test dampers 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 must conform to ASME AG-1, Section DA, Class [0, zero leakage] [1, low leakage]. Construct the blade/disk, frame, shafts, and linkages of Type 304 stainless steel. Provide the dampers with Type 304 stainless steel disk with a [butyl rubber] [EPDM] gasket. The isolation damper disk gasket (seal) and shaft seal must be replaceable. Operate each isolation damper by an independent electrically-actuated drive mechanism [with

manual backup]. Provide isolation dampers of all welded design. [Factory drill in isolation damper flanges 11 mm 7/16 inch holes, located on the filtration unit [as indicated] and no more than 100 mm 4 inches apart as described in DOE HDBK-1169]. Reinforce the flanges with flat stock of the same material to provide a combined minimum thickness of 6 mm 1/4 inch.

2.10.1 Electrically and Manually Actuated Isolation Damper Operators

Operate damper operators in an automatic mode [with manual backup]. Provide an electric/manual operator 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 is 11.3 kg 25 pounds. Provide controls as specified in [Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] [Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS].

2.10.2 Fan Unit

Provide fans, airflow control dampers, and actuators as specified in Section 23 30 00 HVAC AIR DISTRIBUTION. Provide single-inlet, centrifugal type fans, with the fan [inlet] [outlet] connected to the filtration unit with a flexible duct connector and duct transition to the filtration unit housing. Control the fan by [a manually] [an automatic electrically] actuated, [inlet vortex] [outlet opposed blade] damper suitable for the specified static pressure.

2.10.3 Flexible Duct Connectors

Provide a flexible duct connector approximately 152 mm 6 inches in width where sheet metal connections are made to the fan unit. Lock the flexible material, chemically resistant butyl rubber, to metal collars and install using normal duct construction methods. The flexible material must withstand the indicated system pressures. Provide composite connector system in compliance with NFPA 701 and classified as flame-retarded fabrics in UL 723.

2.11 DUCTWORK AND DUCT TRANSITIONS

Provide ductwork and duct transitions of stainless steel, and as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.12 THERMAL INSULATION

Provide thermal insulation for ductwork and equipment as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.13 PRESSURE GAUGE

Provide dial type pressure gauges, diaphragm operated, with two pressure relay switches for low and high limit relay control. Incorporate adjustable switch point indicators for continuous indication of switch settings into the gauges. Provide gauges for roughing filter, pre-filter, HEPA filter banks, post filter, and total filter system pressure drop. Provide gauges that are at least 98 mm 3-7/8 inches in diameter, have white dials with black figures with graduations, and a minimum range of 250 Pa 1 inch wg beyond the specified final resistance for the individual filter served. Incorporate a screw operated zero adjustment into each

gauge and furnish complete with stainless steel compression fittings and tubing. Mount all hardware in one location and test at the factory. All gauges must have a dual dial scale readout in units of pascals and inches water gauge.

2.14 PRESSURE PORTS

****

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

****

Locate static pressure ports on the filtration unit upstream and downstream of each roughing filter, pre-filter, HEPA filter bank, and post filter. Use 6 mm 1/4 inch 300 series stainless steel pipe nipples and caps for port connections.

PART 3 EXECUTION

3.1 INSTALLATION AND ERECTION

Install and erect CBR Air filtration systems 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. Include in the drawings a table and/or schematic identifying outline or significant interface dimensions and any information required to demonstrate that the system has been coordinated and properly functions as a unit, and shows equipment relationship to other parts of the work, including clearances required for operation and maintenance.

3.2 ACCEPTANCE TESTS

Conduct all acceptance tests in accordance with the procedures in ASME AG-1 and as required by MIL-PRF-32016.

a. 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.

b. 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. Document, in the report, 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 AG-1.

3.2.2 Airflow Capacity and Distribution Test

Measure the airflow across each filtration element bank to verify that it meets the designed flow rate under actual field conditions. Also verify that the airflow is distributed evenly across each filtration element bank as required by ASME AG-1 which is +/- 20 percent of the average airflow through each filter bank. Perform all tests in accordance with ASME AG-1.

3.2.3 Air-Aerosol Mixing Uniformity Test

Introduce a challenge gas into the air system to verify that it has uniformly mixed before entering the filtration element bank. Follow and comply with the test procedure in ASME AG-1.

3.2.4 Damper Operation and Leakage Test

Test the damper to verify that it operates as specified. Measure and record the air leakage rate through the isolation dampers. Functionally test the damper as required in ASME AG-1. [Apply the pressure decay or bubble test method leakage test for Class 0 dampers as specified in ASME AG-1.] [Perform the leakage test for Class 1 dampers in accordance with ASME AG-1.]

3.2.5 System Bypass Test (Filter and Adsorber Mounting Frame)

Remove and replace the filtration elements at each [HEPA] [HEPA and Carbon Adsorber] mounting frame housing location with a test blank. Test the filtration element housing and housing seal in accordance with ASME AG-1. Measure and record the air that bypasses the test blank as an air leakage rate, repair by seal welding and retest. Caulking or other temporary sealing measures are not allowed. The acceptable leakage rate is zero percent. After testing is completed, remove the blank and reinstall the filtration elements. Turn over the test blank 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. Provide training for a period of [_____] hours of normal working time. Starttraining after the system is functionally complete but prior to the performance tests. The field instruction must cover all of the items contained in the approved Operating and Maintenance Instructions and the Filtration Unit Manuals.

Submit [6] [_____] manuals in [hard copy form] [in electronic form (PDF) on DVD] listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals must 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 must 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, field test the filtration system for leaks using a mechanical test method. Also test the system for leaks between the filter element and its housing. Perform testing after installation by an independent testing agency in accordance with ASME AG-1. Submit testing agency certification prior to in-place filtration element testing in accordance with ASME NQA-1 or provide documentation demonstrating previous experience with similar systems as approved by the Contracting Officer. [Challenge the carbon adsorber system housing and carbon adsorber 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 must be less than 0.03 percent.]

-- End of Section --