

**SECTION 23 40 00  
HVAC AIR CLEANING DEVICES**

SPEC WRITER NOTES:

1. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. Provide the year of latest edition to each publication given in paragraph APPLICABLE PUBLICATIONS.

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Air filters for heating, ventilating and air conditioning.
- C. Definitions: Refer to ASHRAE 52.2 for definitions of face velocity, net effective filtering area, media velocity, initial resistance (pressure drop), MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency), particle size ranges for each MERV number, dust holding capacity and explanation of electrostatic media based filtration products versus mechanical filtration products. Refer to ASHRAE 52.2 for definition of MERV-A.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. Section 23 37 00, AIR OUTLETS AND INLETS.
- G. //Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS//
- H. //Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.//

**1.3 APPLICABLE PUBLICATIONS**

SPEC WRITER NOTES:

1. Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project unless the reference applies to all HVAC systems. Publications that apply

to all HVAC systems may not be specifically referenced in the body of the specification but shall form a part of this specification.

2. Insert the year of approved latest edition of the publications between the brackets // // and delete the brackets if applicable to this project.
- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only. Where conflicts occur these specifications and the VHA standards will govern.
  - B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):  
850-//2013//.....Performance Rating of Commercial and Industrial  
Air Filter Equipment
  - C. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):  
52.2-//2017//.....Method of Testing General Ventilation Air  
Cleaning Devices for Removal Efficiency by  
Particle Size  
170-//2021//.....Ventilation of Health Care Facilities
  - D. American Society of Mechanical Engineers (ASME):  
ASME Boiler and Pressure Vessel Code -  
BPVC Section IX-//2021// Welding, Brazing, and Fusing  
Qualifications
  - E. American Welding Society (AWS):  
D9.1/D9.1M-//2018//.....Sheet Metal Welding Code
  - F. International Organization for Standardization (ISO):  
9001-//2015(R2021)//.....Quality Management Systems - Requirements
  - G. Underwriters Laboratories, Inc. (UL):  
586-//2009(R2017)//.....Standard for High-Efficiency, Particulate, Air  
Filter Units  
900-//2015//.....Standard for Air Filter Units

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 XX XX, SECTION TITLE", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Extended surface filters.
  - 2. Holding frames. Identify locations.
  - 3. Side access housings. Identify locations, verify insulated doors.
  - 4. HEPA filters.
  - 5. Magnehelic gauges.
  - 6. //Carbon Filters.//
- D. Air Filter performance reports.
- E. Suppliers warranty.

SPEC WRITER NOTE: O&M Manuals shall be submitted for content review as part of closeout documents.

- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.

**1.5 QUALITY ASSURANCE**

SPEC WRITER NOTE: Discuss the filter test age with manufacturers and revise it if different from the age stated in the following paragraph. However, the filter test age should not be more than 5 years old.

- A. Air Filter Performance Report for Extended Surface Filters:
  - 1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE 52.2 for type filter under test and acceptable to COR, indicating that filters comply with the requirements of this specification. Filters utilizing partial or complete synthetic media will be tested

in compliance with pre-conditioning steps as stated in ASHRAE 52.2. All testing is to be conducted on filters with a nominal 610 mm by 610 mm (24 inch by 24 inch) face dimension. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.

SPEC WRITER NOTE: Witness testing may be required by the COR on clean room systems and bag-in bag-out systems.

2. //Government Option: The Government at its option may take one of the filters for each different type submitted and run an independent test to determine if the filter meets the requirements of this specification. When the filter meets the requirements, the Government will pay for the test. When the filter does not meet the specification requirements, the manufacturer will be required to pay for the test and replace the filters with filters that will perform as required by the specifications.//
  3. //Guarantee Performance: The manufacturer shall supply ASHRAE 52.2 test reports on each filter type submitted. Any filter supplied will be required to maintain the minimum efficiency shown on the ASHRAE 52.2 report throughout the time the filter is in service. Within the first 6 to 12 weeks of service a filter may be pulled out of service and sent to an independent laboratory for ASHRAE 52.2 testing for initial efficiency only. If this filter fails to meet the minimum level of efficiency shown in the previously submitted reports, the filter manufacturer/distributor shall take back all filters and refund the owner all monies paid for the filters, cost of installation, cost of freight and cost of testing.
- B. Filter Warranty for Extended Surface Filters: Guarantee the filters against leakage, blow-outs, and other deficiencies during their normal useful life, up to the time that the filter reaches the final pressure drop. Defective filters shall be replaced at no additional cost or time to the Government.
- C. Comply with UL 900 for flame test.
- D. Nameplates: Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency//, UL classification// //, and file number//.

- E. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.
- F. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

**1.6 AS-BUILT DOCUMENTATION**

- A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**PART 2 - PRODUCTS**

SPEC WRITER NOTES:

1. The VA Master Specifications do not match with the minimum filtration requirements outlined in ASHRAE 170. The filtration requirements outlined in this section shall govern.
2. Refer to filter schedules on contract drawings for filter size.

**2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED**

- A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01 00 00, GENERAL REQUIREMENTS. Provide one complete set of additional filters to the COR.
- B. The COR will direct whether these additional filters will either be installed as replacements for dirty units or turned over to VA for future use as replacements.

**2.2 EXTENDED SURFACE AIR FILTERS**

- A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the contaminant load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL listed and approved conforming to UL 900.
- C. HVAC Filter Types:

HVAC Filter Types				
MERV Value		Application	Particle Size	Thickness /Type

ASHRAE 52.2				
8		Pre-Filter	3 to 10 Microns	50 mm (2 inch) Throwaway
11		After-Filter	1 to 3 Microns	152 mm (6 inch) or 305 mm (12 inch) Rigid Cartridge
13		(Alternate) After-Filter	0.3 to 1 Microns	152 mm (6 inch) or 305 mm (12 inch) Rigid Cartridge
14		After-Filter	0.3 to 1 Microns	152 mm (6 inch) or 305 mm (12 inch) Rigid Cartridge

## D. HEPA Filters:

HEPA Filters				
Efficiency at 0.3 Micron	Application	Initial Resistance (inches WG)	Rated cfm	Construction
99.97	Final Filter	1.35	1100	Galvanized Frame X-Body
99.97	Final Filter	1.00	2000	Aluminum Frame V- Bank

**2.3 MEDIUM EFFICIENCY PLEATED PANEL PRE-FILTERS (50 MM (2 INCH) ; MERV 8 ; UL 900 CLASS 2)**

- A. Construction: Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic or 100 percent virgin synthetic media, self-supporting media with required media stabilizers, and beverage board enclosing frame. Filter media shall be lofted to a uniform depth and formed into a uniform radial pleat. The media stabilizers shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.
- B. Performance: The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE 52.2. The media shall maintain or increase in efficiency over the life of the filter. All testing is to be conducted on filters with a nominal 610 mm by 610 mm (24 inch by 24 inch) face dimension.

Minimum Efficiency Reporting (MERV)	8
Dust Holding Capacity (Grams)	105
Nominal Size (Inches Width x Height x Depth)	24x24x2
Rated Air Flow Capacity (cfm)	2,000
Rated Air Flow Rate (fpm)	500
Final Resistance (Inches WG)	1.0
Maximum Recommended Change-Out Resistance (Inches WG)	0.66
Rated Initial Resistance (Inches WG)	0.33

- C. The filters shall be approved and listed by Underwriters Laboratories, Inc. as Class 2 when tested according to UL 900.

**2.4 HIGH EFFICIENCY EXTENDED SURFACE (INTERMEDIATE/AFTER (FINAL)) CARTRIDGE FILTERS (305 MM (12 INCH); MERV 14/13/11; UL 900 CLASS 2)**

- A. Construction: Air filters shall consist of 8 pleated media packs assembled into 4 V-banks within a totally plastic frame. The filters shall be capable of operating at temperatures up to 80 degrees C (176 degrees F). The filters shall either fit without modification or be adaptable to the existing holding frames. The molded end panels are to be made of high impact polystyrene plastic. The center support members shall be made of ABS plastic. No metal components are to be used.
- B. Media: The media shall be made of micro glass fibers with a water repellent binder. The media shall be a dual density construction, with coarser fibers on the air entering side and finer fibers on the air leaving side. The media shall be pleated using separators made of continuous beads of low profile thermoplastic material. The media packs shall be bonded to the structural support members at all points of contact, this improves the rigidity as well as eliminates potential air bypass in the filter.
- C. Performance: Filters of the size, air flow capacity and nominal efficiency (MERV) shall meet the following rated performance specifications based on the ASHRAE 52.2 test method. All testing is to be conducted on filters with a nominal 610 mm by 610 mm (24 inch by 24 inch) header dimension.

Minimum Efficiency Reporting Value (MERV)	14	13	11
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Gross Media Area (sf)	197	197	197
Dust Holding Capacity (Grams)	486	430	465
Nominal Size (Inches Width x Height x Depth)	24x24x12	24x24x12	24x24x12
Rated Air Flow Capacity (cfm)	2,000	2,000	2,000
Rated Air Flow Rate (fpm)	500	500	500
Final Resistance (Inches WG)	2.0	2.0	2.0
Maximum Recommended Change-Out Resistance (Inches WG)	0.74	0.68	0.54
Rated Initial Resistance (Inches WG)	0.37	0.34	0.27

**2.5 HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS STANDARD CAPACITY (FINAL FILTER APPLICATION)**

- A. Air filters shall be HEPA grade standard capacity air filters with waterproof micro glass fiber media, corrugated aluminum separators, urethane sealant, 1.6 mm (16 gauge) steel enclosing frame and fluid sealing gasket. Sizes shall be as noted on enclosed drawings or other supporting materials.
- B. Construction: Filter media shall be one continuous pleating of microfine glass fiber media. Pleats shall be uniformly separated by corrugated aluminum separators incorporating a hemmed edge to prevent damage to the media. The media pack shall be potted into the enclosing frame with a fire-retardant urethane sealant. The enclosing frame shall be of 1.6 mm (16 gauge) steel, with a zinc aluminum alloy finish, and shall be bonded to the media pack to form a rugged and durable enclosure. The filter shall be assembled without the use of fasteners to ensure no frame penetrations. Overall dimensional tolerance shall be correct within -3.2 mm (-1/8 inch), +0 mm (+0 inch), and square within 3.2 mm (1/8 inch). A poured-in-place seamless sealing gasket shall be included on the downstream side of the enclosing frame to form a positive seal upon installation.
- C. Performance: The filter shall have a tested efficiency of 99.97 percent when evaluated according to IEST Recommended Practice. Initial resistance to airflow shall not exceed 250 Pa (1 inch WG) at rated capacity. Filter shall be listed by Underwriters Laboratories as UL 900. The filter shall be capable of withstanding 2500 Pa (10 inches WG) without failure of the media pack. Manufacturer shall provide evidence of facility certification to ISO 9001.



HEPA Performance (Standard Capacity)		
Nominal Size (Inches Height x Width x Depth)	Airflow Capacity (cfm)	Media Area (sf)
24x24x12	1080 at 1 Inch WG	153
24x12x12	500 at 1 Inch WG	33
Follow manufacturer's recommendation for change out resistance, typically double the initial.		

- D. Supporting Data: The filter shall be labeled as to tested efficiency, rated/tested cfm, pressure drop and shall be serialized for identification. The manufacturer shall supply a Certificate of Conformance for each HEPA filter supplied to the facility.

## **2.6 HEPA FILTERS HIGH CAPACITY V-BANK HIGH CAPACITY FILTERS (FINAL FILTER APPLICATION)**

- A. Air filters shall be absolute grade HEPA filters consisting of pleated media packs assembled in a V-bank configuration, polyurethane sealant, anodized aluminum enclosure and seamless fluid sealing gasket. Sizes shall be as noted on enclosed drawings or other supporting materials.
- B. Construction: Filter media shall be micro fiber glass formed into mini-pleat pleat-in-pleat V-bank design. The media packs shall be potted into the enclosing frame with fire retardant polyurethane sealant. An enclosing frame of anodized extruded aluminum shall form a rugged and durable enclosure. A seamless sealing gasket shall be included on the downstream side of the filter to form a positive seal upon installation.
- C. Performance: Filter efficiency at 0.3 micron shall be 99.99 percent when evaluated according to the IEST Recommended Practice for applicable type. Each filter shall be labeled as to tested performance. Initial resistance target shall not exceed 250 Pa (1 inch WG) at rated airflow.

HEPA Performance V-Bank Style (High Capacity)		
Nominal Size (Inches Height x Width x Depth)	Airflow Capacity (cfm)	Media Area (sf)
24x24x12	2000 at 1 Inch WG	390
24x12x12	900 at 1 Inch WG	174
Follow manufacturer's recommendation for change out resistance, typically double the initial.		

- D. Supporting Data: The filter shall be labeled as to tested efficiency, rated/tested cfm, pressure drop and shall be serialized for identification. The manufacturer shall supply a Certificate of Conformance for each HEPA filter supplied to the facility.
- E. Filter shall be listed as UL 586 and UL 900 per Underwriters Laboratories. Manufacturer shall provide evidence of facility certification to ISO 9001.

## 2.7 FILTER HOUSINGS/SUPPORT FRAMES

### SPEC WRITER NOTES:

1. Usually, one of the following filter support systems (side servicing or holding frame type) will be omitted. Holding frames are for large systems and are less common than the smaller side access housings.
2. Where final filters are down stream of fan, filter housing shall be designed to withstand the maximum static pressure at filter location which may be higher than the 1 kPa (4 inches WG) noted below. Increase static pressure as required to suit actual conditions. Show filter housing on the contract drawings (specifically note if access is required on both sides).

### A. Side Servicing Housings (HVAC Grade):

1. Filter housing shall be two-stage filter system consisting of 1.6 mm (16 gauge) galvanized steel enclosure, aluminum filter mounting track, universal filter holding frame, insulated dual-access doors, static pressure tap, filter gaskets and seals. Inline housing depth shall not exceed 533 mm (21 inches). Sizes shall be as noted on enclosed drawings or other supporting materials.
2. Construction: The housing shall be constructed of 1.6 mm (16 gauge) galvanized steel with pre-drilled standing flanges to facilitate attachment to other system components. Corner posts of Z-channel construction shall ensure dimensional adherence. //Where installed outdoors, the housing shall be weatherproof and suitable for rooftop/outdoor installation.// The housing shall incorporate the capability of two stages of filtration without modification to the housing. A filter track, of aluminum construction shall be an integral component of housing construction. The track shall accommodate a 50 mm (2 inch) deep prefilter, a 152 mm (6 inch) or 305 mm (12 inch) deep rigid final filter, or a pocket filter with

header. Insulated dual access doors, swing-open type, shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star-style knobs and replaceable door hinges. A universal holding frame constructed of 1.3 mm (18 gauge) galvanized steel, equipped with centering dimples, multiple fastener lances, and polyurethane filter sealing gasket, shall be included to facilitate installation of high-efficiency filters. The housing shall include a pneumatic pressure fitting to allow the installation of a static pressure gauge to evaluate pressure drop across a single filter or any combination of installed filters.

3. Performance: Leakage at rated airflow, upstream to downstream of filter, holding frame, and slide mechanism shall be less than 1 percent at 750 Pa (3 inches WG). Leakage in to or out of the housing shall be less than one half of 1 percent at 750 Pa (3 inches WG). Accuracy of pneumatic pressure fitting, when to evaluate a single-stage, or multiple filter stages, shall be accurate within  $\pm 3$  percent at 150 Pa (0.6 inch WG).
4. Manufacturer shall provide evidence of facility certification to ISO 9001.

SPEC WRITER NOTE: The use of holding frames is prohibited except in special applications (suitable for MERV 8 filters only).

B. //Holding Frame System (HVAC Grade):

1. Air filter-holding frames shall be 1.6 mm (16 gauge) galvanized steel with filter sealing flange, centering dimples, sealing gasket and lances for appropriate air filter fasteners. Sizes shall be as noted on enclosed drawings or other supporting materials.
2. Construction: Filter holding frame shall be constructed of 1.6 mm (16 gauge) galvanized steel. The frame shall be assembled from two corner sections and welded to assure a rigid and durable frame assembly. The frame shall include a variety of pre-punched lances for filter fastener attachment. Fastener shall be capable of being installed without the use of tools, nuts or bolts. Lance penetrations shall be upstream of filter flange to assure leak-free integrity. The frame shall include filter-centering dimples on each frame wall to facilitate ease of filter installation and assure filter centering against filter sealing flange. A 19 mm (3/4 inch)

filter-sealing flange shall be an integral component of the holding frame. All corners shall be flush mitered and a permanently mounted polyurethane foam gasket shall be mounted on the sealing flange to assure filter to frame sealing integrity.

3. Manufacturer shall provide evidence of facility certification to ISO 9001.//

C. Side-Access Housing (HEPA Grade):

1. Filter housing shall be two-stage filter system consisting of 1.9 mm (14 gauge) galvanized steel enclosure, spring-loaded crank-type sealing assembly for gasket seal type final filters, insulated dual-access doors with gasketing and positive sealing doorknobs. Inline housing depth shall not exceed 635 mm (25 inches). Sizes shall be as noted on enclosed drawings or other supporting materials.
2. Construction: The housing shall be constructed of 1.9 mm (14 gauge) galvanized steel with mating flanges to facilitate attachment to other system components. All pressure boundaries shall be of all welded construction. The housing shall be weatherproof and suitable for rooftop/outdoor installation. A prefilter track to accommodate nominal 50 mm (2 inch) deep prefilters, shall be an integral component of the housing. The housing shall incorporate a spring-loaded crank-type final filter sealing mechanism. The mechanism shall be geared to exert 700 pounds of pressure against each filter. The clamping frame shall have a continuous flat surface seal to compress all four downstream gasketed surfaces of the downstream seal filter. The final filter locking mechanism shall include a 19 mm (3/4 inch) socket adapter to facilitate opening or closing the mechanism. Insulated dual access doors shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable UV-resistant positive sealing knobs. The access doors shall be both hinged for swing open operation or designed to be completely removable. The housing shall include static pressure ports 3.2 mm (1/8 inch NPT male) to facilitate pressure drop measurements across prefilter, final filter, or combination thereof.
3. Performance: Manufacturer shall provide evidence of facility certification to ISO 9001.

D. Built-Up Bank HEPA Holding Frames:

1. Holding frames shall be constructed of 1.9 mm (14 guage) galvanized steel. Frames shall be welded and include centering dimples, pre-drilled mounting holes, filter sealing flange and swing bolt assemblies. An appropriate number of swing bolts to match air filters shall also be included. Sizes shall be as noted on enclosed drawings or other supporting materials.
2. Construction: Filter frame shall be all-welded construction of 1.9 mm (14 guage) galvanized steel. The frame shall include pre-drilled mounting holes to align frame-to-frame and ensure built-up bank support. Annular based centering dimples shall be an integral component to assist in proper seating of filter gasket to filter sealing flange. Assembly holes shall be within dimples to recess assembly bolts. Filter securing swing bolt assemblies, of the same construction as the frame, shall be offset to facilitate multiple filter installations. The assembly shall include appropriate swing bolts to match filter depth and equi-bearing clamps to allow uniform filter gasket sealing.
3. Performance: The sealing assembly shall be capable of sealing each element with 1680 mm/kg (30 inch/lbs.) of torque to 50 percent filter gasket compression. Manufacturer shall provide evidence of facility certification to ISO 9001.

E. Bag-In/Bag-Out HEPA Air Filter Housing:

1. Housing shall be side-access bag-in/bag-out, fluid seal housing. The housing shall be adequately reinforced to withstand a negative or positive pressure of 3736 Pa (15 inches WG). Housing design and filter arrangement shall allow air to enter and exit housing without changing direction. The housing shall accommodate standard size filters that do not require any special attachments or devices to function properly in the housing. The housing shall accommodate fluid seal filters which require a penetrating knife edge installed on all filter sealing surfaces. The knife edge shall insert into the fluid filled perimeter channel located on the face of the filter. By engaging the filter seal/release mechanism the filter shall move (push) the fluid filled channel to the sealed position. For removal of the air filters the filter seal/release mechanism shall remove (pull) the filter free of the blade type knife edge. This entire process is performed from inside the filter change out bag.
2. Construction:

- a. Housing shall be constructed of 1.9 mm (14 gauge) and 3.2 mm (11 gauge) T-304 stainless-steel metal. All pressure retaining joints and seams shall be continuously welded with no porosities. Joints and seams requiring intermittent welds, such as reinforcement members, shall be intermittently welded. Housing shall be free of burrs and sharp edges. All weld joints and seams that are a portion of any gasket setting surface, and duct connection flanges, shall be ground smooth and flush with adjacent base metals. All welded joints and seams shall be wire brushed to remove heat discoloration. The housing shall be reinforced to withstand a positive or negative pressure of 3736 Pa (15 inches WG). The upstream and downstream ductwork connections shall have 38 mm (1-1/2 inch) outward-turned flanges.
  - b. The housing shall have a bagging ring around each filter access port that is sealed by a gasketed filter access door. The filter access door gasket shall be silicone and shall be replaceable, if necessary. The bagging ring shall have two (2) continuous formed raised ridges to secure the PVC change-out bag. The bagging ring shall be hemmed on the outer edge to prevent the change-out bag from tearing.
  - c. Ancillary hardware including filter seal/release mechanism, door handles, door studs and labels shall be 300 series stainless-steel. Filter access door knobs shall be cast aluminum and designed to prevent galling of threads.
  - d. One (1) PVC change-out bag shall be furnished with each filter access port. Change-out bags shall be 8-mil. thick with a yellow translucent, non-sticking, matte finish. It shall include a 6 mm (1/4 inch) diameter elastic shock cord hemmed into the opening of the bag so when stretched around the housing bagging ring flange, a secure fit is created. The bag shall include three (3) integral glove ports to assist in filter change-out. One (1) nylon security strap shall be included per filter access port to prevent the bag from sliding off the bagging flange during the change-out process. Design of components shall be such that all change-out operations shall be within the bag so there is a barrier between the worker and the filter at all times.
3. Performance: All welding procedures, welders, and welder operators shall be qualified in accordance with ASME BPVC Section IX. All

production welds shall be visually inspected by qualified personnel, incorporating the workmanship acceptance criteria described in AWS D9.1/D9.1M.

4. The filter housing shall be factory tested for filter fit, alignment of filter sealing knife edge and operation of filter clamping mechanism. The filter sealing surface shall be tested at +2500 Pa (+10 inches WG) and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume. The overall system pressure boundary shall be leak tested at +2500 Pa (+15 inches WG) and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume.
5. Filter bags shall be capable of continuous operating to temperature extremes of -18°C to 65°C (0°F to 150°F).
6. Multi-wide housing shall be equipped with a filter removal rod to pull the filters to the change-out position. The removal rod shall operate from the inside of the filter change out bag.
7. Manufacturer shall provide evidence of facility certification to ISO 9001.

F. Equipment Identification: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**2.8 //ACTIVATED CARBON PLEATED PANEL FILTERS**

SPEC WRITER NOTE: The following paragraphs are Molecular (Gas Phase) Filtration Products used for gas phase contaminant control.

A. Performance Characteristics:

1. Filters of the model designation, size and air flow capacity shall meet the following rated performance specifications based on the ASHRAE 52.2 test method. All testing is to be conducted on filters with a nominal 610 mm by 610 mm (24 inch by 24 inch) face dimension, at a filter face velocity of 500 FPM.

Model Designation	Model of Choice
Nominal Size (Inches Width x Height x Depth)	24x24x2
Rated Air Flow Capacity (cfm)	2,000
Final Resistance (Inch WG)	1.2"
Rated Initial Resistance (Inch WG)	0.75"
Rated Efficiency	MERV 7

2. The filters shall be approved and listed by Underwriters Laboratories, Inc. Class 2 when tested according to UL 900.

B. Physical Characteristics:

1. Each filter shall consist of 3-stages of media to collect both particulate and odor contaminants. The 3-stages of media shall be contained in a die cut frame, constructed of high wet strength, moisture resistant beverage board.
2. Filter Media to be constructed of a 3-stage media system:
  - a. Stage 1: Prefilter Layer - constructed of a high loft polyester media, minimum 19 mm (3/4 inch) thick, acting as a prefilter for particulate to extend the life of the carbon media.
  - b. Stage 2: Activated Carbon Layer - consists of a polyester substrate, impregnated with a high density of granular, 60 percent minimum activity-rated carbon. The amount of carbon per square foot of filter area shall be as follows:

Model Designation	Carbon Density (grams/sf filter face area)
Model of Choice	300

- c. Stage 3: Final Filter Layer - consists of an open cell, reticulated polyurethane foam media. The foam pad shall wrap around the edges of the carbon material, fully encasing the pad, to ensure no carbon granules are shed downstream.
- d. Carbon Activity: The carbon shall be granular with a 60 percent minimum activity rating on carbon tetrachloride adsorbate, tested at 25° C.
- e. Filter frame to consist of two die-cut pieces of clay coated beverage board, one for the air entering side and one for the air leaving side. Each piece of the two mating halves of the frame overlaps one another providing double ply frame sides. The inside of the filter frame shall be bonded to the media on both sides of the filter.
- f. An expanded metal grid shall be installed on the downstream side filters to provide additional strength and support to the filter.//

**2.9 //ACTIVATED CARBON EXTENDED SURFACE, HIGH EFFICIENCY GAS PHASE FILTERS**

- A. Performance Characteristics: Filters of the size and air flow capacity shall meet the following rated performance specifications.



Nominal Size (Inches Width x Height x Depth)	24x24x12	24x20x12	24x12x12
Rated Air Flow Capacity (cfm)	2,000	1,650	1,000
Rated Initial Resistance (Inch WG)	0.20	0.20	0.20
Media Area (sf)	67	55	30

- B. Physical Characteristics: Each filter shall consist of 8 pleated media packs assembled into 4 V-banks within a totally plastic frame. The filters shall be capable of operating at temperatures up to 54 degrees C (130 degrees F). The filters shall either fit without modification or be adaptable to the existing holding frames.
- C. Frame: The molded end panels are to be made of high impact polystyrene plastic. The center support members shall be made of ABS plastic. No metal components are to be used.
- D. Media: The media shall be a comprised of carbon particles bonded into a matrix of bi-component fibers. The bi-component fiber matrix maximizes the exposure of the sorbent to the gas while securely bonding it within the media. Media weight to be 500 grams/sm. Carbon to have an 85 percent CTC activity.
- E. Media Packs: The media shall be pleated into self-supporting pleat packs, without the use of pleat separators of any type.
- F. Media Pack Bond: The media packs shall be bonded to the structural support members at all points of contact, this improves the rigidity as well as eliminates potential air bypass in the filter.//

**2.10 //CHEMICAL MEDIA GAS-PHASE AIR CLEANING CASSETTES - HEAVY DUTY (HD) CASSETTE, MEDIUM DUTY (MD) CASSETTE, CLEANROOM GRADE (CG) CASSETTE**

- A. Performance Characteristics: The chemical filters shall be as described in the following table and shall have a pressure drop, under operating conditions, no greater than those shown.

	Heavy Duty (HD) Cassette	Medium Duty (MD) Cassette	Cleanroom Grade (CG) Cassette
Nominal Size (Inches Height x Width x Depth)	12x24x12	6x24x18	24x12x12
Chemical media capacity (cf)	1	0.5	0.7
Chemical media bed depth	3 Inch V-bank arrangement	1 Inch V-bank arrangement	1 Inch V-bank arrangement

Chemical Media Utilization Index	92% or higher	92% or higher	92% or higher
Rated airflow face velocity (fpm)	250	500	500

Pressure Drop			
	Heavy Duty (HD) Cassette	Medium Duty (MD) Cassette	Cleanroom Grade (CG) Cassette
Media Type	Inches WG @ 250 fpm face velocity	Inches WG @ 500 fpm face velocity	Inches WG @ 500 fpm face velocity
SAAF Oxidant Chemical Media	0.73	0.31	0.47
SAAF Carb Chemical Media	0.87	0.35	0.56
SAAF Blend Chemical Media	0.97	0.34	0.57

B. Physical Characteristics:

1. The cassette shall be formed completely from injection molded, recyclable (or incinerable), high-impact polystyrene (HIPS).
2. No glues or solvents shall be used in the manufacture of the cassette. The plastic components that form the cassette shall be connected together using internal high pressure, snap-lock connectors formed into the connecting components. No glues or solvents shall be allowed to be used in the construction of the cassette to prevent contamination of both the chemical media and the air-stream by off-gassing of VOCs.
3. All surfaces of the cassette should be true and offer external squareness. The cassette construction shall be of precision close tolerance construction having external dimensional and squareness tolerances of +/- 2 mm (+/- 0.08 inch).
4. Chemical media shall be supported between aerodynamically tapered screens with very low drag coefficient (for Energy Efficiency). Injection molded high-impact polystyrene screens shall form individual media beds assembled into a V-bank configuration.
5. Nose Cavities prohibited in cassettes. The inlet and outlet screens shall be parallel and the inlet and outlet face areas shall be equal to ensure equal and complete utilization of the chemical media. The screen openings shall have a maximum width of 2mm to ensure full retention of the chemical media and to eliminate downstream fouling.

6. The screens shall be structurally reinforced with molded plastic ribs to minimize deflection of the screen caused by the weight of the chemical media. The ribs shall span in both directions and shall be orthogonal to each other.
7. The inlet and outlet screens shall have a minimum thickness of 1.9 mm (0.07 inch).
8. A spacer shall be utilized at 152 mm (6 inches) intervals to accurately distance the two screens and maintain squareness and a constant bed depth after filling with chemical media.
9. The side plates of the cassette shall be completely flat and planar and without protrusions to ensure that adjacent cassettes mate accurately. All flanges shall be internal. No external flanges shall be used.
10. 25 mm (1 inch) wide gasket shall be mounted on each side plate to seal between adjacent cassettes. The accurate positioning of the gasket shall be determined by a scribed line formed into the side plate during molding. The gasket shall extend completely from the bottom to the top of the side plate and the edge of the gasket shall be contiguous with the face of the cassette. The gasket material shall be adhesive coated (with an acryl-based adhesive), semi-closed-cell EPDM foam and shall have a Durometer of 50-70. The material shall have good resistance to UV, humidity, high and low temperatures, and chemicals such as acids and alkalis, and fats and grease.
11. V-shaped butterfly gasket shall be located horizontally along the upper and lower edges of the air leaving, or sealing, face of the cassette when the cassette is oriented for horizontal airflow. Two 10 mm (3/8 inch) long, 0.5 mm (0.02 inch) thick, flexible "wings" shall be molded into a 16 mm (5/8 inch) wide, 1.5 mm (0.06 inch) thick, base. When the cassette is installed into the SAH, the wings of the Butterfly® gasket shall engage and envelope the tubular gasket that is installed in the extruded aluminum track providing a complete seal. The Butterfly® gasket shall be extruded polyurethane plastic.
12. No heavy metals (such as cadmium) nor regulated substances (such as CFC's and halogen gases) shall be used during the manufacturing process nor be contained in the product itself.

13. No silicone shall be used during the manufacturing process nor be contained in the product itself.
14. Cassette side plates shall not incorporate the cassette filling ports. Chemical media filling ports shall be located on the face of the cassette. The ports shall be covered and sealed using reinforced injection molded polypropylene covers. The covers shall be fixed to the cassette at a minimum of three locations, being each end and in the center, with high strength, two-component bayonet and receiver style screw-in plastic rivets. The bayonet shall be threaded and, when screwed into the receiver, shall cause the rivet to expand and form a tight connection. The rivet shall be removable to allow access to the media for sampling purposes. The head of the screw shall also completely plug the center of the rivet and prevent air leakage through the rivet. Thread cutting screws, or screws that thread into the wall of the cassette, shall not be allowed.
15. The sealing perimeter of the cassette face shall be completely planar with top, bottom and side flange faces being completely flush. No setbacks or gaps shall be allowed. The outer edges of the top and bottom flanges shall be completely flush with the top and bottom surfaces of the cassette.
16. The cassette shall include a precision molded slot positioned to accept a guide located on the surface of the support track. The slot and guide combination will ensure that the cassette is accurately positioned in the mounting track ensuring full contact and proper compression of the track mounted gasket.
17. The color of the cassette shall be black and the manufacturer's brand shall be permanently and clearly molded into each of the side plates. The brand shall be recessed into the side plate and shall not protrude from the side plate.//

#### **2.11 INSTRUMENTATION**

- A. Magnehelic Differential Pressure Filter Gauges: Nominal 100 mm (4 inch) diameter, 0 to 500 Pa (0 to 2 inches WG), 3 inch for HEPA range//, except for MERV 17 HEPA final filters, where the range shall be 0 to 750 Pa (0 to 3 inches WG)//. Gauges shall be flush-mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment.
- B. DDC Static (Differential) Air Pressure Measuring Station: Refer to Section 23 09 23, DIRECT DIGITAL CONTROL SYSTEM FOR HVAC.

- C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.
- D. Provide one common filter gauge for two-stage filter banks with isolation valves to allow differential pressure measurement.

#### **2.12 HVAC EQUIPMENT FACTORY FILTERS**

- A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.
- B. Cleanable filters are prohibited.
- C. Automatic roll type filters are prohibited.

#### **2.13 FILTER RETURN GRILLES**

- A. Refer to Section 23 37 00, AIR OUTLETS AND INLETS.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.
- B. Install supports, filters, and gauges in accordance with manufacturer's instructions.
- C. Label clearly with words "Contaminated Air" on exhaust ducts leading to the HEPA filter housing.

#### **3.2 STARTUP AND TESTING**

- A. Clean and vacuum air handling units and plenums prior to starting air handling systems.
- B. Replace pre-filters and install clean filter units prior to final inspection as directed by the COR.
- C. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- D. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- E. //The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.//

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